Assessing the Distribution and Abundance of the Western Pond Turtle (*Actinemys marmorata*) on Marine Corps Base Camp Pendleton, California in 2010

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AC/S Environmental Security
Marine Corps Base Camp Pendleton

U. S. DEPARTMENT OF THE INTERIOR
U. S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

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Assessing the Distribution and Abundance of the Western Pond Turtle (*Actinemys marmorata*) on Marine Corps Base Camp Pendleton, California in 2010

By: Sara L. Schuster and Robert N. Fisher

EXECUTIVE SUMMARY

The goal of this study was to understand the current status of the western pond turtle (*Actinemys marmorata*), hereafter referred to as the pond turtle, on Marine Corps Base Camp Pendleton. Marine Corps Base Camp Pendleton will hereafter be referred to as the Base. In order to assess the status of the pond turtle we evaluated the distribution, abundance and general health of the populations on the Base. In 2008, all water bodies and historic pond turtle sites were identified and evaluated through visual, habitat suitability, threat assessment, and trapping surveys. The 2010 surveys were a follow-up to the 2008 survey effort, to further evaluate pond turtle distribution and abundance base wide.

Fifteen sites were trapped at least two, five consecutive days trap sessions with the exception of Cristianitos Creek and O'Neill Lake. Our trapping effort included a total of 5,165 trap days or 41,316 trap hours. A combination of trapping, snorkeling, and seining surveys resulted in the capture of 340 pond turtles, 185 unique individuals at 12 sites. We detected breeding populations of pond turtles at six of the sites by detecting gravid females; Cristianitos Creek, Upper San Mateo Creek, Cockleburr Lagoon, Las Flores Lagoon, and the Upper and Lower Santa Margarita River. Successful recruitment is taking place at four of these sites Upper San Mateo Creek, Cockleburr Lagoon, and the Upper and Lower Santa Margarita River. It looks like successful recruitment might be taking place in Cristianitos Creek; we observed but were unable to capture a juvenile pond turtle. No recruitment was at the Las Flores Lagoon. We are uncertain about the breeding status at San Mateo Lagoon, Aliso Lagoon, and Horseshoe Reservoir.

1. INTRODUCTION

Due to the impacts of agriculture and urbanization, California leads the nation in aquatic habitat loss. In 1988, the California Department of Parks and Recreation reported that California lost a large proportion of historic aquatic habitat, approximately 95% of riparian wetland, 90% of freshwater marshes, and 90% of vernal pools (California Department of Parks and Recreation 1988). As is the case statewide, 90 to 95% of southern California riparian ecosystems have been eliminated (Faber et al. 1989) with much of the remaining aquatic and riparian habitat either degraded or human-made (Riley et al. 2005).

California's south coast ecoregion, the most populated ecoregion in the state, is one of the world's "hot-spots" of native biodiversity, home to many endemic species (Myers 1990, Wilson 1992). Over 400 species of plants and animals are considered "at risk" by government agencies and conservation groups (Hunter 2000). Many animal species are to some extent dependant on riparian habitats and have been impacted by the significant loss and degradation of these habitats. In fact, riparian habitats support 83% of the amphibian and 40% of the reptile species

in California (Brode and Bury 1984). Twenty-five percent of the plants and 55% of the animals designated as threatened or endangered by the State of California are dependant on riparian habitats for their survival (Ferren et al. 1996, Southern California Wetlands Recovery Project 2001).

In response to the need to protect and manage ecosystems and balance the loss of wildlife and habitat with human needs for development, the State of California enacted the Natural Communities Conservation Planning (NCCP) program in 1991 (California Department of Fish and Game 2008). The NCCP program is a cooperative effort through which state government establishes agreements with landowners, local governments, and other stakeholders to identify and protect the most important areas for threatened or endangered species, while allowing compatible development and economic activity (California Department of Fish and Game 2008, County of San Diego 2008). The federal government has a similar program under Section 10A of the Endangered Species Act (1973) which involves creating Habitat Conservation Plans (HCP) to protect individual species (County of San Diego 2008, U. S. Fish and Wildlife Service 2008b). Wildlife agencies in California have combined the NCCP and HCP processes (County of San Diego 2008). Ideally, this protection of threatened and endangered species will help slow extinction rates (Seabloom et al. 2002).

Containing the largest remaining expanse of undeveloped coastline and coastal habitat in southern California, the Base plays a major role in community conservation planning efforts. The primary mission for the Base is "to operate the finest amphibious base possible; to promote the combat readiness of Marines and Sailors by providing necessary facilities and services; to support the deployment of the Fleet Marine Force and other organizations; and to provide support and services responsive to the needs of the Marines, Sailors, retirees and families aboard Camp Pendleton" (MCB Camp Pendleton 2006). In addition, the Base continues to fulfill stewardship and regulatory requirements for the natural resources on base. These requirements include monitoring and management of many threatened and endangered species as described in the Integrated Natural Resources Management Plan (MCB Camp Pendleton 2007).

Many species that were once common throughout southern California now find an important refuge within the borders of the Base. This is true for the arroyo toad (*Anaxyrus californicus*) and the tidewater goby (*Eucyclogobius newberryi*) (Turschak et al. 2008, U. S. Fish and Wildlife Service 2008a) and may be true for the pond turtle. Once common throughout the coastal drainages of southern California, the pond turtle has suffered population declines in recent years. In 2008 and 2010, the Base contracted the United States Geological Survey (USGS) to conduct baseline assessment surveys for the pond turtle in order to determine current status and distribution on Marine Corps Base Camp Pendleton (Schuster and Fisher*, in review*). This data summary details the results and implications of these surveys.

1.1 The Western Pond Turtle

1.1.1 Description

The pond turtle is an elusive, drab-colored turtle of the Emydidae family. The carapace is relatively flat and olive-brown or blackish brown in color. A network of spots, lines, or dashes radiates from the center of each of the carapace shields, distinguishing the pond turtle from other

turtles (Figure 1). Occasionally, no pattern is visible and secondary characteristics are necessary for identification. Secondary characteristics include a network of black markings on the head and neck of the pond turtle and prominent scales on limbs that are flecked or lined in black (Stebbins 2003).

Figure 1. Representative photographs of an adult western pond turtle (*Actinemys marmorata*).

1.1.2 Natural History

A habitat generalist, the pond turtle inhabits a variety of water bodies ranging from permanent to intermittent and from freshwater to brackish environments (Holland 1991, 1994, Buskirk 2002). Pond turtles occupy creeks, slow moving rivers, marshes, ponds, lakes, reservoirs, vernal pools, canals, and even sewage treatment plants (Holland 1991, Ernst et al. 1994, Reese 1996, Stebbins 2003). Pond turtles prefer habitat with slow flowing water with emergent and underwater refugia (Reese 1996, Reese and Welsh 1998b, Buskirk 2002). The pond turtle spends the majority of their time in the aquatic habitat; however, the terrestrial habitat is equally important for reproduction, aestivation, and overwintering (Semlitsch and Jensen 2001). Female pond turtles leave aquatic habitat between May and July to lay eggs (Holland 1991, Jennings and Hayes 1994, Reese 1996, Reese and Welsh 1997, 1998b, Lovich and Meyer 2002, Rathbun et al. 2002).

Although it is clear that pond turtles require terrestrial habitat to meet life history requirements, the amount of time spent in upland areas and the distances traveled from water are poorly known in southern California. During the hottest times, aestivation likely takes place. In this case, pond turtles burrow under the mud or move into upland habitat and burrow under logs or vegetation to avoid the drying or dried aquatic habitat (Hayes et al. 1999). From October to April, the pond turtle will overwinter (Holland 1991). Due to the mild temperatures in southern California, the overwintering period usually lasts one to two months or weeks if it occurs at all (Holland 1994). Pond turtles also move into terrestrial habitat to avoid peak seasonal flows in the aquatic system that could move them significant distances downstream (Dagit et al. 2006), or even to the Pacific Ocean.

1.1.3 Status and Distribution

The pond turtle is the only freshwater turtle native to coastal California. Once common in most major coastal drainages, the pond turtle had a relatively continuous distribution from Washington to northern Baja California, with a few isolated populations elsewhere (Storer 1930, Ernst et al. 1994, Jennings and Hayes 1994, Stebbins 2003). In southern California, pond turtles were once widespread and common (Brattstrom 1988, Brattstrom and Messer 1988). Currently, the pond turtle is in a general state of decline throughout most of its range (Brattstrom and Messer 1988, Holland 1991, Gray 1995, Jennings and Hayes 1994, Janzen et al. 1997). Bury (*in press*) estimates that the pond turtle has declined over 95 to 99% of its range. In addition, Brattstrom and Messer (1988) suggest that only a few viable populations of pond turtles remain in southern California. Most sites occupied by the pond turtle are only occupied by a few individuals. Sites are typically adult and male dominated with little to no breeding or recruitment. Due to their decline in the southern portion of its range, the pond turtle is listed as a California state species of concern by the California Department of Fish and Game (CDFG).

In the 1990's, the pond turtle occupied most of the major drainages on the Base (Holland et al. *unpublished report*). Population estimates completed in 1996 and again in 1999 revealed a 16% base wide decline in pond turtle populations (Holland et al. *unpublished report*). This report is a follow-up to the 2008 effort by USGS to collect base wide distribution data on the species (Schuster and Fisher *in review*). This report represents the most recent data reported with regard to pond turtle populations on the Base.

1.1.4 Taxonomy and Genetics

The phylogenetic relationships of the pond turtle are unclear. Baird and Girard (1852) first described the pond turtle as *Emys marmorata* (Baird and Girard 1852). Since then, the genus has changed three times; from *Emys* to *Clemmys*, and finally to *Actinemys*. The genus *Emys* places the pond turtle in close relation to the European pond turtle (*Emys orbicularis*) and Blanding's turtle (*Emys blandingii*) (Bury and Germano 2008). *Clemmys* gives the pond turtle closer relatedness to the eastern North American turtles (i.e. the spotted turtle (*Clemmys guttata*), the wood turtle (*Clemmys insculpta*), and the bog turtle (*Clemmys muhlenbergii*)) (Bickham et al. 1996, Feldman and Parham 2001). Today, taxonomists do not believe the pond turtle is closely related to any extant species, and consequently, pond turtles are classified in their own genus, *Actinemys*. At present, *Actinemys* is widely accepted by the scientific community (Collins and Taggart 2002, Fritz and Havas 2007, Iverson et al. 2008).

In addition to genus changes, the pond turtle taxon has also been divided into subspecies, groups, and clades several times. First, Seeliger (1945) divided the pond turtle into two subspecies based on morphological differences: the northern Pacific pond turtle (*Clemmys marmorata marmorata*) and the southern Pacific pond turtle (*Clemmys marmorata pallida*). The northern subspecies ranged from Washington to the San Francisco Bay area of California, and the southern subspecies ranged from San Francisco, California to Baja California. In 1992, the pond turtle taxon was again divided into three distinct groups based on morphological characteristics; 1) a Columbia River form, 2) a northern form ranging from the Puget Sound, Washington to central California, and 3) a southern form ranging from the central coast of California south into Baja California (Holland 1992). More recently, Gray (1995) used DNA fingerprinting to understand differences within the pond turtle taxon and found low levels of genetic variation among several

populations and significant differences between the northern and southern pond turtle populations. Research by Spinks and Shaffer (2005) finds differences within the taxon and divides pond turtle populations into four unnamed clades; 1) a clade ranging from Washington to the central coast of California, 2) a clade ranging from the central coast of California to the Transverse Mountain Range (Ventura County, CA), 3) a clade ranging from the Transverse Mountains of southern California into Baja California, and 4) a clade found within the San Joaquin Valley of California. These findings are significant because southern California populations of the pond turtle are considered distinct from the populations north of Los Angeles County. Spinks and Shaffer (2005) state "our genetic results emphasize that southern California may be a repository of cryptic genetic diversity worthy of conservation attention". More research using fine scale genetics is necessary to truly understand the relationships within this taxon.

2. STUDY AREA

The Base occupies approximately 506 km^2 (125,000 acres) and contains 24 km (17 mi) of coastline within northern San Diego County, CA (Figure 2). The cities of San Clemente and Oceanside and Fallbrook border the Base to the northwest and south and east respectively. The Cleveland National Forest and the Pacific Ocean form the northern and western boundaries of the Base (Figure 2). The Base has a typical Mediterranean climate consisting of warm, dry summers and mild winters. Coastal fog is common and wind speeds range from eight to 24 km/hr (4–13 mi/hr) (Atkinson et al. 2002). As part of the Peninsular Ranges physiographic province of California, the Base is characterized by a narrow, sandy shoreline, seaside cliffs, coastal plains, low hills, canyons, and mountains rising to elevations of approximately 823 m (2,700 ft) (Naval Energy and Environmental Support Activity 1984). The base contains many sensitive aquatic habitat types including lagoons, creeks, and rivers that feed into the Pacific Ocean. Some of southern California's largest remaining lowland coastal habitats of coastal sage scrub, chaparral, grassland, and oak woodlands have a stronghold within the borders of the Base.

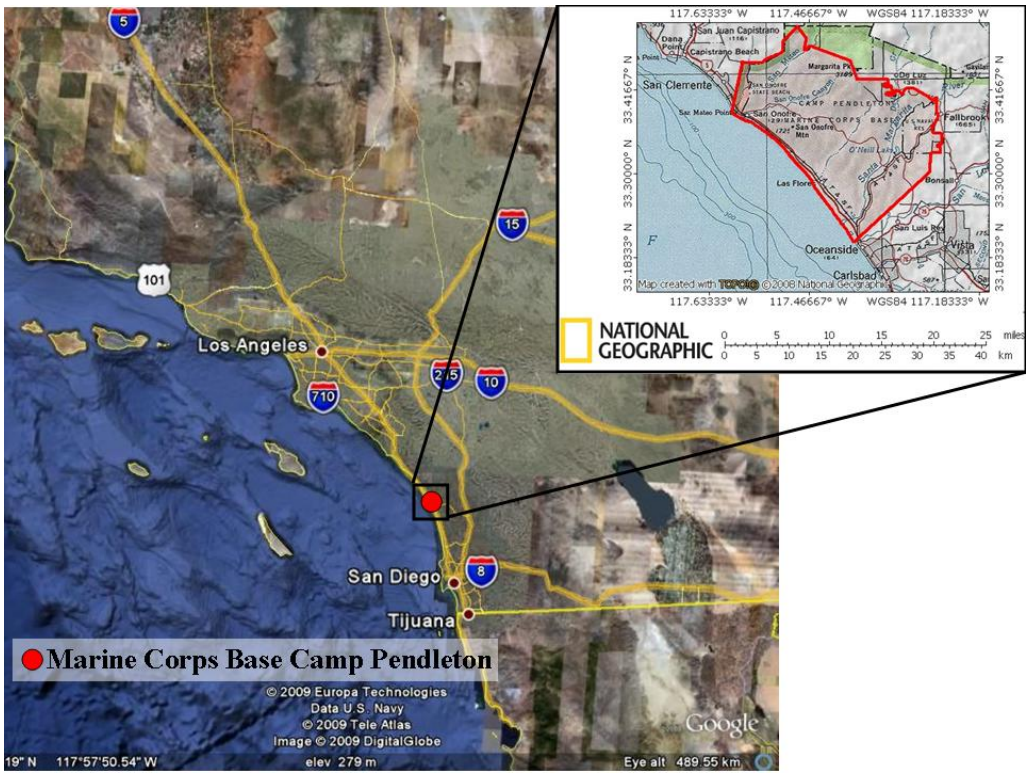


Figure 2. Location of Marine Corps Base Camp Pendleton in southern California.

3. GOALS AND OBJECTIVES

The goal of this project is to understand the status of the pond turtle on the Base by evaluating the distribution, abundance, and general health of the pond turtle populations. In order to achieve this goal, we established several objectives which are listed below.

1. Determine survey sites on the Base
2. Evaluate habitat suitability for the pond turtle through threat assessment surveys and visual surveys on the Base.
3. Determine pond turtle distribution on the Base.
4. Evaluate the general health, abundance, and reproduction of individual and populations of pond turtles on the Base.

4. METHODS

4.1 Site Selection

Based on the 2008 survey effort (Schuster and Fisher, *in review*), 16 sites were identified as potential pond turtle sites for 2009 - 2010. Of these 16 sites, 5 needed further evaluation to determine pond turtle suitability. The remaining 11 sites were occupied by pond turtles, but required further evaluation for their general health and status. We did not get approval to access the pond within the ammunition supply point (ASP Pond), so this site was not evaluated this

year. Two of the sites; San Mateo Creek and the Santa Margarita River were each broken into three sections due to their size (lower, middle, and upper) giving us a total of 20 sites.

4.2 Habitat Suitability

4.2.1 Threat Assessment Surveys

Pond turtles require pristine or minimally disturbed habitat in order to thrive. To assess site suitability for the pond turtle, we developed a list of habitat criteria to analyze and rank all potential habitat (Schuster et al. *unpublished report*). This habitat criteria tool was developed for the "Orange County Aquatics Management Plan – the Western Spadefoot (*Spea hammondii*) and the Western Pond Turtle (*Emys marmorata*) on the Irvine Ranch Land Reserve" (Appendix 1). A three step rating system was used to identify management issues associated with specific pond turtle populations, as well as to identify sites for enhancement or restoration activities. This tool evaluates pond turtle habitat base on these criteria; water depth, aquatic substrate, aquatic vegetation, aquatic refugia, hatchling habitat, basking sites, canopy cover, terrestrial habitat buffer, terrestrial refugia, and human access. The habitat criteria tool identifies potential threats (i.e. human access or non-native species) and ranks sites for habitat suitability. Sites were ranked with 0 – 21 points, and then categorized into *high* (greater than 89% of the points available), *moderate* (between 89 – 80% of the points available), *marginal* (between 79 – 70% of the points available), and *poor* (less than 69% of the points available).

4.2.2 Visual Surveys

Visual surveys were conducted on the Base to assess the habitat quality, detect pond turtle presence, and determine if sites were trappable. The visual surveys were conducted following the "Western Pond Turtle (*Emys marmorata)* Visual Survey Protocol for the Southcoast Ecoregion" (U. S. Geological Survey 2006b). Pond turtles, as habitat generalists, can occupy a wide range of aquatic habitats. For this reason, the most limiting factor of habitat suitability is the presence of water. Our first step in carrying out visual surveys was to determine if water was present. If water was present, we measured the depth to determine if the site could be trapped. The water depth must be greater than 0.75 m (2.5 ft) to accommodate traps.

During visual surveys, we slowly walked upstream or around the water body searching with binoculars, if necessary, for the presence of basking or foraging pond turtles. Pools were first observed from a distance, and then approached slowly and quietly to prevent disturbing any pond turtles. We recorded all aquatic species encountered. The data recorded included; species, age class, and Global Positioning System (GPS) coordinate. We also recorded water quality measurements such as temperature, pH, conductivity, dissolved oxygen saturation, transparency, and salinity (at the lagoons). Finally, we recorded a variety of habitat characteristics including, channel bankful width, flood prone width, entrenchment ratio, the presence of basking sites, canopy cover, upland community type, riparian community type, up to three dominant riparian plant species, percent submergent vegetation, percent emergent vegetation, dominant bank substrate and any invasive vegetation observed. If pond turtles were observed during the visual surveys, attempts were made to capture the individuals. If the capture was successful we followed the methods outlined in Section 4.4 General Health and Reproduction.

After determining potentially suitable pond turtle habitat, we utilized the "Western Pond Turtle (*Emys marmorata*) Trapping Survey Protocol for the Southcoast Ecoregion" (U. S. Geological Survey 2006a) to evaluate trap locations and set turtle traps.

4.3 Distribution and Abundance

4.3.1 Trapping Surveys

The "USGS Western Pond Turtle (*Emys marmorata*) Trapping Survey Protocol for the Southcoast Ecoregion" (U. S. Geological Survey 2006a) is based on Holland (1994), Reese (1996), Ashton et al. (2001), Bury et al. (2001), Lovich and Meyer (2002), and Rathbun et al. (2002). We deployed several types of commercial and handmade hoop traps. Figure 3 illustrates the different types of traps used for trapping surveys. Sizes of the traps are as follows; a) commercial round trap [diameter 0.75 m (2.5 ft), length 1.15 m (3.7 ft), and 4 cm by 4 cm (1.5 in by 1.5 in) mesh], b) commercial round trap [diameter 0.5 m (1.6 ft), length 1.3 m (4.2 ft), and 2.5 cm by 2.5 cm (1 in by 1 in) mesh], c) hand made round trap [diameter 0.5 m (1.6 ft), length 1 m (3.3 ft), and 4 cm by 4 cm (1.5 in by 1.5 in) mesh], and d) hand made oval trap [length 0.5 m (1.6 ft), width 0.7 m (2.3 ft), height 0.36 m (1.18 ft), and 1.5 cm by 1.5 cm (0.6 in by 0.6 in) mesh]. The trap consisted of either a single or double funnel. The funnel design creates a larger opening for entry of the trap, but a small opening at the back of the trap to exit, making it difficult for animals to escape the traps. Traps were baited with sardines packed in oil or mackerel. Punctures were made in the sardine cans; this releases the oils to attract the turtles while preventing the consumption of the bait. Sardine cans were then suspended at the back of the turtle trap. The mackerel, also suspended in the back of the turtle traps, was wrapped in recycled plastic hardware cloth to reduce consumption. In most cases, we placed traps near habitat features likely to be used by pond turtles, usually basking sites or aquatic refugia. In stream environments, we set traps with the opening facing downstream, allowing easier access for turtles as they swam upstream following the scent of the bait. The top of each trap was raised above the water surface with floats to allow captured turtles (and other animals) to surface for air. Traps were anchored to the bank to prevent drifting or loss. Onset® data loggers were placed at each trapping location to record air and water temperatures at 15 minute intervals throughout the sample periods. The recommended sample period is five consecutive days, one day to set the traps and four days of trap checks.

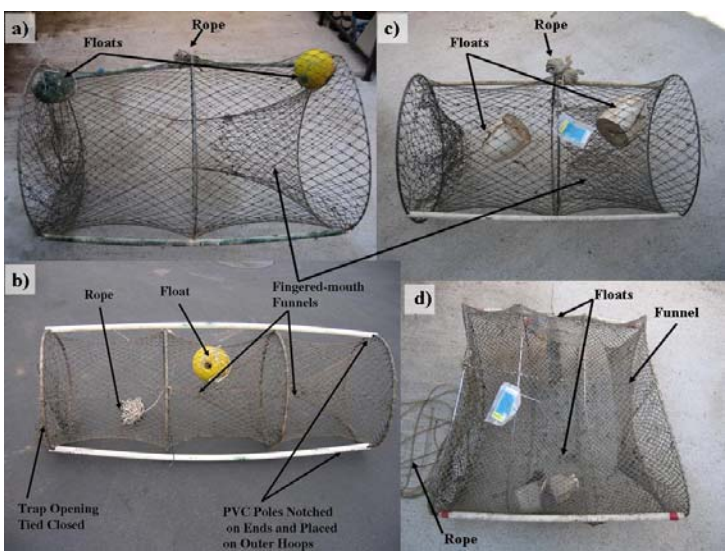


Figure 3. Turtle traps used during western pond turtle trapping surveys on Marine Corps Base Camp Pendleton, California in 2010.

All species captured in the turtle traps were photographed. We recorded the species, location, date, time, capture method, and age class for all individuals. For all non-native turtle captured we recorded the carapace length, weight, and gender. A notch was made on the plastron next to the right hind leg to identify each turtle as a recaptured animal (Figure 4). All captured non-native turtle were removed from the site and sent to the Orange County Chapter of the Turtle and Tortoise Club. The Turtle and Tortoise Club provides medical attention when necessary and adopts non-native turtle out to homes with secure yards and sufficient space. All pond turtles captured followed the processing procedures in section 4.4 General Health and Reproduction

Figure 4. Representative photograph of a plastron notch on a western pond turtle.

4.3.2 Snorkel Surveys

Snorkel surveys were conducted in isolated pools using snorkeling equipment to capture pond turtles. Pools were thoroughly surveyed, checking all open water, cracks, and crevices that may be in the sides of bedrock pools, under rocks, in undercut banks, and in submergent vegetation. Pond turtles were captured through visual and tactile detection. Pond turtles captured were processed using the same methods discussed in section 4.4 General Health and Reproduction.

4.3.3 Seining Surveys

Seining surveys were conducted through collaboration with ECORP Consulting, Inc. (hereafter referred to as ECORP). ECORP is a consulting group contracted by the Base to conduct non-native species removal along the San Mateo Creek and Santa Margarita River. A large 25 m (82 ft) seine was used in isolated pools to capture pond turtles and any fishes in the pools. The seine was set up at one point and stretched along one side of the pool. The seine was then slowly swept perpendicular across the pool to the other side. Upon reaching the other shore, the net was checked for species captured. All fish and amphibians captured were processed by ECORP for their project; while any pond turtles captured were processed using the same methods discussed in section 4.4 General Health and Reproduction.

4.4 General Health and Reproduction

4.4.1 General Health

To assess the general health of individuals and populations of pond turtles we recorded the carapace length, width, and height, plastron length, weight, and gender. We also recorded the number of marginal scutes, signs of shell damage, injuries, and annuli counts of juveniles.

4.4.2 Abundance

To determine abundance of pond turtles within a population pond turtles were permanently marked with a unique identification number. This was done by using two methods; 1) notching of the marginal scutes and 2) Passive integrative transponder tagging (PIT tagging) of all pond turtles greater than 80 mm (3.15 in) in carapace length (Figure 4). Marginal scutes are notched in a numeric sequence based on Dan Holland's work (Figure 5). Marking the pond turtles using two different methods helps to ensure the turtle is identifiable upon recapture.

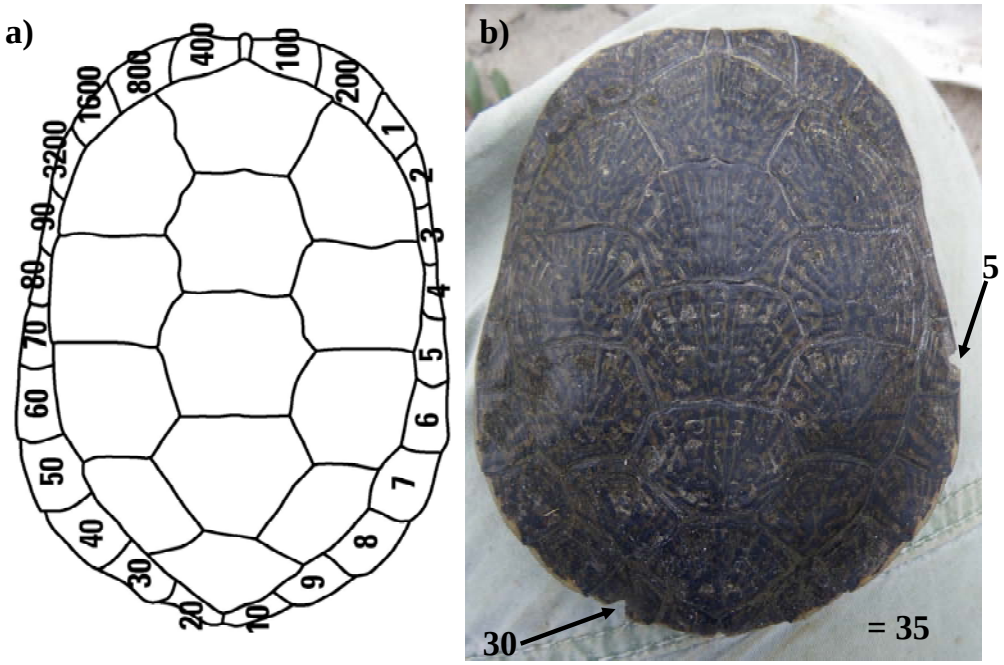


Figure 5. a) Marginal scute schematic and b) representative photograph of a western pond turtle with marginal scute notches.

4.4.3 Reproduction Assessment

All female adults were palpated, to feel for eggs. This is done by extending both hind legs and feeling the body of the pond turtle with your index fingers. All gravid or potentially gravid female pond turtles were x-rayed in the field to confirm breeding. X-rays were taken in the field using a Minxray portable x-ray machine model HF80. The portable x-ray machine was set-up in the field using a Benro A-258n6 tripod and powered by a 1500 watt power inverter hooked up to a car battery. X-ray methods followed the "USGS Vertebrate Sampling Protocol Module: How to X-ray Turtles Using Minxray Portable X-ray Model HF80. This protocol is based on Jeff Lovich's Minxray Portable X-ray Protocol and training (*unpublished protocol*). Jeff Lovich's

protocol is based on operating and safety considerations included in user manuals and through discussions with experts in the field. The pond turtle to be x-rayed was placed at a focal distance of 68.5 cm (27 in) on a cassette containing half speed, blue, 25 cm x 30 cm film. X-rays were taken at 60 kilovolts and between 0.08 and 0.10 seconds. All safety procedures were followed including the use of a lead apron, thyro-shield, and dosimeter badge to measure radiation exposure to individuals taking the x-rays. X-rays were developed at the Santa Ana Zoo using a Konica SRX-101A developer.

5. RESULTS AND DISCUSSION

Visual surveys were conducted at 19 sites on September 30, 2009 and again in March 2010, with the exception of Cristianitos Creek (surveyed on May 25, 2010), O'Neill Lake (surveyed on June 4, 2010) and San Mateo Sewage Disposal Pond (surveyed on April 30, 2010) (Table 1 and 2, Figure 6). The two visual surveys gave us a good idea of the habitat and water availability early and late in the year. San Mateo Sewage Disposal Pond, Stuart Mesa Pond, and Windmill Lake were dry in March of 2010; therefore no further surveys were conducted at these sites.

Habitat suitability surveys were conducted at the remaining 16 sites that were holding water. These sites were ranked based on the habitat suitability criteria (Appendix 1). We ranked the sites as follows; 9 *high*, 5 *moderate*, 1 *marginal*, and 1 *poor* (Table 3). The sites ranked as *high* included; Cristianitos, all of San Mateo Creek, Aliso Lagoon, Cockleburr Lagoon, Las Flores Lagoon, and the lower and upper portions of the Santa Margarita River. We ranked San Mateo Lagoon, Las Flores Creek, LCAC Pond, the middle portion of the Santa Margarita River, and Horseshoe Reservoir as *moderate*. The only *marginal* and *poor* sites were O'Neill Lake and Canal, respectively.

Of the 19 sites, we determined 15 sites suitable for trapping. All 15 sites were trapped for at least two, five consecutive days trap sessions with the exception of Cristianitos Creek, Las Flores Creek, and O'Neill Lake. Our base wide trapping effort included a total of 5,165 trap days or 41,316 trap hours. A combination of trapping, snorkeling, and seining surveys resulted in the capture of 340 pond turtles, 185 unique individuals at 12 sites (Table 4). Pond turtles were captured at 1) Cristianitos Creek (1 capture), 2) San Mateo Creek, lower (3 captures, 3 individuals), 3) San Mateo Creek, middle (1 capture), 4) San Mateo Creek, upper (51 captures, 40 individuals), 5) San Mateo Lagoon (6 captures, 5 individuals), 6) Aliso Lagoon (1 capture), 7) Cockleburr Lagoon (242 captures, 105 individuals), 8) Las Flores Lagoon (11 captures, 9 individuals), 9) O'Neill Lake Canal (1 capture), 10) Santa Margarita River, lower (16 captures, 12 individuals), 11) Santa Margarita River, middle (1 capture), and 12) Santa Margarita River, upper (6 captures, 6 individuals).

Below, we discuss site by site the results of the threat assessment and various surveys conducted at each site on the Base. Refer to Appendices 1, 2, 3, and 4 for habitat assessment criteria used to rank potential pond turtle habitat, site photographs, pond turtle data, and digital x-ray vouchers.

Table 1. Locations of western pond turtle surveys on Marine Corps Base Camp Pendleton, California in 2009 – 2010.

Site Number[1]	Site Name	Site Section	Training Area	START			END		
				UTM Easting [2]	UTM Northing [2]	Military Grid[3]	UTM Easting [2]	UTM Northing [2]	Military Grid[3]
San Juan Watershed (hu)[4] - San Mateo (ha)[5]									
1	Cristianitos Creek	Upper	Area 63	446893	3701282	470014	446893	3701282	470014
2a	San Mateo Creek	Lower	Sierra	445118	3694873	451948	446940	3698001	469979
2b		Middle	Bravo 3, Alpha 1	446940	3698001	469979	452607	3700698	526007
2c		Upper	Bravo 1, Yankee, Delta	452607	3700698	526007	456902	3703744	570037
3	San Mateo Lagoon	All	California State Parks, Leased	444807	3694274	448944	444807	3694274	448944
4	San Mateo Sewage Disposal Ponds	All	Area 63	447002	3697725	470977	447002	3697725	470977
San Juan Watershed (hu)[4] - San Onofre (ha)[5]									
5	Aliso Lagoon	All	Section E Aliso Beach (White)	458829	3680777	588807	458829	3680777	588807
6	ASP Pond	All	ASP	459761	3691491	598916	459761	3691491	598916
7	Cockleburr Lagoon	All	Section F Beach	459890	3679217	600793	459890	3679217	600793
8	Las Flores Creek	Lower	Las Pulgas Beach Section C (Red Beach)	457429	3683739	574837	457429	3683739	574837
9	Las Flores Lagoon	All	Las Pulgas Beach Section C (Red Beach)	456820	3683576	568836	456820	3683576	568836
10	LCAC Pond	All	Section F Beach	459594	3679820	596798	459594	3679820	596798
11	Stuart Mesa Pond	All	Oscar 2	458681	3683009	587830	458681	3683009	587830
Santa Margarita Watershed (hu)[4] - Ysidora and DeLuz (ha)[5]									
12	O'Neill Lake [6]	All	Area 27	470050	3687953	700880	470050	3687953	700880
13	O'Neill Lake Canal [6]	All	Area 27	469263	3688898	693889	468426	3686181	685864
14a	Santa Margarita River	Lower[6]	None, India, Hotel	463217	3677709	633777	466105	3684752	664848
14b		Middle[6]	None, India	466105	3684752	664848	470050	3691458	700915
14c		Upper[7]	India, Hotel	470050	3691458	700915	476144	3695908	759959
San Luis Rey Watershed (hu)[4] - Lower San Luis (ha)[5]									
15	Horseshoe Reservoir	All	None	471669	3682167	715826	471669	3682167	715826
16	Windmill Lake	All	Lima	468972	3679319	690795	468972	3679319	690795

[1] *Number corresponds with location on map, figure 6*

[2] *Location obtained in WGS 84 datum, Zone 11S*

[3] *Location obtained using the military grid reference system, 100 meter reference*

[4] *Hydrologic unit - a drainage area, based on the California Watershed Portal*

[5] *Hydrologic area - major subdivisions of hydrologic units, based on the California Watershed Portal*

[6] *Within the Ysidora hydrologic area*

[7] *Within the DeLuz hydrologic area*

Table 2. Survey dates for the western pond turtle surveys on Marine Corps Base Camp Pendleton, California in 2009 – 2010.

Site Number[1]	Site Name	Site Section	Type of Survey Conducted	Survey Start Date	Survey End Date
San Juan Watershed (hu)[2] - San Mateo (ha)[3]					
1	Cristianitos Creek	Upper	Visual	25-May-2010	25-May-2010
		Upper	Trapping	25-May-2010	28-May-2010
		Upper	Seining	28-May-2010	28-May-2010
2	San Mateo Creek	All	Visual	30-Sep-2009	30-Sep-2009
		All	Visual	2-Mar-2010	2-Mar-2010
		Lower / Middle	Visual	14-Apr-2010	14-Apr-2010
		Middle / Upper	Visual	15-Apr-2010	15-Apr-2010
		Lower / Middle	Trapping	10-May-2010	14-May-2010
		Upper	Trapping	24-May-2010	28-May-2010
		All	Trapping	21-Jun-2010	25-Jun-2010
		Lower / Middle	Trapping	19-Jul-2010	23-Jul-2010
		Upper / Middle	Trapping	27-Jul-2010	31-Jul-2010
		Upper	Snorkeling	30-Jul-2010	31-Jul-2010
		Upper	Seining	8-Sep-2010	8-Sep-2010
3	San Mateo Lagoon	All	Visual	30-Sep-2009	30-Sep-2009
		All	Visual	2-Mar-2010	2-Mar-2010
		All	Trapping	5-Apr-2010	9-Apr-2010
		All	Trapping	28-Jun-2010	2-Jul-2010
		All	Trapping	19-Jul-2010	23-Jul-2010
4	San Mateo Sewage Disposal Ponds	All	Visual	30-Apr-2010	30-Apr-2010
San Juan Watershed (hu)[2] - San Onofre (ha)[3]					
5	Aliso Lagoon	All	Visual	30-Sep-2009	30-Sep-2009
		All	Visual	2-Mar-2010	2-Mar-2010
		All	Trapping	22-Mar-2010	26-Mar-2010
		All	Trapping	30-Apr-2010	5-May-2010
6	ASP Pond		Access Denied		
7	Cockleburr Lagoon	All	Visual	30-Sep-2009	30-Sep-2009
		All	Visual	2-Mar-2010	2-Mar-2010
		All	Trapping	22-Mar-2010	26-Mar-2010
		All	Trapping	30-Apr-2010	5-May-2010
		All	Trapping	7-Jun-2010	11-Jun-2010
		All	Trapping	19-Jul-2010	23-Jul-2010
8	Las Flores Creek	All	Visual	30-Sep-2009	30-Sep-2009
		All	Visual	2-Mar-2010	2-Mar-2010
		All	Trapping	5-Apr-2010	9-Apr-2010

[1] *Number corresponds with location on map, figure 6*
[2] *Hydrologic unit - a drainage area, based on the California Watershed Portal*
[3] *Hydrologic area - major subdivisions of hydrologic units, based on the California Watershed Portal*

Table 2 (cont). Survey dates for the western pond turtle surveys on Marine Corps Base Camp Pendleton, California in 2009 – 2010.

Site Number[1]	Site Name	Site Section	Type of Survey Conducted	Survey Start Date	Survey End Date
San Juan Watershed (hu)[2] - San Onofre (ha)[3]					
9	Las Flores Lagoon	All	Visual	30-Sep-2009	30-Sep-2009
		All	Visual	2-Mar-2010	2-Mar-2010
		All	Trapping	5-Apr-2010	9-Apr-2010
		All	Trapping	28-Jun-2010	2-Jul-2010
		All	Trapping	19-Jul-2010	23-Jul-2010
10	LCAC Pond	All	Visual	22-Mar-2010	22-Mar-2010
11	Stuart Mesa Pond	All	Visual	22-Mar-2010	22-Mar-2010
Santa Margarita Watershed (hu)[2] - Ysidora and DeLuz (ha)[3]					
12	O'Neill Lake[4]	All	Visual	4-Jun-2010	4-Jun-2010
		All	Trapping	7-Jun-2010	11-Jun-2010
13	O'Neill Lake Canal[4]	All	Visual	17-Jun-2010	17-Jun-2010
		All	Trapping	14-Jun-2010	18-Jun-2010
14	Santa Margarita River	All[4, 5]	Visual	30-Sep-2009	30-Sep-2009
		All[4, 5]	Visual	2-Mar-2010	2-Mar-2010
		Lower[4]	Trapping	10-May-2010	14-May-2010
		Upper[4]	Visual	19-May-2010	19-May-2010
		Lower / Middle[4]	Visual	20-May-2010	20-May-2010
		Lower[4]	Trapping	24-May-2010	28-May-2010
		Middle[4] / Upper[5]	Trapping	14-Jun-2010	18-Jun-2010
		Lower[4] /Upper[5]	Trapping	12-Jul-2010	16-Jul-2010
San Luis Rey Watershed (hu)[2] - Lower San Luis (ha)[3]					
15	Horseshoe Reservoir	All	Visual	30-Sep-2009	30-Sep-2009
		All	Visual	2-Mar-2010	2-Mar-2010
		All	Trapping	10-May-2010	14-May-2010
		All	Trapping	12-Jul-2010	16-Jul-2010
16	Windmill Lake	All	Visual	2-Mar-2010	2-Mar-2010

[1] *Number corresponds with location on map, figure 6*
[2] *Hydrologic unit - a drainage area, based on the California Watershed Portal*
[3] *Hydrologic area - major subdivisions of hydrologic units, based on the California Watershed Portal*
[4] *Within the Ysidora hydrologic area*
[5] *Within the DeLuz hydrologic area*

Table 3. Ranking of potential western pond turtle habitat on Marine Corps Base Camp Pendleton, California in 2010.

Site Number[1]	Site Name	Portion of the Site	Water Depth (0-3 Points)	Aquatic Substrate (0-3 Points)	Aquatic Vegetation (0-2 Points)	Aquatic Refugia (0-1 Points)	Hatchling Habitat (0-2 Points)	Basking Sites Present (0-1 Points)	Terrestrial Habitat Buffer (0-3 Points)	Canopy Cover (0-2 points)	Terrestrial Refugia (0-1)	Human Access (0-3 Points)	TOTAL (0-21 Points)	Habitat Quality Rating
San Juan Watershed (hu)[2] - San Mateo (ha)[3]														
1	Cristianitos Creek	Upper	1	3	2	1	2	1	3	2	1	3	19	High
2	San Mateo Creek	Lower	3	3	2	1	2	1	3	2	1	1	19	High
		Middle	3	3	2	1	2	1	3	2	1	1	19	High
		Upper	3	3	2	1	2	1	3	2	1	3	21	High
3	San Mateo Lagoon	All	3	3	2	1	2	1	3	1	1	0	17	Moderate
4	San Mateo Sewage Disposal Ponds	All	DRY										--	--
San Juan Watershed (hu)[2] - San Onofre (ha)[3]														
5	Aliso Lagoon	All	3	3	2	1	2	1	3	1	1	3	20	High
6	ASP pond	All	ACCESS DENIED										--	--
7	Cockleburr Lagoon	All	3	3	2	1	2	1	3	2	1	3	21	High
8	Las Flores Creek	Lower	1	1	2	1	2	1	3	2	1	3	17	Moderate
9	Las Flores Lagoon	All	3	3	2	1	2	1	3	2	1	3	21	High
10	LCAC Pond	All	0	3	2	1	2	1	3	1	1	3	17	Moderate
11	Stuart Mesa Pond	All	DRY										--	--
Santa Margarita Watershed (hu)[2] - Ysidora and DeLuz (ha)[3]														
12	O'Neill Lake	All[4,5]	3	1	2	1	2	1	3	2	1	0	16	Marginal
13	O'Neill Lake Canal	All[4,5]	3	1	2	1	0	1	0	1	1	1	11	Poor
14	Santa Margarita River	Lower[4]	3	3	2	1	2	1	3	2	1	1	19	High
		Middle[4]	2	3	2	1	2	1	3	2	1	1	18	Moderate
		Upper[5]	3	3	2	1	2	1	2	2	1	3	20	High
San Luis Rey Watershed (hu)[2] - Lower San Luis (ha)[3]														
15	Horseshoe Reservoir	All	3	1	2	1	2	1	3	1	1	3	18	Moderate
16	Windmill Lake	All	DRY										--	--

[1] *Number corresponds with location on map, figure 6*

[2] *Hydrologic unit - a drainage area delineated to nest in a multi-level, hierarchical drainage system*

[3] *Hydrologic area - major subdivisions of hydrologic units*

[4] *Within the Ysidora hydrologic area*

[5] *Within the DeLuz hydrologic area*

Table 4. Survey results for the western pond turtle on Marine Corps Base Camp Pendleton, California in 2009 – 2010.

Site Number[1]	Site Name	Site Section	Historic Locations[2]	Detected in 2008/2009	2010						Trap Effort (hours)[3]
					Detected in 2010	Breeding Population Detected	Number of Captures	Number of Individuals Captured	Sex Ratio (Male:Female)	Age Ratio (Adult:Juvenile)	
San Juan Watershed (hu)[4] - San Mateo (ha)[5]											
1	Cristianitos Creek	Upper	X	–	X	X	1	1	0 : 1	1 : 0	47
2a	San Mateo Creek	Lower	X	–	X	–	3	3	3 : 0	3 : 0	387
2b		Middle		–	X	–	1	1	1 : 0	1 : 0	3053
2c		Upper		X	X	X	51	40	19 :21	39 : 1	3793
3	San Mateo Lagoon	All	X	X	X	–	6	5	4 : 1	4 : 1	5906
4	San Mateo Sewage Disposal Ponds	All	DRY								
San Juan Watershed (hu)[4] - San Onofre (ha)[5]											
5	Aliso Lagoon	All	X	X[6]	X	–	1	1	1 : 0	0 : 1	1919
6	ASP Pond	All	ACCESS DENIED								
7	Cockleburr Lagoon	All	X	X	X	X	242	105	64 : 33	68 : 37	8621
8	Las Flores Creek	Lower	X	–	–	–	0	0	0	0	378
9	Las Flores Lagoon	All	X	X	X	X	11	9	8 : 1	9 : 0	5011
10	LCAC Pond	All	DRY								
11	Stuart Mesa Pond	All	DRY								
Santa Margarita Watershed (hu)[4] - Ysidora and DeLuz (ha)[5]											
12	O'Neill Lake	All	–	–	–	–	0	0	0	0	2695
13	O'Neill Lake Canal	All	–	–	X	–	1	1	1 : 0	1 : 0	563
14a	Santa Margarita River	Lower[7]	X	X	X	X	16	12	6 : 6	6 : 6	4513
14b		Middle[7]		–	X[9]	–	1	1	0 : 1	1 : 0	642
14c		Upper[8]		–	X	X	6	6	3 : 3	6 : 0	1971
San Luis Rey Watershed (hu)[4] - Lower San Luis (ha)[5]											
15	Horseshoe Reservoir	All	X	X[10]	–	–	0	0	0	0	1817
16	Windmill Lake	All	DRY								
TOTALS			**12**	**8**	**12**	**6**	**340**	**185**	**110 : 67**	**139 : 46**	**41316**

[1] *Number corresponds with location on map, figure 6*

[2] *Historic western pond turtle (Actinemys marmorata) locations are based on Holland et al., (unpublished)*

[3] *Trap effort is the combined total number of traps at each site and the total number of hours each trap is open*

[4] *Hydrologic unit - a drainage area delineated to nest in a multi-level, hierarchical drainage system*

[5] *Hydrologic area - major subdivisions of hydrologic units*

[6] *Deceased western pond turtle (Actinemys marmorata) detected*

[7] *Within the Ysidora hydrologic area*

[8] *Within the DeLuz hydrologic area*

[9] *Western pond turtles (Actinemys marmorata) detected during a arroyo toad (Anaxyrus californicus) survey by USGS*

[10] *Western pond turtles (Actinemys marmorata) detected during a bird survey by USGS*

Table 5. Species detected during trapping surveys on Marine Corps Base Camp Pendleton, California in 2010.

Site Number[1]	Site Name	Site Section	TURTLES		FISHES								INVASIVE SPECIES			TOTALS
		Common Name	western pond turtle[2]	red-eared slider	black crappie	bluegill sunfish	bullhead catfish	common carp	green sunfish	largemouth bass	mosquitofish	striped mullet[2]	crayfish	American bullfrogs	African clawed frog	
		Scientific Name	*Actinemys marmorata*	*Trachemys scripta elegans*	*Pomoxis nigromaculatus*	*Lepomis macrochirus*	*Ameiurus sp.*	*Cyprinus carpio*	*Lepomis cyanellus*	*Micropterus salmoides*	*Gambusia affinis*	*Mugil cephalus*	*Procambarus clarkii*	*Rana catesbeiana*	*Xenopus laevis*	
San Juan Watershed (hu)[3] - San Mateo (ha)[4]																
1	Cristianitos	Upper	X	--	--	--	--	--	--	--	--	--	--	--	--	**1**
2	San Mateo Creek	Lower	X	--	--	--	--	--	X	--	X	--	--	--	--	**3**
		Middle	X	X	--	--	X	--	X	--	--	--	X	X	--	**6**
		Upper	X		--	--	X	--	X	--	--	--	X	X	--	**4**
3	San Mateo Lagoon	All	X	X	--	--	--	--	--	--	--	--	X	--	--	**3**
4	San Mateo Sewage Disposal Ponds	All	Dry													--
San Juan Watershed (hu)[3] - San Onofre (ha)[4]																
5	Aliso Lagoon	All	X	--	--	--	--	--	--	--	--	--	--	--	--	**1**
6	ASP Pond	All	Access Denied													--
7	Cockleburr Lagoon	All	X	--	--	--	--	--	--	--	X	--	X	--	--	**3**
8	Las Flores Creek	Lower	--	--	--	--	--	--	--	--	X	--	X	--	--	**2**
9	Las Flores Lagoon	All	X	--	--	--	--	--	--	--	--	--	--	--	--	**1**
10	LCAC Pond	All	Dry													--
11	Stuart Mesa Pond	All	Dry													--
Santa Margarita Watershed (hu)[3] - Ysidora (ha)[4]																
12	Santa Margarita River	Lower[5]	X	--	--	--	--	--	--	--	X	X	X	--	--	**4**
		Middle[5]	X *	--	--	--	X	--	--	--	X	--	X	X	--	**5**
		Upper[6]	X	X	--	--	X	--	--	--	X	--	X	X	--	**5**
13	O'Neill Lake	All	--	X	X	X	X	X	--	X	X	--	X	X	--	**7**
14	O'Neill Lake Canal	All	X	--	--	--	X	--	--	--	X	--	X	X	--	**3**
San Luis Rey Watershed (hu)[3] - Lower San Luis (ha)[4]																
15	Horseshoe Reservoir	All	--	X	--	--	X	--	--	--	--	--	--	X	--	**3**
16	Windmill Lake	All	Dry													--
	TOTALS		**12**	**5**	**1**	**1**	**7**	**1**	**3**	**1**	**8**	**1**	**10**	**7**	**0**	

[1] *Number corresponds with location on map, figure 5*

[2] *Native species*

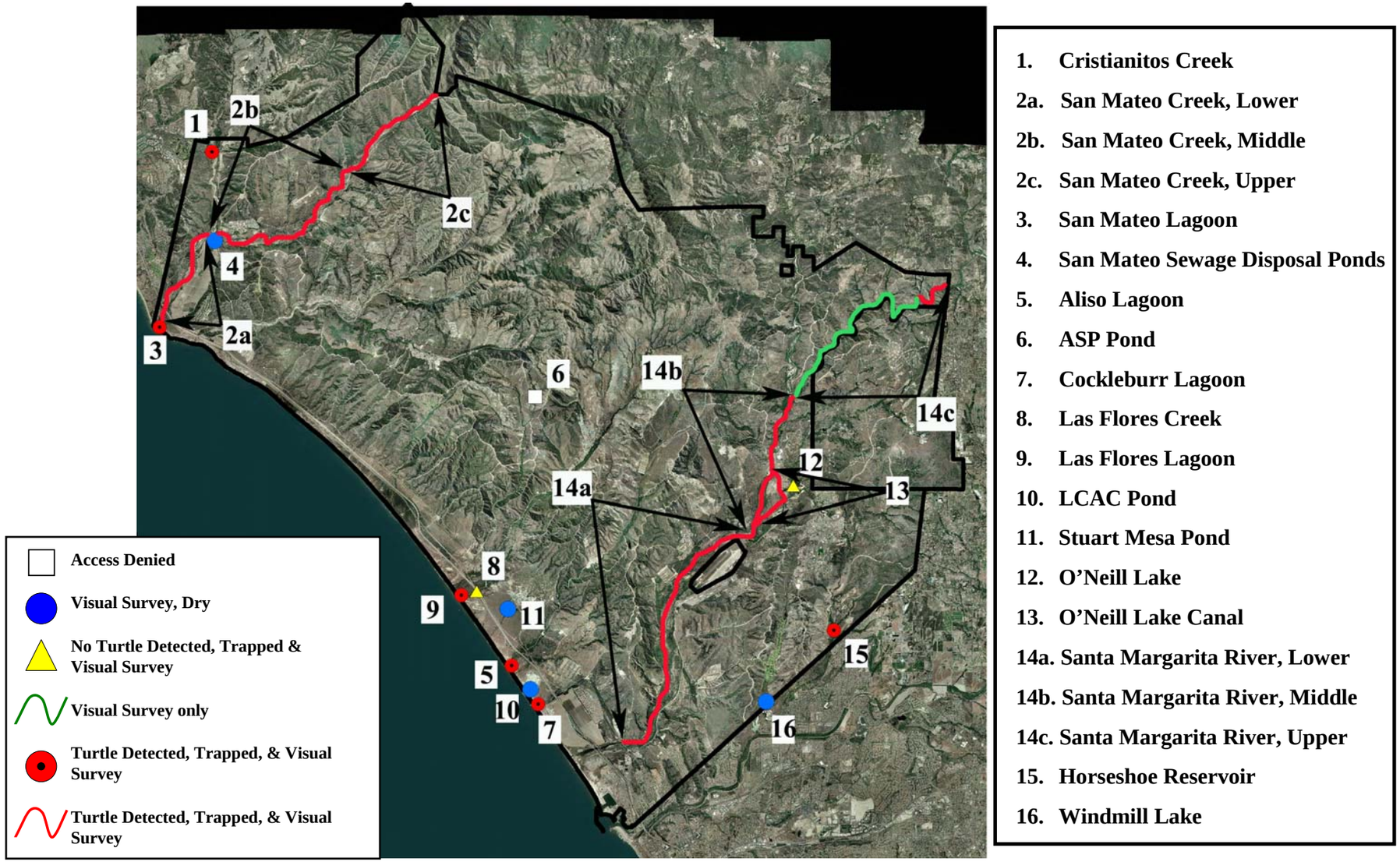
[3] *Hydrologic unit - a drainage area, based on the California Watershed Portal*

[4] *Hydrologic area - major subdivisions of hydrologic units, based on the California Watershed Portal*

[5] *Within the Ysidora hydrologic area*

[6] *Within the DeLuz hydrologic area*

Figure 6. Map of survey locations and results for the western pond turtle surveys on Marine Corps Base Camp Pendleton, California in 20 10.



5.1 San Juan Watershed – San Mateo

5.1.1 Cristianitos Creek

Cristianitos Creek is an ephemeral creek that is part of the San Juan Watershed hydrologic unit and the San Mateo Hydrologic Area. The creek runs along the most western corner of the Base with 54%, 8.33 km (5.17 mi), within the Base boundaries in Area 63 (Table 1, Figure 6). Due to urbanization and stream alterations this creek has not had flowing water since 2003, with the exception of storm flow run-off. Cristianitos Creek consist of a mulefat riparian area and a coastal sage scrub upland. Dominant plants within the riparian zone are mulefat (*Baccharis salicifolia*), cottonwood (*Populus fremontii*), and willow (*Salix sp*.). Threats to the pond turtles at this site are the lack of water and the continued reduction from urbanization and stream alterations related to the expected increase with the proposed Orange County Southern Subregional Natural Community Conservation Plan (Natural Community Conservation Plan and Habitat Conservation Plan 1995). Cristianitos Creek ranked *high* (19 of 21 total points) in habitat suitability, only losing points for the lack of water (Table 3).

From previous survey efforts we know of only one deep pool, approximately 1 m (3.28 ft) deep, in the northern most portion of creek near the Talega housing (Area 64). Positioned against a bedrock canyon wall this pool typically stays wet through the end of May/June. The USGS arroyo toad monitoring team observed a turtle at this site on May 23rd. We followed this up by conducting a visual survey (May 25th) followed by trapping May 25 – 28th totaling 47 trap hours (Tables 2 and 4). During the visual survey we observed two pond turtles; one adult and one juvenile. We documented breeding with the capture of one gravid female during the trapping survey (Table 4). The only other species observed was Pacific chorus frog (*Pseudacris regilla*) tadpoles (Table 5).

This is the first documented observation of a pond turtle within Cristianitos Creek on the Base. There are records of pond turtles observed upstream of the Base 1997 and again in 2003 (California Department of Fish and Game, 2008). The lack of pond turtle observations in the past nine years of repeated stream surveys along the Base portion of this creek indicates that this is probably a small population of pond turtles.

5.1.2 San Mateo Creek

San Mateo Creek is part of the San Juan Watershed hydrologic unit and the San Mateo Hydrologic Area. Only about 20% of this creek is located on the north end of the Base from the Cleveland National Forest to the Pacific Ocean, within Training Areas Sierra, Bravo 1, Bravo 3, Alpha 1, Yankee, and Delta (Table 1, Figure 6). This creek is typically dry from July to October; in drought years will remain dry year-round. Bedrock pools in the upper portion of the creek remain wet all year. We surveyed 17.27 km (10.73 mi) of San Mateo Creek from Interstate 5 to the northernmost border of the Base, totaling 55 pond turtle captures. From 2008 and 210 surveys we captured 46 individual pond turtles (Figure 7). Pond turtles were detected throughout this creek, however the majority of the turtles are in the upper portions of the creek. We believe pond turtles are moving throughout this creek on average or above average rain years. Capture data is discussed in further detail below in sections 5.1.2.1-3. Since this is a long stretch of creek we broke it into three sections the lower 4.09 km (2.54 mi), middle 5.71 km (3.55 mi) and upper

7.47 km (4.64 mi) (Table 1). Also included in this section are the San Mateo Lagoon and San Mateo Sewage Disposal Ponds (sections 5.1.2.4-5).

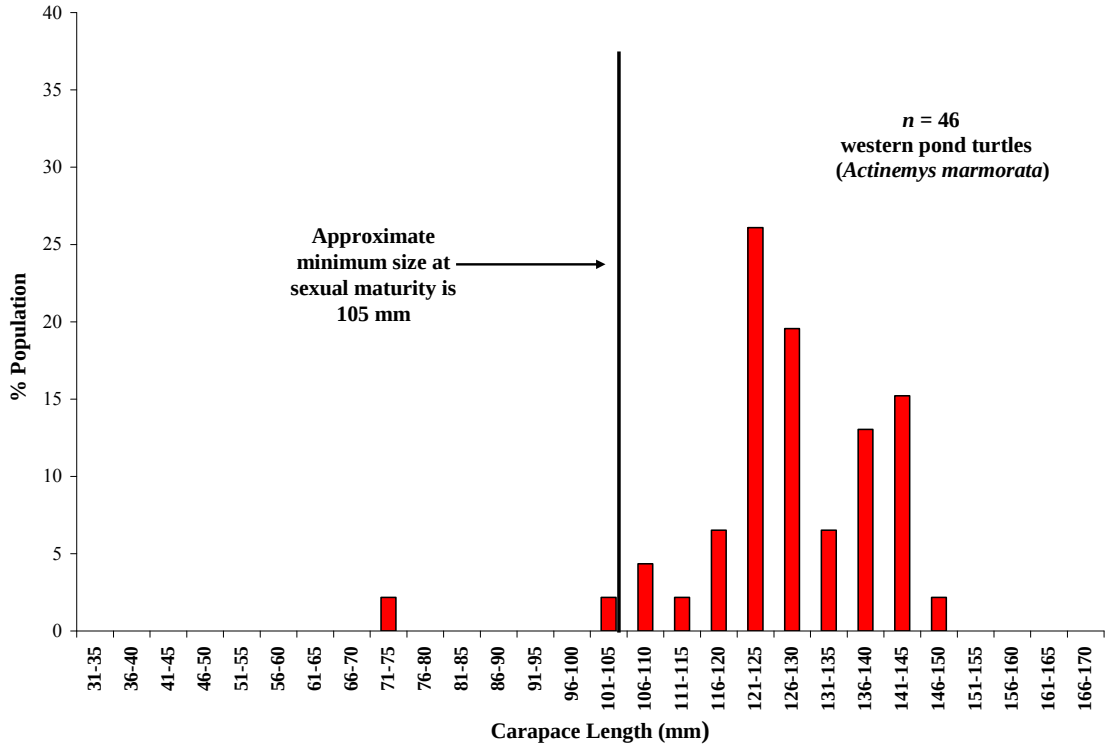


Figure 7. The population structure of the western pond turtle in the San Mateo Creek on Marine Corps Base Camp Pendleton, California in 2008 and 2010.

5.1.2.1 San Mateo Creek Lower

The lower portion of San Mateo Creek, 4.09 km (2.54 mi), is the driest portion of this creek. This was the first year the lower portion of the creek had running water since 2005 (Table 1). The lower San Mateo Creek section is a wide mulefat scrub wash dominated by mulefat and willow. The upland habitat is composed of coastal sage scrub. The greatest threats to the pond turtles at this site include limited water resources, non-native species, and human access. These attributes reduced the habitat suitability ranking to *moderate* (19 of 21 total points) (Table 3).

An intensive visual survey of the lower San Mateo Creek conducted on April 14th identified two locations deep enough to trap. Upon trapping, only one of these locations was suitable. Two weeks of trapping surveys were conducted in this section, May 10 – 14th and July 19 – 23rd totaling 387 trap hours (Tables 2 and 4). From our survey efforts we captured three adult males in the lower portion of San Mateo Creek. We did not capture any females; therefore, we were unable to document any reproduction taking place within this portion of the creek (Table 4). We also observed native arroyo toad (*Anaxyrus californicus*), western toad (*Anaxyrus boreas*) metamorphs, and pacific chorus frog tadpoles. We also observed non-native green sunfish (*Lepomis cyanellus*), and mosquitofish (*Gambusia affinis*) (Table 5).

5.1.2.2 San Mateo Creek, Middle

The middle portion of the San Mateo Creek, 5.71 km (3.55 mi), is the most urbanized portion of the creek (Table 1). There is a large amount of military housing and training along this stretch of

creek. The beginning portion of the middle section of San Mateo Creek begins as a mulefat scrub, but quickly transitions into a southern willow scrub dominated by willow, cottonwood, and mulefat. The terrestrial habitat adjacent to this stretch of San Mateo Creek is composed of coastal sage scrub. The greatest threats to the pond turtles in this stretch are non-native species and human access. These attributes reduced the habitat suitability ranking to *moderate* (19 of 21 total points) (Table 3).

On April 14th and 15th visual surveys were conducted along this stretch to identify deep pooling water where trapping surveys could be conducted (Table 2). Sixteen locations were identified and prioritized for trapping. Three weeks of trapping were conducted along the middle portion of the San Mateo Creek, May 10 – 14th, July 19 – 23rd, and July 27 – 31st for a total of 3053 trapping hours (Tables 2 and 4). We captured one adult male pond turtle. We did not capture any females; therefore, we were unable to document any reproduction taking place within this portion of the creek. We observed native arroyo toad tadpoles and metamorphs and Pacific chorus frog tadpoles and adults. We also observed non-native bullhead catfish (*Ameiurus sp.*), green sunfish, crayfish (*Procambarus clarkii*), American bullfrogs (*Rana catesbeiana*), hereafter referred to as bullfrogs, and several other pond turtles that we were unable to capture (Table 5). One red-eared slider (*Trachemys scripta elegans*), hereafter referred to as slider was also captured and removed from the sites (Table 5).

5.1.2.3 San Mateo Creek, Upper

We consider the upper portion of San Mateo Creek to be pristine pond turtle habitat, receiving a habitat suitability ranking of *high* (21 of the 21 total points) (Table 3). This site ranked as one of our highest in habitat suitability receiving 100% of the points possible. The riparian habitat consists of southern willow scrub on the lower end and transitions into a sycamore–alder riparian habitat in the remote northernmost corner of the Base. The upper portion of San Mateo Creek is adjacent to the Cleveland National Forest. Ideal for pond turtles, this upper portion of San Mateo Creek contains a handful of deep pools that remain wet all year. In addition, the site contains adequate aquatic substrate and vegetation, hatchling habitat, basking sites, canopy cover, terrestrial refugia, and a terrestrial buffer from urbanization. Potential threats to this site include drought, fire, non-native species, and heavy vehicle use along San Mateo Road.

Three weeks of trapping was conducted along the upper portion of the San Mateo Creek during May 24-28th, June 21-25th, and July 27-31st for a total of 3793 trap hours (Tables 2 and 4). We also conducted snorkeling surveys on July 30th and 31st, and seining surveys as part of a collaborative effort with ECORP on September 8th (Table 2). The majority of San Mateo Creek had dried by the end of June; only four large bedrock pools were deep enough to trap during our July – September surveys. From our survey efforts we captured 46 pond turtles. Combining 2008 and 2010 captures we captured a total of 51 pond turtles, 40 individuals. We documented a sex ratio of 21:19 males to females. Reproduction was documented within the upper portion of the San Mateo Creek. Six gravid females were captured and five of the six were x-rayed for confirmation.

In addition to pond turtles, we observed native arroyo toads and several non-native species while trapping the upper portion of San Mateo Creek including; green sunfish, mosquitofish, bullhead catfish, and bullfrogs (Table 5).

5.1.2.4 San Mateo Lagoon

San Mateo Lagoon is part of a long-term leased area, managed by California State Parks as part of the San Mateo Creek Natural Reserve. It is a long, triangular lagoon closed off from the Pacific Ocean by a barrier beach (Trestles Beach) at the mouth of San Mateo Creek (Table 1, Figure 6). The barrier beach is often breached during heavy winter rains and may remain open for several months afterward. San Mateo Lagoon is approximately 70 m (230 ft) wide and 500 m (1640 ft) long. Vegetation is comprised of riparian southern willow scrub, dominated by willows, cattails (*Typha latifolia*), and bulrushes (*Schoenoplectus californicus*). The terrestrial habitat adjacent to San Mateo Lagoon is composed of coastal sage scrub. The greatest threats to the pond turtles at this site include non-native species and human access. These attributes reduced the habitat suitability ranking to *moderate* (17 of 21 total points) (Table 3).

We conducted three weeks of trapping surveys at the San Mateo Lagoon April 5 – 9th, June 28 – July 2nd, and July 19 – 23rd for a total of 5906 trap hours (Tables 2 and 4). In the combined three week trapping effort we captured six pond turtles, five individuals. We obtained a male to female sex ratio of 4:1. No breeding female or juvenile pond turtles were observed (Table 4). Combining our captures from 2008 and 2010 a total of 13 pond turtle were captured, with one recapture from 2008 (Figure 8). The small sample size in 2010 precludes the determination of a population estimate.

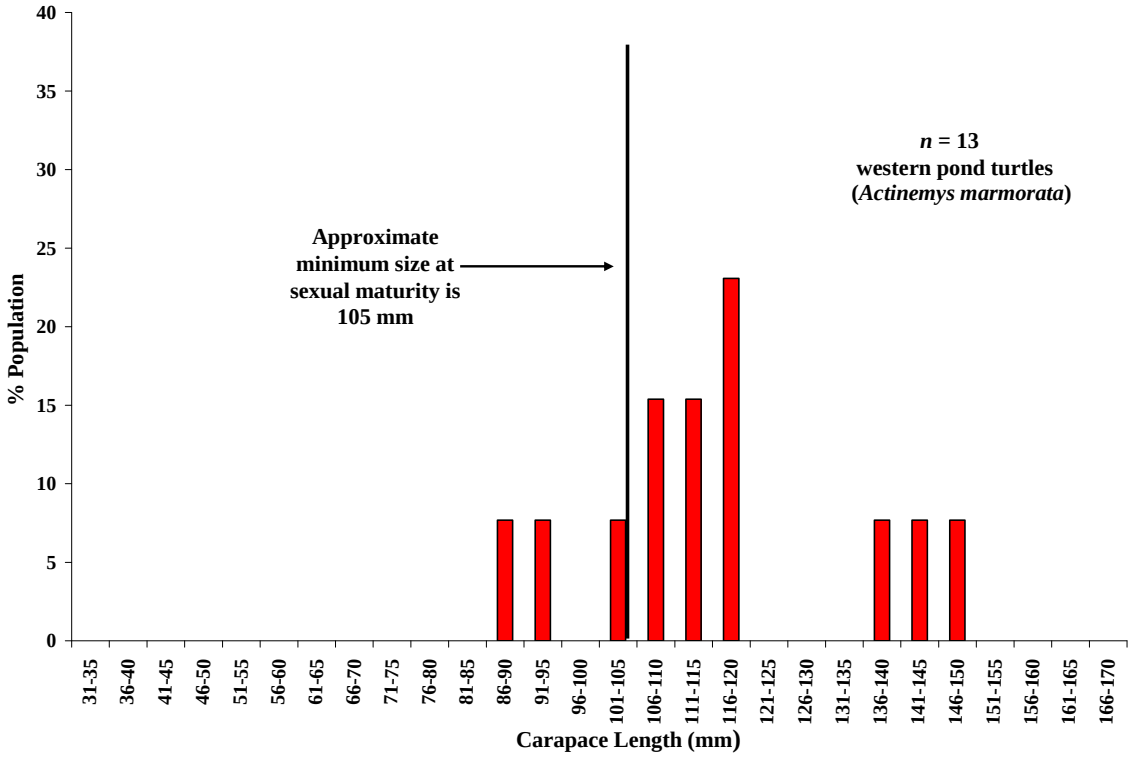


Figure 8. The population structure of the western pond turtle in the San Mateo Lagoon on Marine Corps Base Camp Pendleton, California in 2008 and 2010.

Even though we were unable to estimate a population size, it appears that the San Mateo Lagoon consists of a small population of pond turtles. This was the first year since 2005 that San Mateo

Creek was flowing to the lagoon and actually opened to the Pacific Ocean. Pond turtles have been isolated in the lagoon for the past five years. Although we were unable to document any movement, it is possible there was pond turtle movement this year. Turtles could have moved into the lagoon on there own or with the help of storm flow events. The pond turtles that were isolated in the lagoon finally had an opportunity this year to move upstream.

In addition to pond turtles, we observed non-native crayfish, and one slider (Table 5). The slider was captured and removed from the site.

5.1.2.5 San Mateo Sewage Disposal Ponds

The San Mateo Sewage Disposal Ponds are located west of San Mateo Creek, immediately adjacent to the confluence of San Mateo and Cristianitos Creeks within Area 63 (Table 1, Figure 6). The site consists of three ponds. Only one of these ponds held water in 2008 and in 2010 all three ponds were dry. We detected one pond turtle at this site in 2008. No surveys other than visual surveys were conducted at this site since the ponds were dry (Table 2).

5.2 San Juan Watershed – San Onofre

5.2.1 Aliso Lagoon

Aliso Lagoon is centrally located on the Base, 3 km (1.86 mi) south of Las Flores Lagoon, in Section E-Aliso Beach or (White Beach) (Table 1, Figure 6). Aliso Lagoon is a crescent shaped lagoon, approximately 200 m (656 ft) long and only about 25 m (82 ft) across at its widest point. It lies in a coastal salt marsh riparian area, surrounded by upland habitat of coastal sage scrub. The best pond turtle habitat is located at the inland section of the lagoon, where there is a transition from coastal salt marsh riparian habitat to southern willow scrub habitat. Aliso Lagoon ranked *high* in habitat suitability with 20 of the 21 points possible (Table 3). We identified salinity levels as the only threat to pond turtles at Aliso Lagoon. At certain times of the year, high salinity levels may render this site unsuitable for pond.

Two weeks of trapping surveys were conducted at the Aliso Lagoon, March 22-26th and April 30th – May 5th totaling 1919 trap hours (Tables 2 and 4). A single pond turtle was captured at this site in 2010. This was the first pond turtle documented in the Aliso Lagoon since Dan Holland's work (Holland et al. *unpublished report*). The only turtle documented in 2008 was a deceased turtle found on shore. The salinity at the lagoon during this trap session was 24.5 ppt, brackish water. The salinity was only slightly higher during the second trapping session at 26 ppt, also considered brackish water. During warm temperatures throughout the spring and summer months, the water in the Aliso Lagoon evaporates and salinity increases. In 2008, trapping in July, salinity of 36 ppt was documented, this is considered sea water. Once the salinity of the lagoon reaches a certain threshold, any resident pond turtle may be forced to leave and aestivate. Considering the frequent drought conditions and dry summers over the past few years, Aliso Lagoon is likely viable pond turtle habitat only in wet years or during early spring months. No other aquatic species were documented at this site (Table 5).

5.2.2 ASP Pond

The ASP pond is centrally located along Basilone Road on the Base (Table 1, Figure 6). The ASP area is a high security area, not an official training area. We were unable to obtain access during 2008 or 2010. There are no historic pond turtle records for the site.

5.2.3 Cockleburr Lagoon

Cockleburr Lagoon, located in Section F on the Base, connects Cockleburr Canyon with the Pacific Ocean (Table 1, Figure 6). It is a relatively small lagoon, approximately 150 m (492 ft) long and 20 m (66 ft) wide. The riparian habitat is coastal salt marsh to the north and west, and southern willow scrub to the south and east. The perimeter of Cockleburr Lagoon is surrounded by cattails, bulrushes, and ice plant. The upland community consists of coastal sage scrub. Cockleburr Lagoon is considered brackish water; however it's on the low end with the salinity ranging from 0.05 to 3.36 ppt. Just upstream of the lagoon, there is a large pond historically occupied by pond turtles. This pond no longer holds water. There is some low water flow in Cockleburr Creek, but no pooling water. It is possible that turtles move up into the creek. We did not observe any pond turtles during our survey of the creek, but the dense vegetation would make them very difficult to detect. We ranked this site *high* in habitat suitability for the pond turtle, with 21 of a possible 21 points (Table 3). There are very few threats to the pond turtle at the Cockleburr Lagoon. The main concern is the human access as the lagoon is located next to one of the main beach access points.

We trapped Cockleburr Lagoon for 4 weeks; March 22 – 26th, April 30th – May 5th, June 7 – 11th, and July 19 – 23rd for a total of 8621 trapping hours (Tables 2 and 4). We captured 242 pond turtles (105 individuals) with a sex ratio of 64:33 males to females (Table 4). We conducted an additional trap session at the Cockleburr Lagoon in 2009 as part of the California Polytechnic University, Pomona's Herpetology class field trip. Combining our 2008 – 2010 data a total of 118 individual pond turtles were captured (Figure 9). Breeding and successful recruitment was documented at the lagoon with two gravid females and the capture of three of last years hatchlings (less than 40 mm in carapace length and only 1 annuli observed). Using the Schnabel method of estimation, we estimated the population of pond turtles at Cockleburr Lagoon to be 119 (95% CI = 104, 139). This is a decline from Dan Holland's observations 1998 – 1999 estimates between 150 – 200+ individuals.

We trapped for an additional week at Cockleburr Lagoon for two reasons 1) high variation in pond turtle captures during individual trapping sessions and 2) little recruitment was documented. Pond turtle captures varied greatly during individual trapping sessions. During the March trap effort we captured 84 pond turtles, 72 adults and 12 juveniles. The total captures dropped off dramatically during our April/May survey session with 24 captures, consisting of 17 adults and 7 juveniles. During our third trap session we documented an increase in the number of juveniles captured. A total of 55 pond turtles captured, 31 adults, 21 juveniles, and 3 hatchlings. On our last trap effort in July we captured a total of 79 pond turtles consisting of 69 adults and 10 juveniles. Breeding and recruitment were documented at Cockleburr Lagoon, two gravid females and 3 hatchlings that we documented during our June effort.

The only other species observed at the lagoon were non-native mosquitofish and crayfish (Table 5).

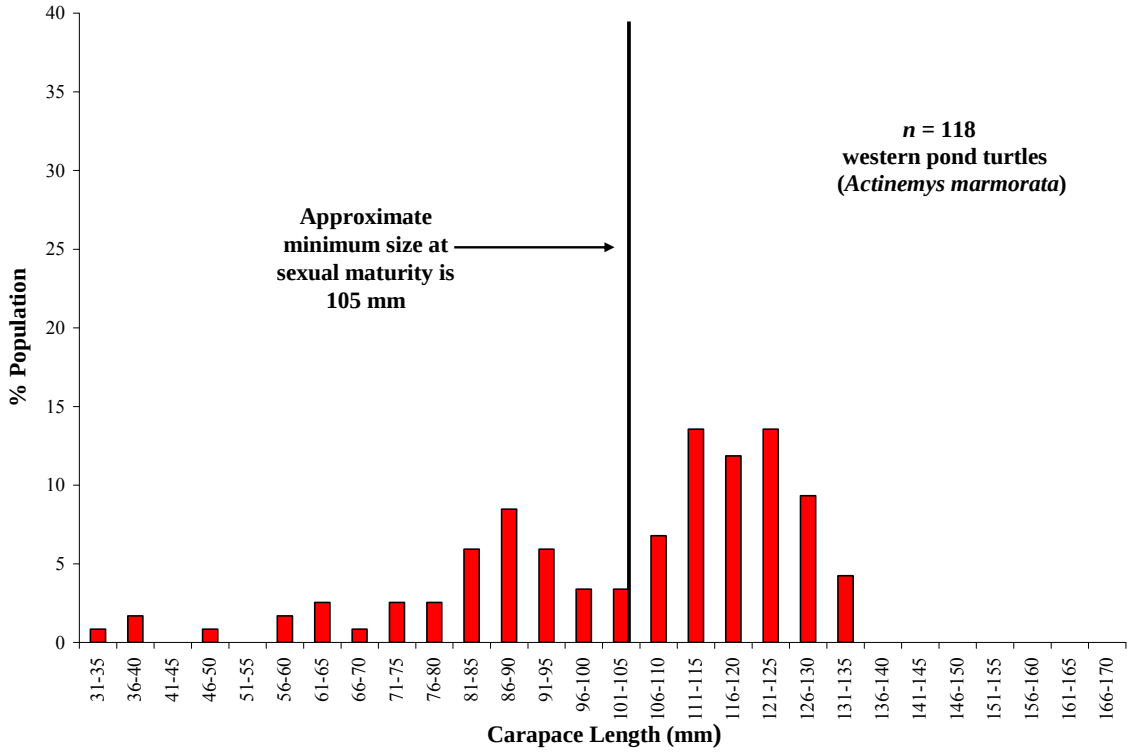


Figure 9. The population structure of the western pond turtle in the Cockleburr Lagoon on Marine Corps Base Camp Pendleton, California in 2008 – 2010.

5.2.4 Las Flores Creek

Las Flores Creek is centrally located on the Base within the Oscar Two and Las Pulgas Beach Section C (Red Beach) Training Areas (Table 1, Figure 6). It is a relatively small creek, 16.9 km (10.5 mi), consisting of a dense southern willow riparian zone dominated by willow, poison oak (*Toxicodendron diversilobum*), and cattails. The adjacent terrestrial habitat is coastal sage scrub. Las Flores ranked *moderate* in habitat suitability (17 of the 21 points) (Table 3).

Las Flores Creek does not hold much water and the vegetation is very dense. We focused our efforts within the Red Beach Training Area on the section of the creek under the Interstate 5 where pond turtles were documented by Dan Holland in the 90's (Holland et al., *unpublished report*). We trapped this site for one week due to water levels April 5-9th, a total of 378 trap hours (Tables 2 and 4). The only species observed at this site were non-native mosquitofish and crayfish (Table 5).

Las Flores Creek may not have a resident population of pond turtle anymore, or the population is very small. It is possible that pond turtles are in the creek between the lagoon and Stuart Mesa Road, but there is not a lot of water, even in the spring, and the dense vegetation makes surveying difficult. We suspect that the majority of the turtles in the Las Flores system are in the lagoon.

5.2.5 Las Flores Lagoon

Las Flores Lagoon is centrally located on the Base in the Red Beach Training Area (Table 1, Figure 6). The lagoon is 60 m (196 ft) wide and 325 m (1066 ft) long, surrounded by southern willow scrub riparian habitat with a large component of cattails. The upland habitat is mainly coastal sage scrub. Las Flores Lagoon ranked *high* in habitat suitability for the pond turtle, receiving all of the 21 points possible (Table 3). Threats to the pond turtle include non-native species like sliders and mosquitofish.

We trapped Las Flores Lagoon for 3 weeks; April 5-9th, June 28th – July 2nd, and July 19-23rd for a total of 5011 trapping hours (Tables 2 and 4). Eleven adult pond turtles were captured, 9 individuals, a sex ratio of 8:1 males to females. (Table 4). Breeding was documented at the Las Flores Lagoon by a single female carrying one egg. Combining our 2008 and 2010 data, we captured a total of 14 individual pond turtles at the lagoon (Figure 10). The small sample size precludes a population estimate; however we believe the populations to be small due to our low capture rates in 2008 and again in 2010. The salinity at the back of the lagoon during the trapping sessions were 1.4, 4.6, and 8.79 ppt (respectively) all considered brackish water, but on the lower end of the spectrum. We did not document any other aquatic species during our surveys (Table 5).

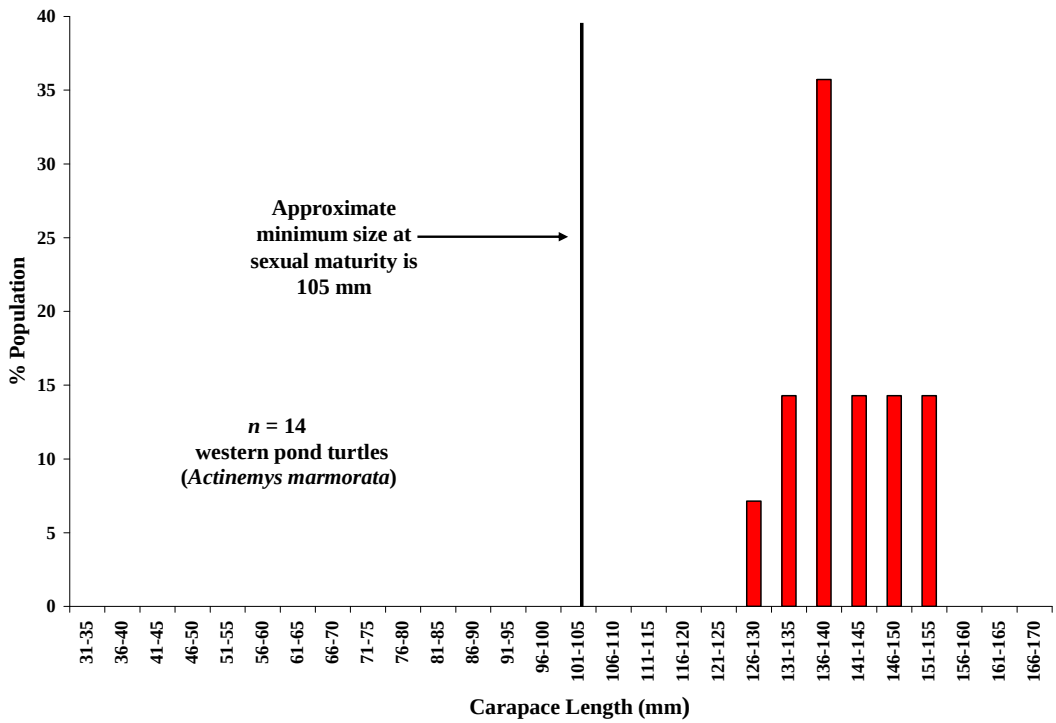


Figure 10. The population structure of the western pond turtle in the Las Flores Lagoon on Marine Corps Base Camp Pendleton, California in 2008 and 2010.

5.2.6 LCAC Pond

Located in Section F Beach on the Base, the LCAC Pond is centered between Aliso Lagoon and Cockleburr Lagoon (Table 1, Figure 6). It is a small pond, approximately 20 m (66 ft) by 2 m (6.5 ft), and less than 0.5 m (1.6 ft) in depth. The LCAC Pond is surrounded by Bermuda grass (*Cynodon sp.*) ice plant (Aizoaceae family), and cattails. The upland community consists of

coastal sage scrub. We ranked the LCAC Pond as *moderate* in habitat suitability (17 of the 21 points) (Table 3). The greatest threat to pond turtles at the LCAC Pond is the small size of the site which increases pond turtle vulnerability to predators.

During surveys in the 1990's, Holland was unable to document pond turtles at this site, but he suspected pond turtles from the Cockleburr Lagoon population periodically utilized this pond and the vernal pools associated with the LCAC facility (Holland et al. *unpublished report*). We did not conduct trapping surveys at this pond, due to insufficient water levels.

5.2.7 Stuart Mesa Pond

The Stuart Mesa Pond is located on the west side of Stuart Mesa Road, in the Oscar Two Training Area (Table 1, Figure 6). There are no historic records of pond turtles at this site. Like 2008, we did not complete a habitat assessment survey at Stuart Mesa Pond, as the pond was dry during our visit on March 22nd (Table 2).

5.3 Santa Margarita Watershed – De Luz & Ysidora

5.3.1 Santa Margarita River

The Santa Margarita River is part of the Santa Margarita River Watershed hydrological unit and the portions of this river that are on the Base are part of the Ysidora and De Luz Hydrologic Area. Only about 10% of this river is on the Base, encompassing the stretch from Fallbrook to the Pacific Ocean. Urbanization and habitat alteration upstream have had direct impacts on the Base portion of this river. We surveyed 28.22 km (13 mi) from Stuart Mesa Road Bridge to the upper Base boundary near Fallbrook (Table 1, Figure 6). Pond turtles occur throughout the Santa Margarita River from the upper limits of the tidal influence to the eastern most boundary of the Base. We captured 23 pond turtles, 19 individuals in 2010 (Figure 11). Our small sample size precludes the determination of a precise population estimate for the Santa Margarita River. We believe the population is fairly small and scattered along the river. The majority of the turtles are in the lower and upper portions of the creek and the middle portion of the river is used more as a corridor for movement between the upper and lower portions of the river. Capture data is discussed in further detail in sections 5.3.1.1-3. The Santa Margarita River is broken into three sections the lower 8.65 km (5.37 mi), middle 8.5 km (5.28 mi), and upper 11.07 km (6.88 mi) (Table 1, Figure 6).

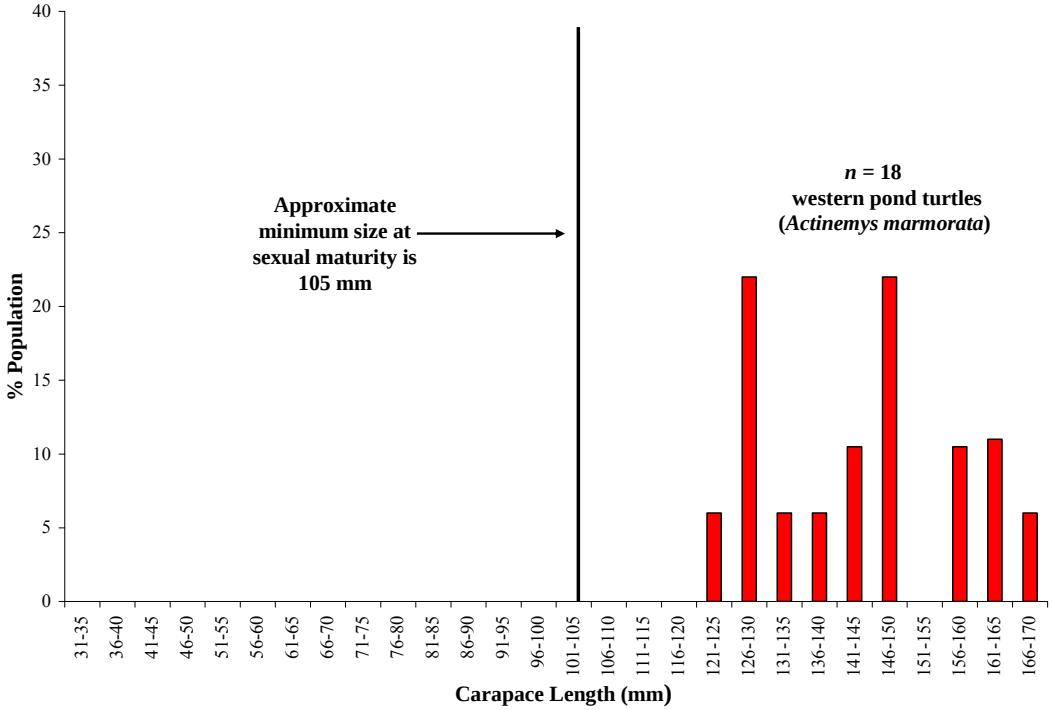


Figure 11. The population structure of the western pond turtle in the Santa Margarita River on Marine Corps Base Camp Pendleton, California in 2010.

5.3.1.1 Santa Margarita River, Lower

The lower portion of the Santa Margarita River begins at the Stuart Mesa Road bridge and stretches 8.65 km (5.37 mi) to the Base's airstrip and includes the Ysidora section of the Santa Margarita River (Table 1, Figure 6). Although this portion of the river consists of a southern willow scrub habitat, the majority of this reach was choked in by arundo (*Arundo donax*). Removal efforts by the Base have greatly reduced the amount of arundo. However, the arundo is returning and continual removal efforts are needed. The lower portion of this reach receives tidal influx; therefore it does not dry during summer months. However, the drying upstream combined with tidal influx often causes increases in salinity, which is a threat to the pond turtle. High salinity may reduce the number of non-native species present at the site. This lower section of the Santa Margarita River ranks *high* in habitat suitability (19 of the 21 possible points) (Table 3).

Trapping in the lower portion of the Santa Margarita River was conducted over three weeks; May 10-14th, May 24-28th, and July12-16th totaling 4513 trapping hours (Tables 2 and 4). The lower portion of the Santa Margarita River changed this year, rendering the lower 1.36 km (0.84 mi) accessible only by boat. We captured a total of 16 pond turtles, 12 individuals and 4 recaptures (Table 4). The sex ratio was 6:6 males to females and gravid females were detected (Table 4). We also documented native striped mullet (*Mugil cephalus*), and non-native mosquitofish and crayfish (Table 5).

5.3.1.2 Santa Margarita River, Middle

The middle section of the Santa Margarita River begins at the Base's airstrip and extends upstream confluence of the Santa Margarita River and De Luz Creek 8.5 km (5.28 mi) within the

India Training Area (Table 1, Figure 6). The riparian vegetation on this stretch is mainly southern willow scrub dominated by willow, mulefat, and yellow waterweed (*Ludwigia peploides*). The lower half of the middle section of the Santa Margarita River dries in the summer, while the upper half consist of portions choked in by yellow waterweed and other areas that are a wide, flat, sandy channel. There are several side pools approximately 50 m (164 ft) from the main channel that remain wet throughout most of the year. These side channels provide an excellent refuge for pond turtles as the main channel dries. We ranked the middle portion of the Santa Margarita River as *moderate* in habitat suitability (18 of the 21 points), due to summer drying and reduced canopy over the water (Table 3). Non-native species, especially bullfrogs are also a threat to the pond turtle at this site. Finally, the close proximity to O'Neill Lake and the resident slider population threaten pond turtles occupying this middle portion of the Santa Margarita River.

We trapped the middle portion of the Santa Margarita River for one week, June 14-18th for 642 trapping hours (Tables 2 and 4). A single, adult female pond turtle was detected in this portion of the Santa Margarita River in 2010. This turtle was not captured from trapping efforts, but incidentally captured during an arroyo toad survey. Other aquatic species observed were non-native mosquitofish, crayfish, and bullfrogs (Table 5).

5.3.1.3 Santa Margarita River, Upper

Beginning in Temecula Canyon, the upper Santa Margarita River makes its way through the cities of Temecula and Fallbrook before reaching the Base near De Luz Road. The upper portion of the Santa Margarita River that we surveyed is from where the river enters the Base to where it merges with De Luz Creek 11.07 km (6.88 mi) (Table 1, Figure 6). This portion of the river meanders through the Hotel and India training areas and is composed of dense southern willow scrub vegetation. The upper Santa Margarita River ranked *high* in habitat suitability (20 of the 21 points), losing points only in the water depth category (Table 3). Although the river has some deep pools, the average water depth is less than 0.5 m (1.54 ft). Apart from water depth, threats to the pond turtle include non-native species, further urbanization, and stream alterations.

The upper portion of the Santa Margarita was trapped for two weeks, June 14-18th and July 12-16th for a total of 1971 trap hours (Tables 2 and 4). This was a difficult section of the river to survey due to upstream water releases. These releases made it difficult to visually observe turtles, to physically move through the system, and to set traps. We captured six adult pond turtles, 3:3 males to females. We captured and removed one slider (Table 5). Non-native bullhead catfish, mosquitofish, crayfish, and bullfrogs were also observed (Table 5).

5.3.2 O'Neill Lake

O'Neill Lake is the largest lake on the Base, covering an area 1.5 km (0.9 mi) long by 50 m (164 ft) wide within Area 27 (Table 1, Figure 6). The lake is managed as a recreational area with activities such as hiking, biking, picnicking, fishing, boating, and camping. The north end of the lake is the best habitat for pond turtles, as it contains dense stands of bulrushes and cattails, and has reduced human access. O'Neill Lake ranked *marginal* in habitat suitability with 16 of a possible 21 points (Table 3). We consider human access and non-native species to be the major threats to pond turtles at this site.

O'Neill Lake was trapped from June 7-11th for a total of 2695 trap hours (Tables 2 and 4). We did not capture any pond turtles while trapping the site; however we captured and removed 72 sliders from the site (Table 4, 5). Other aquatic species observed at O'Neill Lake included non-native, black crappie (*Pomoxis nigromaculatus*), bluegill sunfish (*Lepomis macrochirus*), bullhead catfish, common carp (*Cyprinus carpio*), largemouth bass (*Micropterus salmoides*), and mosquitofish (Table 5). While pond turtles may occupy O'Neill Lake, just east of the Santa Margarita River, the large number of non-native species and human recreation greatly reduces the chance of a successful breeding and resident population.

5.3.3 O'Neill Lake Canal

The O'Neill Lake Canal connects O'Neill Lake to the Santa Margarita River. The canal system is 0.5 km (0.3 mi) long and approximately 5 m (16 ft) wide (Table 1, Figure 6). The depth varies, as water is constantly pumped in and then released. We ranked O'Neill Lake Canal as *poor* with regard to habitat suitability for the pond turtle (11 of the 21 points) (Table 3). Major threats to pond turtles include the fluctuating water depth, presence of non-native species, and roads.

We trapped the O'Neill Lake Canal from June 14-18th for a total of 563 trap hours and captured 1 adult male pond turtle (Tables 2 and 4). Throughout the trapping session, we observed non-native bullhead catfish, mosquitofish, and crayfish (Table 5).

5.4 San Luis Rey Watershed – Lower San Luis

5.4.1 Horseshoe Reservoir

Horseshoe Reservoir is located near the southern border of the Base, adjacent to Vandergrift Road near Area 17 (Table 1, Figure 6). It is an S-shaped reservoir, approximately 200 m (656 ft) long and 50 m (164 ft) wide and is used as a sewage holding pond. The riparian vegetation is mainly southern willow scrub, with a dense stand of bulrushes surrounding the perimeter of the reservoir. The upland community consists of coastal sage scrub. We ranked this site as *moderate* in habitat suitability with 18 of 21 possible points (Table 3). At Horseshoe Reservoir, the primary threats to pond turtles are the artificial nature of the site, lack of canopy cover, and number of non-native species.

Horseshoe Reservoir was trapped twice; May 10-14th and July 12-16th for a total of 1817 trap hours (Tables 2 and 4). No pond turtles were detected during our surveys; however a pond turtle was detected at the site in 2009 during a bird survey along Pilgrim Creek. The pond turtle was observed in 2009 approximately 100 m (260 ft) from the reservoir moving northeast away from the reservoir (Madden-Smith pers. comm). The only other species observed were non-native bullhead catfish, crayfish, and a slider (Table 5). A slider was captured and removed from the site.

5.4.2 Windmill Lake

Windmill Lake is located in the southern corner of the Base within the Lima Training Area (Table 1, Figure 6). The lake is relatively large, covering an area 500 m (1640 ft) long and 200 m (656 ft) wide. However, Windmill Lake was completely dry during our visual surveys in 2008 and 2010.

5.5 Non-native Species

5.5.1 Non-native Turtles

The impacts of non-native turtles on the pond turtle are hard to quantify but are almost certainly negative (Spinks et al. 2003, Madden-Smith et al. 2005). The slider and various other turtle species, common in the pet trade industry for decades, have been released or escaped and have managed to establish populations throughout the world (Iverson 1992 and Williams 1999). Non-native turtle species are usually more abundant in urban aquatic systems in California than the native pond turtle (Spinks et al. 2003 and Madden-Smith et al. 2005). Non-native turtles outcompete native turtles for food, basking sites, and nesting habitat (Spinks et al. 2003). In addition, non-native turtles may introduce new pathogens into pond turtle populations (Spinks et al. 2003).

Sliders are larger and considered more aggressive than pond turtles (Arvy and Servan 1998, Cadi and Joly 2004). Sliders have higher fecundity than pond turtles. They nest up to 5 times per year and lay up to 23 eggs per clutch, while pond turtles nest 1 to 2 times per year and lay up to 13 eggs per clutch (Storer 1930, Ernst et al. 1994, Goodman 1997a, 1997b, Arvy and Servan 1998, Hayes et al. 1999, Pires 2001, Spinks et al. 2003, Cadi and Joly 2004, Bury*, in press*). In addition, slider eggs tolerate higher moisture levels than pond turtle eggs (Spinks et al. 2003).

Finally, sliders host a variety of pathogens that may be transferred to pond turtles. Hayes et al. (1999) suggested that the slider was the vector of a respiratory disease deadly to many pond turtles in Washington in 1990. Sliders from southern California host exotic leaches and other parasites that may be transmitted to pond turtles (Madden-Smith et al. 2005, Moser et al. 2005).

We documented non-native turtles at five sites on the Base including, San Mateo Creek, San Mateo Lagoon, Santa Margarita River, O'Neill Lake, and Horseshoe Reservoir (Table 5). Sliders were the only non-native turtle species observed, all captured were removed from the site. With the exception of O'Neill Lake, non-native turtles appear to be in low densities throughout the Base. One to two sliders were documented at the sites where they were present, indicating non-breeding populations. However, we did document a breeding population of sliders at O'Neill Lake, where we captured and removed 72 sliders. We found the population of sliders at O'Neill Lake to be female biased, with a male to female sex ratio of 16:54.

5.5.2 American Bullfrogs

Bullfrogs are the largest frog in the United States, reaching a snout-vent length of 15.2 cm (6 in) (Stebbins 2003). They are typical looking frogs, long-legged, narrow-waisted, and smooth-skinned with webbed hind toes and dorsolateral folds. Color varies from solid green to a netlike pattern of gray or brown on a green background (Stebbins 2003). Their conspicuous eardrums help distinguish bullfrogs from other ranid frog species. Bullfrogs prefer warm slow moving water including, sluggish backwaters, oxbows, farm ponds, reservoirs, marshes, and still waters with dead woody debris (Storer 1922). Bullfrogs also occupy shorelines of streams and lakes and are native from Florida west to Wisconsin and across the Great Plains to the Rockies (Stebbins 2003). Populations are now established as far west as California, as well as in Mexico,

Canada, Cuba, Jamaica, Brazil, Uruguay, Japan, and Europe (Lawler et al. 1999, Stebbins 2003, Garner et al. 2006). Bullfrog introduction to California occurred several times between 1914 and 1920 (Storer 1922). Bullfrogs pose a potential threat to pond turtle hatchlings as an introduced predator (Holland 1991, 1994, Lovich and Meyer 2002).

Pond turtle hatchlings are approximately the size of a silver dollar, and are vulnerable to predation by bullfrogs (Moyle 1973, Brattstrom and Messer 1988, Holland 1991). Dan Holland documented the recovery of small turtles from the stomachs of bullfrogs during his work on the Base (Holland et al. *unpublished report*). In addition, bullfrogs host many pathogens, bacteria and parasites (Casper and Hendricks 2005). Crawshaw (1997) and Daszak et al. (2004) implicate bullfrogs as carriers of the intraerythrocytic virus.

Bullfrogs were observed at 7 of the 16 trapping sites on the Base. The affected sites include; 1) San Mateo Creek, Middle, 2) San Mateo Creek, upper, 3) Santa Margarita River, Middle, 4) Santa Margarita River, Upper 5) O'Neill Lake, 6) O'Neill Lake Canal, and 7) Horseshoe Reservoir (Table 5). Both bullfrogs and pond turtles were documented in the middle and upper portions of San Mateo Creek, and the middle and upper portions of the Santa Margarita River. We did not observe bullfrogs in the lower portions of the Santa Margarita River, but we know that bullfrogs are generally common throughout the Santa Margarita River (Turschak et al. 2008).

5.5.3 Non-native Fish

The introduction of non-native fish to California began in 1871 (Dill and Cordone 1997). Currently, approximately half of the established freshwater fish species in California have been introduced (Dill and Cordone 1997).

Predatory fish, like the largemouth bass, pose a potential threat to pond turtles, especially hatchlings and juveniles (Holland 1991, 1994, Lovich and Meyer 2002). Bass are "gape limited" predators known to eat small pond turtles (Moyle 1973, Brattstrom and Messer 1988, Holland 1991, 1994). Semlitsch and Gibbons (1989) and Britson and Gutzke (1993) found a lack of largemouth bass predation on the conspicuously colored red-eared slider. Their findings suggest that cryptically colored turtles, such as the pond turtle, are more susceptible to predation by largemouth bass.

Although carp, sunfish, and mosquitofish do not directly predate pond turtles, they may pose other threats. Carp can negatively impact water quality through feeding activities. These feeding activities often muddy the water, resulting in reduced densities of zooplankton (Hayes et al. 1999). The diet of young pond turtles is poorly understood, but they likely rely on zooplankton as a food source. In addition, young pond turtles likely feed on nekton (actively swimming aquatic organisms). Sunfish species keep nekton levels so low that they can stunt their own growth (McGinnis 1984, Jennings and Hayes 1994). In addition, many researchers suspect sunfish of competing with pond turtles for food (Holland 1991, Jennings and Hayes 1994, McAllister et al. 1996, Hayes et al. 1999) by depleting or altering the invertebrate prey base (Holland 1991). Finally, sunfish and mosquitofish are known paratenic hosts (intermediate hosts in which no development of parasite occurs, although its presence may be required as an

essential link in the completion of the parasites life cycle) of turtle parasites in the genus *Falcaustra* (Moravec et al. 1995).

All fish documented during these surveys were either visual observations or through incidental captures. Although we did not focus our efforts on detecting fish, we observed seven non-native fish species including black crappie, bluegill sunfish, bullhead catfish, common carp, green sunfish, largemouth bass, and mosquitofish at survey sites within the Base (Table 5). It is likely we are under reporting non-native fish species on the Base since we were not setting minnow traps or seining sites specifically for fish.

5.5.4 Crayfish

Crayfish non-native freshwater crustaceans, were detected at 8 of the 16 pond turtle trapping sites within the Base including; 1) Middle San Mateo Creek, 2) Upper San Mateo Creek, 3) San Mateo Lagoon, 4) Cockleburr Lagoon, 5) Las Flores Pond, 6) Lower Santa Margarita River, 7) Middle Santa Margarita River, 8) Upper Santa Margarita River, 9) O'Neill Lake, and 10) O'Neill Lake Canal (Table 5). Crayfish are native to the southeastern United States, but have become widespread and well established in aquatic habitats worldwide. Crayfish pose a threat to freshwater biodiversity and ecosystem function (Lodge et al. 2000). As predators, they are particularly detrimental to the egg and larval stages of most amphibians (Gamradt and Kats 1996 and Riley et al. 2005). Crayfish can serve as a main food source for adult pond turtles, but pose a threat to hatchling pond turtles through competition and predation.

6. CONCLUSIONS

Visual and trapping surveys were conducted at 15 sites within the Base (Table 2, Appendix 2). We observed pond turtles at 12 of those sites (Table 4, Appendix 4). Of the 12 confirmed pond turtle location five are within the San Mateo Hydrologic Area of the San Juan Watershed (Cristianitos Creek, San Mateo Creek Lower, Middle, and Upper, and the San Mateo Lagoon); three locations are within the San Onofre Hydrologic Area of the San Juan Watershed (Las Flores Lagoon, Aliso Lagoon, and Cockleburr Lagoon); and four locations are within the De Luz and Ysidora Hydrologic Areas of the Santa Margarita River Watershed (the Santa Margarita River Lower, Middle, and Upper, and O'Neill Lake Canal). Comparing the weights and lengths of the pond turtles captured on the Base to a subset of pond turtles throughout southern California the populations on the Base appear to be healthy. Their weight and lengths are similar to the southern California subset with the exception of the Cockleburr Lagoon. The pond turtle at the Cockleburr Lagoon are smaller in size than the pond turtles in other populations (Figure 12).

Breeding populations of pond turtles were detected at six of the sites by detecting gravid females; Cristianitos Creek, Upper San Mateo Creek, Cockleburr Lagoon, Las Flores Lagoon, and the Upper and Lower Santa Margarita River. We learned that you can not always detect a gravid female by palpating them. Adult female turtles with above average weights should be x-rayed to verify if they are gravid. Our confirmed gravid females all had above average weights (Figure 13).

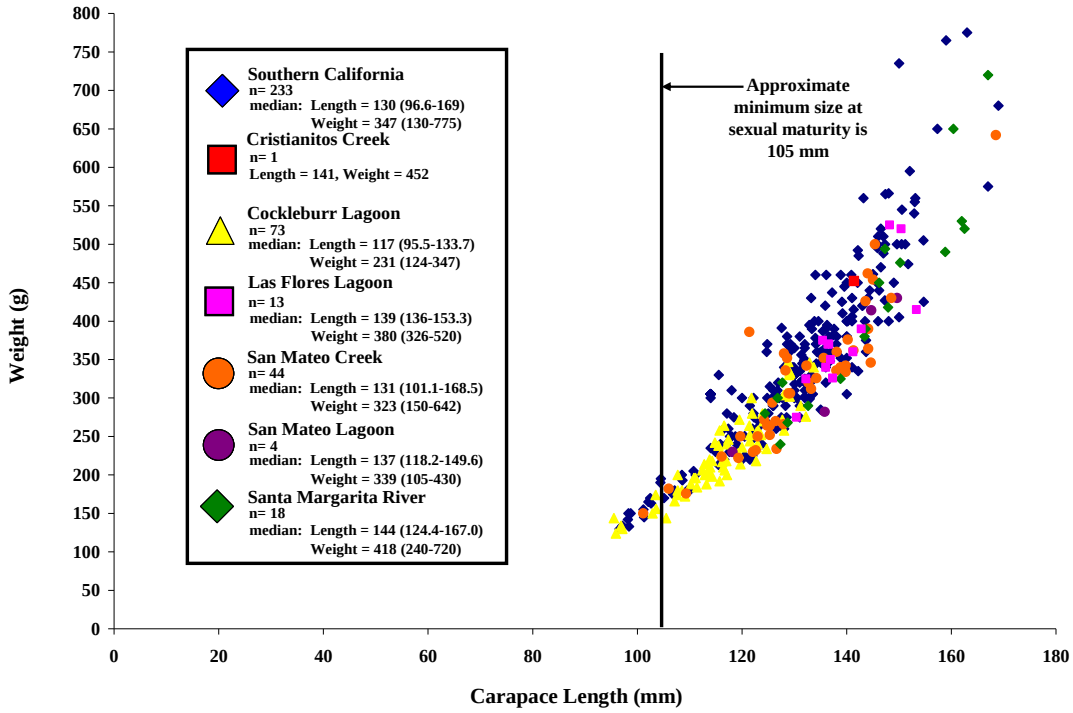


Figure 12. Length-weight relationship of western pond turtles captured on Marine Corps Base Camp Pendleton to pond turtles in southern California. Minimum length of a pond turtle used in this comparison was 95 mm.

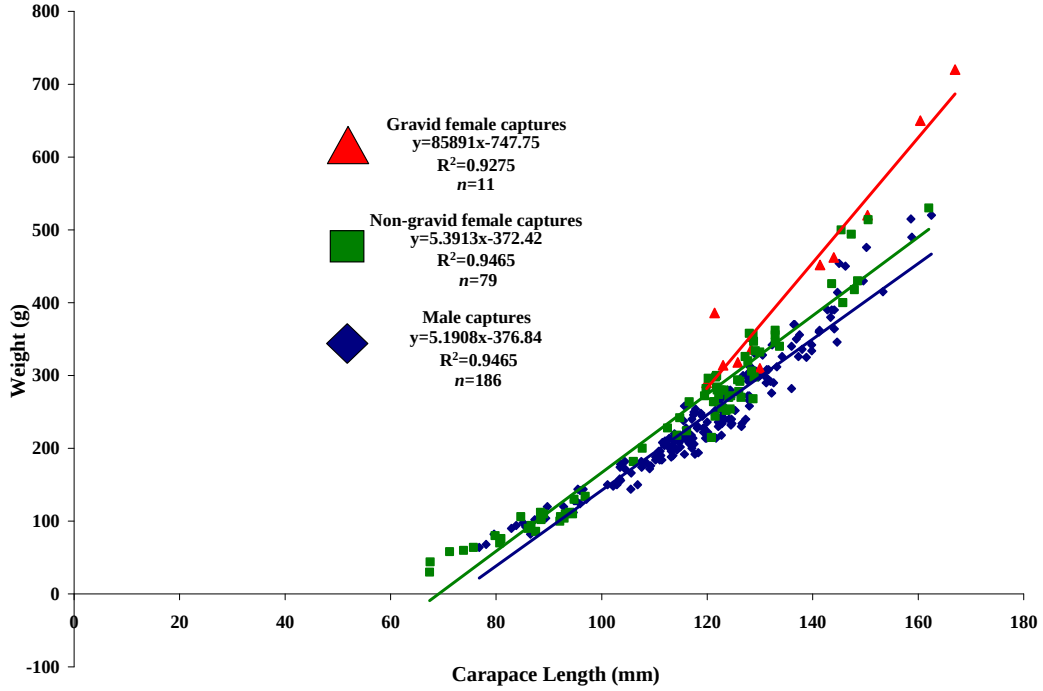


Figure 13. Length-weight comparison of gravid females, females, and male western pond turtles on Marine Corps Base Camp Pendleton California in 2010.

Successful recruitment is taking place at three of these sites; the San Mateo Creek, Cockleburr Lagoon, and the Santa Margarita River. It appears there may be successful recruitment taking place in Cristianitos Creek; we observed but were unable to capture a juvenile pond turtle. We were unable to document recruitment at the Las Flores Lagoon. San Mateo Lagoon has a population of pond turtles, we are uncertain about their breeding status, but we believe that they do move into San Mateo Creek during average or high rain years when the creek is flowing to the Pacific Ocean. We are uncertain about the pond turtle population status at Aliso Lagoon and Horseshoe Reservoir due to a single pond turtle captured at each site.

During the 2010 surveys we determined the Cockleburr Lagoon pond turtle population to be 119 (95% CI = 104, 139). We were unable to obtain accurate population estimates at all other sites surveyed. Cristianitos Creek, San Mateo Lagoon, Aliso Lagoon, and Horseshoe Reservoir very low capture rates making it difficult to obtain population estimates. San Mateo Creek and the Santa Margarita River are going to require more effort than three weeks of trapping to obtain accurate population estimates. San Mateo Creek was a test site for this. We were not getting a lot of captures in the traps and realized quickly that trapping surveys alone were not enough. We believe there is adequate food in the system that the pond turtles are not interested in the traps. In a case like this snorkel survey and/or seining surveys need to accompany the trapping surveys to increase capture success.

7. MANAGEMENT STRATEGIES

The pond turtle was historically more widespread and abundant in southern California, as well as within the Base. Below, is a list of monitoring and management suggestions to sustain and improve pond turtle populations on the Base. Our research shows learning more about the current pond turtle populations, increasing pond turtle populations, enhancing habitat, and expanding pond turtle numbers into other suitable areas should be part of the Base's management goals if the intent is to increase pond turtle populations. These goals may be achieved by monitoring current populations, restoring or enhancing habitat, and removing non-native species, especially non-native turtles, bullfrogs, predatory fish, and crayfish. The following suggestions could benefit the pond turtle, as well as other native aquatic species. With few remaining populations of pond turtles on the Base, action needs to be taken to better understand these populations and effectively manage for this species.

7.1 Additional Surveys

In order to obtain a better understanding of pond turtles on the Base, additional pond turtle surveys are needed. The methodology used in this study should be repeated and expanded upon to examine population size, demographics, status, recruitment, and viability. More intensive surveys are necessary to better understand both upland and aquatic habitat use, along with reproductive status of the pond turtle.

7.1.1 Base-level Monitoring

Conducting trapping, snorkeling, and seining surveys at Cristianitos Creek, Aliso Lagoon, and Horseshoe Reservoir would further increase our understanding of the pond turtle populations at these sites. It is important to collect more data from these sites to obtain better population estimates and better understand the demographics, recruitment, and viability of the pond turtle at

each site. These data are imperative to fully understanding the Base pond turtle dynamics, and in implementing management strategies base wide.

7.1.2 Monitoring Known Pond Turtle Populations

Two monitoring strategies; 1) one more year of intense surveys along San Mateo Creek and the Santa Margarita River and 2) long-term monitoring of known pond turtle populations (San Mateo Creek, San Mateo Lagoon, Aliso Lagoon, Las Flores Lagoon, Cockleburr Lagoon, Santa Margarita River) are important for a better understanding of the pond turtle populations on the Base. These sites should be trapped two to four times for five consecutive days beginning in early spring and spaced at least one month apart. Trapping should be supplemented with visual surveys, snorkel surveys and seining surveys. All female pond turtles should be palpated and x-rayed to determine if they are carrying eggs. The additional data provided by multiple trapping surveys of known pond turtle populations, in concert with visual, snorkeling and seining surveys, will provide more accurate population estimates, demographics, recruitment and viability. Future monitoring of these populations is necessary to fully understand the Base pond turtle dynamics, and in implementing management strategies to slow the gradual decline of these populations

7.1.3 Habitat Assessment

More detailed habitat assessment at each pond turtle population site would be useful to better understand the habitat requirements for the pond turtle. In the future, all pond turtle habitat should be periodically assessed (i.e. every five years) to account for habitat alterations over time. In addition to the general habitat characteristic data collected during the visual surveys, more detailed data should be collected to characterize the aquatic and surrounding upland habitat. These data can be based on fine-scale orthophotographs, 1 m resolution, and should include estimates of the extent of open water, submerged aquatic vegetation, emergent vegetation, canopy cover, riparian, and upland habitats, roads, commercial, and residential areas within a 1 km radius of the pond turtle population.

7.1.4 Water Quality Assessment

Monitoring of water quality is important in areas where pond turtles occur. Water quality measurements should include dissolved oxygen, pH, turbidity, salinity, nitrate, and phosphate levels. With the training activities that take place on the Base, we also suggest testing water for lead and aluminum.

Monitoring water quality is especially important in the lagoons with pond turtle populations, namely San Mateo, Las Flores, Cockleburr, and possibly Aliso Lagoons. All four of these lagoons are closed lagoons, meaning they are closed to the Pacific Ocean except during periods of heavy rainfall. Contaminants move downstream, become trapped in these closed lagoons, and reach high concentrations.

7.1.5 Genetics Study

Spinks and Shaffer (2005) stated “genetic results emphasize that southern California may be a repository of cryptic genetic diversity worthy of conservation attention”. Further, fine scale genetics is necessary to truly understand relationships within the pond turtle taxon. It is important to maintain genetic diversity and adaptive potential within the species.

A collaborative genetics pond turtle project between CDFG and USGS is currently underway using multiple markers, mtDNA sequences and microsatellite markers. Differentiation between mtDNA sequences will reveal genetic divergences in the maternal lineages of the species and may reveals information about the evolutionary and biogeographic history of the species. Microsatellites are rapidly evolving codominant, nuclear markers that allow for high resolution genotyping of individuals which can be used to delineate population on the basis of genetic similarity. This can be used to make inferences about dispersal of the last 1-2 generations, and to determine levels of genetic diversity contained within populations. These data could be used to implement management strategies including translocation, headstarting, and captive breeding activities consistent with natural patterns of genetic diversity across the landscape.

7.1.6 Movement Pattern Surveys

Minimal data exists regarding the upland movement of the pond turtle in southern California. As a result, little is known about the size of the upland buffer zone required to protect pond turtle populations. In a Mediterranean climate, pond turtles are known to move upland to overwinter, to nest, and to rest for short periods (1–5 days) at terrestrial basking sites (Goodman 1997a, Rathbun et al. 2002). Studies have found pond turtles moving 100 m (328 ft) to over 400 m (1312 ft) perpendicular to aquatic habitat in order to nest (Storer 1930, Rathbun et al. 1992, 2002, Holland 1994, Goodman 1997a, Reese and Welsh 1997, Lovich and Meyer 2002). Further, pond turtles are known to travel 500 m into the upland habitat (Reese and Welsh 1998b, Hayes et al. 1999) with linear home ranges up to 4.26 km (3.65 mi) being reported (Goodman 1997a, Goodman and Stewart 2000). Rathbun et al. (2002) suggests that pond turtles may require long and wide upland habitat corridors, extending at least 0.5 km (0.31 mi) on each side of the aquatic habitat. It is important to protect these upland habitats year-round to safeguard eggs and overwintering hatchlings in nests. Since most of the available upland habitat use data is for northern populations of pond turtles and since these requirements may differ for southern populations, more studies are needed to determine upland requirements of southern pond turtle populations. It is possible that upland habitat is more important in the more arid southern portion of the pond turtle's range, where the aquatic habitat dries regularly.

Movement pattern surveys using radio-telemetry are important in gathering more information on upland and aquatic habitat use, and the timing of these usages. Data collected during movement pattern surveys would benefit the management of pond turtles on the Base by providing information to; 1) identify the size of upland buffer zones, 2) determine time periods when high impact military training might pose a threat to pond turtle upland movements, 3) identify roads posing a threat to pond turtles, and 4) protect important corridors within and between pond turtle populations. The highest priority for these data includes San Mateo Creek and Cockleburr Lagoon.

7.1.7 Reproduction, Recruitment, and Population Viability Surveys

It appears that successful recruitment is low or in some cases not occurring within the Base's pond turtle populations. Future studies will be important in determining; 1) if reproduction is taking place, 2) if recruitment is occurring and at what level, 3) what are the direct and indirect causes of reduced or absent recruitment, and 4) how the negative pressures on recruitment can be reduced or eliminated. Future management strategies may involve protecting nesting females,

finding and protecting nest sites throughout the year, and protecting the juveniles and assessing juvenile feeding and habitat requirements. In addition, we may need to consider headstarting and/or captive rearing may be needed to increase population recruitment (see section 7.8). A reduction in recruitment will reduce and may eventually eliminate pond turtle populations, so this issue should be addressed immediately. However, effective management must also address and protect all life stages in order to maintain viable populations of pond turtles. High adult survival in combination with increased juvenile recruitment could boost pond turtle population numbers and increase the chances of population persistence in the future (Rubin et al. 2004). Long lived species, such as pond turtles, usually possess life history traits limiting their ability to maintain stable populations (i.e. relatively low fecundity, high adult survival), and as a result they require extremely high juvenile survival to maintain population stability (Congdon et al. 1993).

Radio-telemetry would aid in gathering more information on the reproductive status of the pond turtles within the Base. Female pond turtles should be tracked intensively especially during the breeding season to obtain data on reproductive success. In addition to female location data, data should also be recorded for nest location, and nest site characteristics, including soil type, cover, habitat type, aspect, and distance from the water. These data could be used to determine if action needs to be taken to stabilize pond turtle populations on the Base. Radio-telemetry studies are important for upper San Mateo Creek, Cockleburr Lagoon, San Mateo Lagoon, and Las Flores Lagoon. Radio-telemetry studies for the reproduction and recruitment of pond turtles could be combined with the radio-telemetry studies necessary for the movement pattern study (section 7.1.6)

7.2 Natural Threats

Natural threats to pond turtle populations include stochastic and catastrophic events, such as drought, fire, and floods. These events may cause direct mortality or displacement, as well as habitat alteration.

7.2.1 Drought

Drought is an environmental stressor that can result in significant impacts to pond turtle populations. The drought of 1987 – 1991 severely reduced pond turtle populations (Holland 1991). Dan Holland documented the impacts of this drought in San Mateo Creek, where he recorded increases in pond turtle captures/hour due to increases in local density in remaining wet areas. Among the pond turtles captured, he also observed many low weight and stressed individuals (Holland et al. *unpublished report*). Drought increases the concentration of pond turtles, can reduce the number of eggs laid, and may increase emigration, resulting in increased exposure to predation, a decreasing prey base, reduced recruitment, increased road mortality, and altered age structure moving toward adult bias (Gibbons et al. 1983, Holland 1991, Holland et al. *unpublished report*, Jennings and Hayes 1994). We recommend monitoring known pond turtle populations, especially San Mateo Creek, to better understand each individual population and its susceptibility to drought.

7.2.2 Fire

Since pond turtles utilize both terrestrial and aquatic habitat, they are highly susceptible to the impacts of fire. However, little is known about fire impacts on pond turtles. They may be

directly impacted by fire during times when they are occupying the upland habitat, especially during times of overwintering, aestivating, and nesting. Eggs and overwintering hatchlings are likely most vulnerable to fire. Beyond the direct impacts of fire, habitat type conversion can reduce habitat suitability for the pond turtle. Debris flows and the habitat alteration following fire can also convert once suitable aquatic habitat into undesirable habitat. We are particularly concerned about the San Mateo Creek population of pond turtles.

San Mateo Canyon is very similar to pre-fire Fremont Canyon in Orange County, California. Prior to 2006, Fremont Canyon was ideal turtle habitat, with deep rock pools and permanent water. However, post-burn rains averaged 38 cm (15 in), resulting in debris flows and sand deposition throughout Fremont Canyon. These events destroyed what was once optimal pond turtle habitat. Historically, pond turtles survived these events by moving downstream to suitable habitat, but today not much suitable habitat remains. Like Fremont Canyon, San Mateo Creek's pond turtle population is susceptible to the impacts of fire. We recommend monitoring the pond turtle population within San Mateo Creek to better understand the population and its susceptibility to large-scale fires and post-fire effects.

7.3 Large and Mesopredator Species

Raccoons (*Procyon lotor*), skunks (*Mephitis mephitis*), and coyotes (*Canis latrans*) are natural predators of the pond turtle. These species and the non-native opossum (*Didelphis virginiana*) can be highly successful predators, particularly in urban systems. In general, urbanization may expose species, like the pond turtle, to unnaturally high densities of predators. These predators likely have the most impact on nests, but pond turtle adults and hatchlings are also vulnerable especially when occupying terrestrial habitat. Predator populations should be monitored and controlled, if necessary. Predator removal or control has been shown to reduce the number of destroyed turtle nests and enhance hatchling yield (Christiansen and Gallaway 1984).

7.4 Non-native Species

An estimated 50,000 non-native species have been introduced into the United States (Pimentel et al. 2000). Approximately 400 of the 958 species currently listed as threatened or endangered are considered at risk primarily due to competition and predation by non-native species (Wilcove et al. 1998). Non-native species also contribute to the introduction of pathogens and the alteration of habitat. As a result, non-native species represent a growing threat to native wildlife. To protect native species, efforts are needed to control the numbers and spread of non-native species. Non-native aquatic vertebrate species have resulted in declines of amphibians, fish, and turtle species throughout the United States. In southern California crayfish, African clawed frog (*Xenopus laevis*), bullfrog, and several species of turtles and fish are of particular concern for the pond turtle.

7.5 Disturbance

During our survey efforts, we detected only low numbers of female and juvenile pond turtles, as well as low population sizes overall. As a result, the dwindling pond turtle populations left on the Base are at increased risk from human activities related to disturbance and take of pond turtles (e.g. military training, recreation, collection, and roads).

7.5.1 Human Recreation

To minimize disturbance and take of pond turtles, it is recommended limiting human access, in aquatic and upland habitats used by pond turtles. High human activity can all potentially trigger problems for the pond turtle. For example, Garber and Burger (1995) found a 100% decrease in two wood turtle (*Glyptemys insculpta*) populations within 19 years of a wildlife reserve being opened up to recreation. Human activity can lead to collection of turtles, road kills, destruction of habitat, introduction of non-native species (Garber and Berger 1995), and increased predation as a function of increased food waste which may attract predators (raccoons, coyotes) (Joslin and Youmans 1999). It is imperative to manage human activities to prevent or minimize disturbance to pond turtles and their habitat. For example, restricting access to pond turtle upland breeding habitat could help prevent disturbance to all life history stages (eggs, juveniles, and adults). This action would be especially important at San Mateo Lagoon, where pond turtle habitat is located near Trestles Beach.

7.5.2 Roads

High road density near pond turtle populations is a concern. Roads increase the likelihood of turtles being injured or killed due to encounters with vehicles. In addition, there are other potentially negative effects caused by roads, including run-off, pollution, and changes in temperature. Further, greater road densities are associated with turtle populations that are predominantly male. Females are more susceptible to road mortality due to the higher frequency of upland movement associated with nesting (Marchand and Litvaitia 2004, Steen and Gibbs 2004). Greater road densities are also associated with turtle populations containing a higher proportion of adults (Marchland and Litvaitis 2004, Steen and Gibbs 2004), indicating reduced recruitment, possibly as a result of fewer females in the populations. In addition to causing mortality, roads also change soil density, temperature, soil water content, light levels, dust levels, surface waters patterns, runoff, sedimentation, and they add heavy metals (especially lead), salts, organic molecules, ozone, and nutrients to roadside environments (Trombuklak and Frissell 2000).

In locations on the Base where road mortality is an issue, we advise measures to prevent the negative effects of roads on pond turtles. These measures should include monitoring run-off, water quality and creating structures, such as barriers, fences, or wildlife ecopassages (Boarman et al. 1997, Barichivich and Dodd 2002) to divert turtles from roads. Barichivich and Dodd (2002) recorded a 41% decrease in traffic-related wildlife mortality, including a dramatic decline in the number of road-killed turtles, after wildlife ecopassages and wildlife barriers were created near highways. Similarly, Boarman et al. (1997) suggest that barrier fences can reduce wildlife mortality, but must also include a means for animals to safely cross roads to prevent an increase in population fragmentation. Monitoring of roads on the Base to identify locations where road mortality is a problem, Vandergrift Road and Stuart Mesa Road are just some examples. These roads run along or cross the Santa Margarita River. In addition, the unpaved roads near the San Mateo Creek, San Mateo and Cockleburr Lagoons should also be monitored for disturbance from military training activities.

7.5.3 New Construction

Protecting both the aquatic and terrestrial habitats is critical for the management of any semi-aquatic species like the pond turtle (Semlitsch and Jensen 2001). New construction should not

be within 500 m (1640 ft) of any potential pond turtle aquatic habitat. There has been very little study of the upland movements of pond turtles in southern California and as a result, little is known about the size of buffer required to protect pond turtle populations. Pond turtle movement studies (mostly radio-telemetry) have found movement between 100 m (328 ft) to 500 m (1640 ft) perpendicular to wetland habitats to nest (Storer 1930, Holland 1994, Rathbun et al. 1992, Goodman 1997a, Reese and Welsh 1997, Lovich and Meyer 2002, Rathbun et al. 2002) and linear movements up to 4.3 km (Goodman 1997a, Goodman and Stewart 2000). Rathbun et al. (1992) suggests that pond turtles require long and wide upland habitat corridors, extending a minimum of 500 m on each side.

7.6 Education and Outreach

The installation of educational kiosks or signs at recreational areas to educate regarding native species can be useful. Informative displays should provide information such as; 1) access restrictions for sites, 2) importance of not disturbing or molesting wildlife, 3) potential danger(s) of handling and collecting wild animals, 4) ramifications of releasing pets, emphasizing that it is also illegal (California Fish and Game Code Section 2121 and California Penal Code 597s), and 5) information about what to do with unwanted pets. Employees at O'Neill Lake should be educated in identification and basic biology of turtles, to help facilitate the removal of non-native turtles.

7.7 Habitat Restoration and Creation

Creating a management goal to expand the abundance and range of known pond turtle populations through restoration or creation of wetland and upland habitat would help the pond turtle base wide. Habitat degradation or loss can lead to abnormal population structure in pond turtles (Dodd 1990, Reese and Welsh 1998a) and eventually result in population decline, and extirpation. All known populations of pond turtles within the Base would benefit from habitat restoration. Habitat restoration is site specific, and the threats we identified in this study should be addressed to improve current habitat. Habitat creation is another option to consider in when attempting to increase the base wide pond turtle populations and the number of occupied sites.

7.8 Head Starting, Captive Breeding, and Translocation

After threats to pond turtles have been removed and suitable habitat has been restored or created, a reintroduction or population establishment program (using translocation, head starting, or captive rearing) could be considered. The head starting, captive breeding, and reintroduction programs of the Washington Department of Fish and Wildlife and the Oregon Department of Fish and Wildlife have proven that this type of program can be successful in increasing pond turtle populations (Heltzel 2000, Allen and Slavens 2002). More locally, a pond turtle population was successfully established in Orange County, California through the translocation of turtles to an artificial site specifically created for pond turtles (Harmsworth Associates 1998, Harmsworth Associates and Goodman 2000, 2006) and a head starting project is in the beginning phases in San Diego County.

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Appendix 1. Criteria for ranking potential western pond turtle habitat.

This is an excerpt taken from the Orange County Aquatics Management Plan – the Western Spadefoot (*Spea hammondii*) and the Western Pond Turtle (*Emys marmorata*) on the Irvine Ranch Land Reserve (Schuster et al. *unpublished report*).

Habitat Criteria

The Oregon and Washington Departments of Fish and Wildlife have set guidelines, through either pond turtle recovery plans or public outreach, for the restoration or creation of pond turtle habitat (Hayes et al. 1999, Oregon Department of Fish and Wildlife 2000). These guidelines in combination with other turtle research were used to determine habitat characteristics to consider for enhancement, restoration, or creation of pond turtle habitat based on Bash (1999), Hayes et al. (1999), Oregon Department of Fish and Wildlife (2000), and others. This habitat analysis can also be used as a tool to identify suitable pond turtle habitat. Although requirements are based on northern populations of pond turtles, they provide useful guidelines for southern populations.

To better assess site suitability for the pond turtle, a list of habitat criteria was developed to analyze and rank all of the waters in Orange County. This three step rating system will help identify the management issues as well as priorities for habitat enhancement or restoration for sites within each management unit. The evaluation process will utilize ArcGIS® to identify potential pond turtle habitat and sites within the management units by using the spatial coverage for habitat characteristics required by the pond turtle. This analysis will result in a ranking of potential pond turtle habitat as high, medium, low, and poor. This will serve as our simple model or hypothesis of sites where the pond turtle could occur within the county. Sites ranked as high or medium will be evaluated to further identify issues at a site specific level to help guide habitat enhancement or restoration efforts.

GIS Analysis

Below are descriptions of criteria identified to predict suitable habitat characteristics for the pond turtle.

1. **Water Permanency:** Water is a necessary habitat requirement for the pond turtle. Permanent water is preferred pond turtle habitat; however, permanent water can increase the number of non-native aquatic species at a site. Most non-native species require permanent water. Sites with permanent water may require exotic species control. Ephemeral water is suitable pond turtle habitat; however the pond turtle must find refuge once the site dries.

   Ranking:

   Potential Habitat –Water is present during the spring of an average rainfall year.
   Not Potential Habitat – No water is present.

Appendix 1 (cont). Criteria for ranking potential western pond turtle habitat.

2. **Channel Type:** Channels must have some natural substrate to support pond turtles.

   Ranking:
   Potential Habitat – Channel with natural substrate (natural watercourse, earthen channel, concrete lined with soft bottom, and riprap).
   Not Potential Habitat – Channel with no natural substrate (concrete lined or conduit).

3. **Upland Buffer:** Upland natural habitat at least 50 m from water bodies.

   Ranking:
   Potential Habitat – Water body has the characteristics listed above.
   Not Potential Habitat – Water body does not have the characteristics listed above.

Ranking of Potential Habitat Enhancement, Restoration, or Creation Areas

Once sites have been determined based on the minimum habitat requirements, sites are ranked against a second set of criteria (step 2). Criteria components are categorized into high, medium, low, or poor with a point value associated with each; high is 3 points, medium is 2 points, low is 1 point, and poor is 0 points. Point values can range from 27 – 0 points.

1. **Non-native Turtle Presence:** The introduction of non-native turtles to a site negatively affects all life stages of the pond turtle (Spinks et al. 2003). This topic is discussed in detail in section 4.3.3.

   Ranking:
   High (3 points) No non-native turtles present.
   Medium (2 points) Non-breeding population of non-native turtle present.
   Low (1 point) A small population of non-native turtle present.
   Poor (0 points) A thriving population of non-native turtles.

2. **Water Depth:** Water bodies should contain still or slow-moving water with some areas with at least one meter, but preferably up two meters deep for adults (Hayes et al. 1999, and Oregon Department of Fish and Wildlife 2000).

   Ranking:
   High (3 points) Sites that are greater than 1 m in depth.
   Low (1 point) Sites that are between 0.5 – 1 m in depth.
   Poor (0 points) Sites less than 0.5 m in depth.

Appendix 1 (cont). Criteria for ranking potential western pond turtle habitat.

3. **Aquatic Substrate:** Pond turtles are predicted to occur in natural water bodies, including those modified to increase or decrease aquatic habitats (Madden-Smith et al. 2005).

   Ranking:
   High (3 points) Natural water bodies without modifications (natural watercourse).
   Low (1 point) Natural water bodies with modifications (earthen channel).
   Poor (0 points) Modified water bodies (concrete lined with soft bottom or riprap).

4. **Aquatic Vegetation:** There should be emergent and submergent aquatic vegetation present, but the water body should get good sun exposure. Reese and Welsh (1998b) suggest that some cover, especially along the waters edge, may help pond turtles avoid predation and that pools receiving patchy sunshine may allow for better thermoregulation (Oregon Department of Fish and Wildlife 2000). If the water bodies become too choked with vegetation, some vegetation should be removed (Oregon Department of Fish and Wildlife 2000).

   Ranking:
   High (2 points) Both emergent and submergent aquatic vegetation present.
   Low (1 point) One type of aquatic vegetation present either emergent or submergent.
   Poor (0 points) No aquatic vegetation present.

5. **Aquatic Refugia:** Aquatic refugia should be present to aid pond turtles in the avoidance of predators by diving into the interstitial spaces formed underwater by woody debris, submergent vegetation, roots balls, rocks, and undercut banks (Hayes et al. 1999, Oregon Department of Fish and Wildlife 2000). Pond turtles may also use the aquatic refugia to sleep, especially in crevices under logs (F. Slavens, pers. comm. 1999 in Bash, 1999).

   Ranking:
   High (1 points) aquatic refugia present (undercuts, tree roots, woody debris, rock crevices, aquatic submergent vegetation, aquatic emergent vegetation, floating materials, other).
   Poor (0 points) No aquatic refugia present.

Appendix 1 (cont). Criteria for ranking potential western pond turtle habitat.

6. **Hatchling Habitat:** Hatchlings require shores with a gentle gradient with water less than 30 cm (1 foot). At least 25 percent of the water's edge should be less than 30 cm deep with a gentle gradient for young juveniles (Hayes et al. 1999, Oregon Department of Fish and Wildlife 2000). Native plants and small root balls or tree branches should be available in shallow areas for juveniles to take refuge.

   Ranking:
   High (2 points) 25% of the waters edge less than 30 cm deep and a gradual gradient.
   Low (1 point) either 25% of water's edge less than 30 cm deep or a gentle gradient.
   Poor (0 points) 25% of the water's edge is greater than 30 cm deep with no gradual gradient.

7. **Basking Sites:** Aquatic basking sites, such as logs, rocks, vegetation, or root balls provide safe basking areas for pond turtles (Hayes et al. 1999, Oregon Department of Fish and Wildlife 2000). Pond turtles appear to be more abundant in habitats that have basking sites (Holland and Bury 1998).

   Ranking:
   High (1 points) Basking sites present.
   Poor (0 points) Basking sites not present.

8. **Terrestrial Habitat Buffer:** Protect upland habitats at least 500 m (546 yd) from water bodies. There has been very little study of the upland movements of pond turtles in southern California and as a result, little is known about the size of the upland buffer zone required to protect pond turtle populations. Studies (mostly radio-telemetry studies) of pond turtles have found pond turtles moving a maximum of 100 m (109 yd) to just over 400 m (437 yd) perpendicular to wetland habitats to nest (Storer 1930, Rathbun et al. 1992, Holland 1994, Goodman 1997a, Reese and Welsh 1997, Lovich and Meyer 2002, Rathbun et al. 2002). Pond turtles are known to travel as far as 500 m (546 yd) into the uplands (Reese and Welsh 1998b, Hayes et al. 1999) and linear home ranges as long as 4263.2 m (4662 yd) have been reported (Goodman 1997a, Goodman and Stewart 2000). Rathbun et al. (1992) suggest that pond turtles may require a long and wide upland habitat corridor, extending a minimum of 500 m on each side of the wetland habitat and that it is important to protect these habitats year-round in order to protect eggs and overwintering hatchlings in nests. It is possible that upland habitat is more important in the more arid southern portion of the pond turtle's range, where rivers and streams regularly dry as a result of drought

Appendix 1 (cont). Criteria for ranking potential western pond turtle habitat.

and/or diversion or damming to support human water needs (e.g., drinking water, agriculture). A buffer zone is also needed around known nest sites protecting these areas from grazing, human recreation, and predation.

A study by Semlitsch and Jensen (2001) on three species of aquatic turtles in the southeast found that 275 m (302 yd) of upland habitat is necessary to fully protect aquatic turtle nesting overwintering sites. This 275 m (302 yd) of upland includes core habitat surrounded by a 50 m (54 yd) terrestrial buffer to ensure the protection of core habitat (Semlitsch and Jensen 2001). Temple (1987) found a reduction in nest predation of nests that were greater than 50 m (54 yd) from the edge of a habitat.

Ranking:

High (3 points) A > 500 m buffer exists within the site.
Medium (2 points) A 499 – 275 m buffer exist within the site.
Low (1 point) A 274 – 51 m buffer exists within the site.
Poor (0 points) A ≤ 50 m of buffer exist within the site.

9. **Canopy Cover:** Reese and Welsh (1998b) determined canopy cover is an important habitat characteristic for the pond turtle which provides protection from predators, decrease human accessibility, decrease visibility, increases camouflage. The conditions of patchy sunlight created by canopy cover allow pond turtles to thermoregulate efficiently, by shifting there body position (Holland 1985 in Reese and Welsh 1998b).

Ranking:

High (2 points) Canopy cover between 11 – 50%.
Low (1 point) Canopy cover between 1 – 10% or 50 – 75%.
Poor (0 points) Canopy cover 0% or 76 – 100%.

10. **Terrestrial Refugia:** Terrestrial refugia are present in the form of logs, vegetation, or leaf litter for use by pond turtles (Hayes et al. 1999). Individuals use refugia as hiding or resting sites as they move through the habitat or as shelters for aestivation and overwintering (Hayes et al. 1999). Overwintering sites within the terrestrial habitat commonly utilized are the leaf litter near trees or shrubs. Logs are primarily used in hiding or resting and are not necessarily a requirement for aestivation or overwintering (Bash 1999).

Ranking:

High (1 points) Terrestrial refugia present (vegetation, logs, leaf litter, or other).
Poor (0 points) Terrestrial refugia not present.

Appendix 1 (cont). Criteria for ranking potential western pond turtle habitat.

11. **Human Access:** Pond turtles are more abundant in areas with less human access (Madden-Smith et al. 2005). With human access comes increased introduction of non-native species, collection of pond turtles, and disturbance of individuals and habitat.

    Ranking:
    High (3 points) Sites that are remote or sites with restricted or limited access, i.e. wilderness areas or ecological reserves.
    Low (1 point) Sites with moderate visitation.
    Poor (0 points) Sites with no access restrictions.

Management Issues and Action Items Necessary at Each Site

Once a site has been ranked against the first two sets of criteria (steps 1 and 2), high ranked sites need to be assessed on a site-by-site basis (step 3). This will help identify unique management issues within each site. The ranking and discussion of the sites within the Irvine Ranch Wildlands will be discussed in the second phase of this plan.
Once a site is identified for habitat enhancement or restoration, additional criteria (listed below) should be applied to the site. These criteria will assess specific site characteristics important to pond turtle persistence and guide the habitat enhancement or restoration process.

12. **Native Turtle Presence:** Do pond turtles currently occupy this site? Sites with recent or historic records for pond turtles should be higher priorities. Questions that should be asked about the pond turtles at each site; 1) Is there any current or historic pond turtle records at this site, 2) Are there sites close by with known pond turtle populations, 3) Pond turtles present, but is there successful breeding and recruitment, 4) If it's a breeding population how is the population doing, are populations increasing, stable, or declining.

13. **Connectivity Within Site:** Pond turtle mortality increases with the presence of roads (Trombulak and Frissell 2000, Gibbs and Shriver 2002, Aresco 2005). Safe passage is required between multiple water bodies within the site and to access adjacent terrestrial habitat for egg laying.

14. **Connectivity Between Sites:** Travel corridors such as streams, rivers, and riparian areas should allow movement between pools, ponds, and populations (important for maintaining genetic diversity).

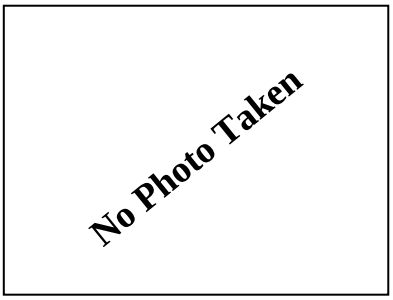
15. **Nesting Habitat:** Pond turtles appear to prefer nesting habitat in open sunny areas with southern exposure, sparse vegetation, and bare soils. They seem to travel a clear visual path between the water and the nesting habitat (Hayes et al. 1999 and Oregon Department of Fish and Wildlife 2000).

Appendix 1 (cont). Criteria for ranking potential western pond turtle habitat.

16. **Chemical Control:** Chemical use (fungicides, herbicides, insecticides, and pesticides) must be considered when restoring or creating habitat for pond turtles. Chemical removal of vegetation or insects should be avoided as they might affect or contaminate the pond turtle and their food source. Rotenone, a commonly used pesticide for fishery management, has been documented to kill turtles and should not be used in areas where pond turtles occur (Fontenot et al. 1994).

17. **Predators:** A number of non-native aquatic and terrestrial predators such as bass, bullfrogs, raccoons, and opossums affect the success of the pond turtle. As nest predation increases the more fragmented the habitat becomes (Temple 1987).

Appendix 2. Survey locations for the western pond turtle on Marine Corps Base Camp Pendleton, California in 2010.



1. Cristianitos

2a. San Mateo Creek, Lower

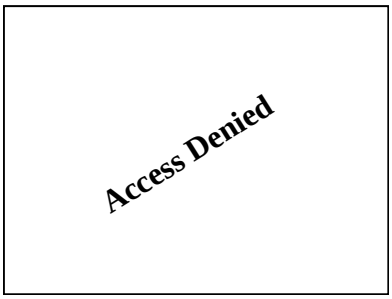
2b. San Mateo Creek, Middle

2c. San Mateo Creek, Upper

3. San Mateo Lagoon

4. San Mateo Sewage Disposal Pond

5. Aliso Lagoon

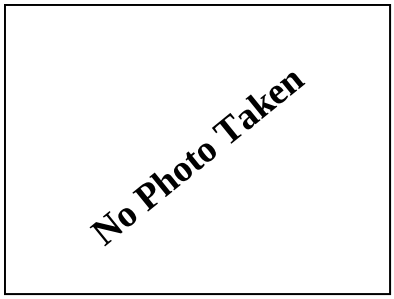


6. ASP Pond

7. Cockleburr Lagoon

8. Las Flores Creek

9. Las Flores Lagoon



10. LCAC Pond

Appendix 2 (cont). Survey locations for the western pond turtle on Marine Corps Base Camp Pendleton, California in 2010.

11. Stuart Mesa Pond

12. O'Neill Lake

13. O'Neill Lake Canal

14a. Santa Margarita River, Lower

14b. Santa Margarita River, Middle

14c. Santa Margarita River, Upper

15. Horseshoe Reservoir

16. Windmill Lake

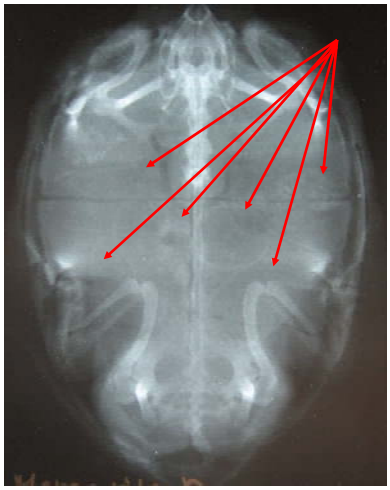
Appendix 3. Western pond turtle x-ray voucher for each site where gravid females detected.

1. Cristianitos

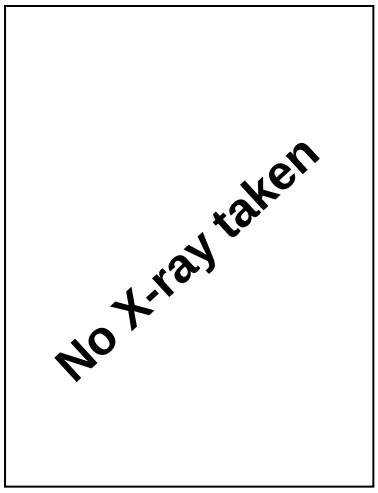
2c. San Mateo Creek, Upper

7. Cockleburr Lagoon

9. Las Flores Lagoon



12a. Santa Margarita River, Lower



12c. Santa Margarita River, Upper

Appendix 4. Western pond turtle capture data from Marine Corps Base Camp Pendleton, California in 2010.

Site Number[1]	Site Name	Portion of the Site	Date	PIT-tag Identification Number	Marginal Scute Identification Number	Age	Gender	Weight (g)	Carapace Length (mm)	Carapace Width (mm)	Carapace Height (mm)	Plastron Length (mm)	UTM Easting [2]	UTM Northing [2]
San Juan Watershed (hu)[2] - San Mateo (ha)[3]														
1	Cristianitos Creek	Upper	5/26/2010	–	70 USGS	Adult	Female	452	141.4	111.7	58	123	446891	3701286
2a	San Mateo Creek	Lower	5/11/2010	48615828	51 USGS	Adult	Male	336	138	102.1	48	119.1	446122	3697136
			5/11/2010	48599846	Holland 52	Adult	Male	362	141.3	103.2	47	116.5	446121	3697124
			5/14/2010	48584524	53 USGS	Adult	Male	390	144.1	110.8	117.3	47	446114	3697124
2b	San Mateo Creek	Middle	6/22/2010	48607052	93 USGS	Adult	Male	454	145	122.5	49.5	125.3	448500	3697852
2c	San Mateo Creek	Upper	4/15/2010	48610087	44 USGS	Adult	Female	500	145.4	–	53	130.3	454005	3702380
			5/25/2010	48589304	69 USGS	Juvenile	Male	150	101.1	76	35.5	88.4	456260	3703554
			5/25/2010	48605558	58 USGS	Adult	Female	182	106	84.5	49.5	92.4	454315	3702483
			5/25/2010	48595582	56 USGS	Adult	Male	222	119.3	88.7	103.6	40	454315	3702483
			5/25/2010	48592330	65 USGS	Adult	Male	270	124.5	91.9	44	106.5	456165	3703577
			5/25/2010	48615352	66 USGS	Adult	Female	278	126	96.6	46	108.9	456165	3703577
			5/25/2010	48605259	60 USGS	Adult	Male	266	127.9	94.2	43	110.6	454483	3702680
			5/25/2010	–	59 USGS	Adult	Female	358	128	95.4	53	113.7	454315	3702483
			5/25/2010	48610608	67 USGS	Adult	Male	326	134.2	97.3	47	112.9	456165	3703577
			5/25/2010	48588863	68 USGS	Adult	Male	334	139.8	48	101.4	122.1	456266	3703547
			5/25/2010	–	–	Adult	Female	–	–	–	–	–	454315	3702483
			5/28/2010	–	200 USGS	Adult	Female	386	121.4	89	50	112.8	456266	3703547
			5/28/2010	48609863	75 USGS	Adult	Male	250	123	90.3	41	104.5	454490	3702688
			5/28/2010	48589308	71 USGS	Adult	Male	252	125.3	96.6	40	106.6	451661	3699689
			5/28/2010	48585549	74 USGS	Adult	Male	230	126.5	98.5	44	107.1	454490	3702688
			5/28/2010	48611337	73 USGS	Adult	Male	234	126.6	91	44	109.2	451661	3699689
			5/28/2010	48599344	71 USGS	Adult	Male	342	132.3	92.2	43	118.4	451661	3699689
			6/23/2010	48599598	95 USGS	Adult	Male	230	122.1	88.7	40	103.1	456248	3703549
			6/23/2010	96816377	Holland: 4939	Adult	Female	318	125.8	95.3	48	108.5	456225	3703556
			6/23/2010	–	Holland: 700	Adult	Female	310	130	98.6	49.5	111.6	456089	3703561
			6/23/2010	96854880	94 USGS	Adult	Male	346	144.6	106.4	46.5	124.3	456089	3703561
			6/24/2010	–	Holland: 730	Adult	Female	336	128.3	93.9	50	113.9	456248	3703549
			6/24/2010	–	96 USGS	Adult	Female	462	144	105.1	56	124.5	456075	3703537
			6/25/2010	48595356	98 USGS	Adult	Female	356	137.5	101.3	45	121.1	454332	3702469
			6/25/2010	48599522	97 USGS	Adult	Male	364	144.1	110.8	46	116.3	454332	3702469
			7/20/2010	–	116 USGS	Adult	Female	430	148.5	106.5	53	130.6	451644	3699673
			7/28/2010	53565263	125 USGS	Adult	Male	176	109.3	84.3	37	94.6	456422	3703710
			7/28/2010	53523348	124 USGS	Adult	Male	260	122.5	86.9	43	107.3	456264	3703568
			7/28/2010	48592330	65 USGS	Adult	Male	272	124.2	91.7	44	105.9	456507	3703829

[1] *Number corresponds with location on map, Figure 6*

[2] *Location obtained in WGS 84 datum, Zone 11S*

[2] *Hydrologic unit - a drainage area, based on the California Watershed Portal*

[3] *Hydrologic area - major subdivisions of hydrologic units, based on the California Watershed Portal*

Appendix 4 (cont). Western pond turtle capture data from Marine Corps Base Camp Pendleton, California in 2010.

Site Number[1]	Site Name	Portion of the Site	Date	PIT-tag Identification Number	Marginal Scute Identification Number	Age	Gender	Weight (g)	Carapace Length (mm)	Carapace Width (mm)	Carapace Height (mm)	Plastron Length (mm)	UTM Easting [2]	UTM Northing [2]
San Juan Watershed (hu)[2] - San Mateo (ha)[3]														
2c	San Mateo Creek	San Mateo Creek, Upper	7/28/2010	53559056	123 USGS	Adult	Female	300	128.7	94.4	47.5	111.4	456306	3703564
			7/29/2010	96816377	Holland: 4939	Adult	Female	294	125.8	99	108.4	48	456264	3703568
			7/29/2010	53530376	126 USGS	Adult	Female	352	128.6	98	49	115.5	456680	3703914
			7/30/2010	53556054	127 USGS	Adult	Female	224	116.1	87.6	42	109	456902	3703744
			7/30/2010	53534822	128 USGS	Adult	Male	312	133.2	99.8	46	112.8	456249	3703548
			7/30/2010	53537016	96 USGS	Adult	Female	426	143.6	103.5	53	124.2	456260	3703529
			7/30/2010	96816377	Holland: 4939	Adult	Female	–	–	–	–	–	456244	3703542
			7/31/2010	48615352	66 USGS	Adult	Female	270	126.4	97.7	45.5	108.8	456060	3703523
			7/31/2010	48585549	74 USGS	Adult	Male	306	129.2	104.4	45.5	107.9	456304	3703522
			7/31/2010	48588863	68 USGS	Adult	Male	342	139.8	87.8	48	122	456680	3703914
			7/31/2010	53537016	96 USGS	Adult	Female	–	–	–	–	–	456276	3703562
			9/8/2010	53526107	135 USGS	Adult	Male	250	119.7	87.1	44.5	103.6	456248	3703549
			9/8/2010	53550110	136 USGS	Adult	Male	232	122.6	94	50	106.5	456248	3703549
			9/8/2010	53523348	124 USGS	Adult	Male	264	124.8	93.1	43	107.9	456248	3703549
			9/8/2010	53556377	133 USGS	Adult	Female	264	125.3	98.6	46	112	456248	3703549
			9/8/2010	53559056	123 USGS	Adult	Female	306	128.9	93.5	48	111.7	456248	3703549
			9/8/2010	53554033	134 USGS	Adult	Female	320	132.7	99.2	50	114.8	456248	3703549
			9/8/2010	53558011	132 USGS	Adult	Female	352	135.6	98.8	51.5	119.4	456248	3703549
			9/8/2010	48595356	98 USGS	Adult	Female	360	138.1	101.9	46	121.5	456248	3703549
			9/8/2010	53542286	131 USGS	Adult	Male	340	138.8	104.8	47	116.7	456248	3703549
			9/8/2010	53531306	129 USGS	Adult	Female	376	140.2	104.2	52	121.6	456248	3703549
			9/8/2010	53536336	130 USGS	Adult	Female	642	168.5	120.3	62	147.7	456248	3703549
3	San Mateo Lagoon	All	4/6/2010	48606779	39 USGS	Adult	Male	218	115.6	89.4	41.5	95	444985	3694475
			4/6/2010	20850594	119 USGS	Adult	Male	414	144.7	106.5	51.5	124.5	445016	3694550
			4/8/2010	48593605	42 USGS	Adult	Male	430	149.6	108.3	51	123.3	444863	3694409
			6/30/2010	48001533	10 USGS	Juvenile	Female	105	88.5	69.3	32	74.9	444920	3694439
			6/30/2010	48606779	39 USGS	Adult	Male	230	118.2	91.3	41	96.1	444781	3694373
			7/20/2010	48611307	115 USGS	Adult	Male	282	136	101.4	46	112.3	445002	3694536
San Juan Watershed (hu)[5] - San Onofre (ha)[6]														
5	Aliso Lagoon	All	3/23/2010	43108837	40 USGS	Juvenile	Male	106	88.5	79.5	32.5	82.5	458809	3680964

[1] *Number corresponds with location on map, Figure 6*

[2] *Location obtained in WGS 84 datum, Zone 11S*

[2] *Hydrologic unit - a drainage area, based on the California Watershed Portal*

[3] *Hydrologic area - major subdivisions of hydrologic units, based on the California Watershed Portal*

Appendix 4 (cont). Western pond turtle capture data from Marine Corps Base Camp Pendleton, California in 2010.

Site Number[1]	Site Name	Portion of the Site	Date	PIT-tag Identification Number	Marginal Scute Identification Number	Age	Gender	Weight (g)	Carapace Length (mm)	Carapace Width (mm)	Carapace Height (mm)	Plastron Length (mm)	UTM Easting [2]	UTM Northing [2]
San Juan Watershed (hu)[5] - San Onofre (ha)[6]														
7	Cockleburr Lagoon	All	3/23/2010	43104363	12 USGS	Juvenile	Male	94	85.6	68.8	32	75.7	459806	3679168
			3/23/2010	48605370	18 USGS	Juvenile	Female	94	86.6	68.4	31	78.1	459849	3679212
			3/23/2010	48609077	24 USGS	Juvenile	Female	102	88.5	75	31.5	78.1	459859	3679232
			3/23/2010	48615524	20 USGS	Juvenile	Female	128	94.8	74.7	34.5	82.8	459849	3679205
			3/23/2010	48588020	15 USGS	Juvenile	Male	124	95.9	75.5	33.5	84.1	459850	3679182
			3/23/2010	96846059	21 USGS	Adult	Male	172	104.4	80.2	37	90.5	459859	3679232
			3/23/2010	43269529	2 USGS	Adult	Male	144	105.5	81.5	35	91.2	459804	3679144
			3/23/2010	96850524	9 USGS	Adult	Male	166	105.6	80.6	36.5	90.4	459806	3679159
			3/23/2010	96853332	8 USGS	Adult	Male	182	107.5	83.6	37.5	96.4	459806	3679159
			3/23/2010	43117843	6 USGS	Adult	Male	180	107.7	82.5	37.5	90.9	459827	3679149
			3/23/2010	43111551	13 USGS	Adult	Male	184	110.2	88.6	38	94.6	459833	3679193
			3/23/2010	43268590	3 USGS	Adult	Male	196	111.1	86.3	39	94.7	459796	3679162
			3/23/2010	96850860	17 USGS	Adult	Male	208	111.5	88.8	39	99.8	459849	3679212
			3/23/2010	43119604	7 USGS	Adult	Male	200	112.9	89.8	38	95	459827	3679149
			3/23/2010	59078590	Holland: 100	Adult	Male	198	114.3	98.7	85	40.5	459859	3679232
			3/23/2010	96828580	Holland: 5807	Adult	Male	216	115.5	90.3	40	96.4	459804	3679144
			3/23/2010	59121261	1 USGS	Adult	Male	192	115.7	90.1	38.5	98.2	459804	3679144
			3/23/2010	96811806	19 USGS	Adult	Male	228	116	89.3	40	101.3	459849	3679205
			3/23/2010	96822376	16 USGS	Adult	Male	210	116.4	91	40	95.5	459851	3679202
			3/23/2010	48597278	Holland: 907	Adult	Female	264	116.6	89.2	46.5	107.5	459843	3679204
			3/23/2010	96833083	Holland: 136	Adult	Male	248	118.8	90.4	42	102	459859	3679232
			3/23/2010	20870874	Holland: 500 or 600	Adult	Male	228	119.3	84.5	41	104.9	459849	3679212
			3/23/2010	48586049	22 USGS	Adult	Male	214	119.7	92.8	40.5	102.2	459859	3679232
			3/23/2010	96845095	Holland: 1338?	Adult	Female	264	121.2	94.1	46.5	102.4	459851	3679202
			3/23/2010	96845782	14 USGS	Adult	Female	244	121.5	95.1	42	108.6	459843	3679204
			3/23/2010	63770590	Holland: 10	Adult	Male	214	121.7	88.1	39	104.8	459806	3679168
			3/23/2010	43279351	4 USGS	Adult	Female	284	121.8	97.9	46	106.3	459796	3679162
			3/23/2010	96828554	Holland: 2815	Adult	Male	232	122.4	91.6	41	107.3	459804	3679144
			3/23/2010	20883092	Holland: 1606	Adult	Male	274	123.1	93.3	43.5	103.6	459796	3679162
			3/23/2010	20841358	5 USGS	Adult	Male	240	123.3	95.2	4	104.1	459827	3679149
			3/23/2010	59548269	11 USGS	Adult	Male	240	124.1	90.1	39.5	108.7	459806	3679168
			3/23/2010	59556309	Holland: 1229	Adult	Male	312	128.1	95.2	45	112.1	459827	3679149
			3/23/2010	96812318	Holland: 5809	Adult	Female	334	129.1	98.2	46	117.9	459804	3679144
			3/23/2010	20835328	Holland: 960	Adult	Male	302	129.1	95.3	46	105.6	459827	3679149

[1] *Number corresponds with location on map, Figure 6*

[2] *Location obtained in WGS 84 datum, Zone 11S*

[2] *Hydrologic unit - a drainage area, based on the California Watershed Portal*

[3] *Hydrologic area - major subdivisions of hydrologic units, based on the California Watershed Portal*

Appendix 4 (cont). Western pond turtle capture data from Marine Corps Base Camp Pendleton, California in 2010.

Site Number[1]	Site Name	Portion of the Site	Date	PIT-tag Identification Number	Marginal Scute Identification Number	Age	Gender	Weight (g)	Carapace Length (mm)	Carapace Width (mm)	Carapace Height (mm)	Plastron Length (mm)	UTM Easting [2]	UTM Northing [2]
San Juan Watershed (hu)[5] - San Onofre (ha)[6]														
7	Cockleburr Lagoon	All	3/23/2010	43109892	Holland: 1320 or 1322	Adult	Female	362	132.9	103.4	50	122.8	459827	3679149
			3/23/2010	20868349	Holland: 870 or 872	Adult	Female	356	132.9	100.4	50	117.9	459827	3679149
			3/24/2010	–	34 USGS	Juvenile	–	40	63.4	53.5	23	55.7	459849	3679212
			3/24/2010	–	33 USGS	Juvenile	Male	68	78.1	61.9	27.5	68.9	459849	3679212
			3/24/2010	48588076	29 USGS	Juvenile	Male	90	82.9	65.7	29.5	77.8	459833	3679193
			3/24/2010	96823341	30 USGS	Juvenile	Male	92	85.6	64.5	31	79.3	459843	3679204
			3/24/2010	48590572	23 USGS	Juvenile	Male	120	89.7	69.9	32	80.5	459859	3679232
			3/24/2010	96822000	25 USGS	Adult	Male	200	107.7	78.6	39	98.9	459806	3679159
			3/24/2010	96828580	Holland: 5807	Adult	Male	208	114.7	83.4	41	94.6	459840	3679202
			3/24/2010	43111115	Holland: 1706 or 1707	Adult	Male	258	115.7	84.5	44	96.2	459843	3679204
			3/24/2010	20850316	28 USGS	Adult	Male	214	116.3	85.8	40	96.4	459840	3679202
			3/24/2010	96833083	Holland: 136	Adult	Male	248	117.6	90.3	41	101.8	459840	3679202
			3/24/2010	20870874	Holland: 500 or 600	Adult	Male	228	118.1	84.3	41	104.3	459833	3679193
			3/24/2010	48600563	31 USGS	Adult	Male	228	119.3	86.3	41	102.8	459859	3679232
			3/24/2010	21004047	Holland: 2706 or 2707	Adult	Female	282	119.8	86.9	48	103.8	459843	3679204
			3/24/2010	48596024	32 USGS	Adult	Male	236	120	90.1	41	100.9	459859	3679232
			3/24/2010	20841358	5 USGS	Adult	Male	246	121.5	88.5	39.5	104	459851	3679202
			3/24/2010	20884629	27 USGS	Adult	Female	274	122.2	84.5	48	111.9	459827	3679149
			3/24/2010	48584865	Holland: 1209	Adult	Male	280	123.9	96.2	43	114.8	459851	3679202
			3/24/2010	20875548	Holland: 101	Adult	Female	292	126.2	91.7	46	109.3	459806	3679168
			3/24/2010	96812318	Holland: 5809	Adult	Female	326	127.2	117.9	46	97.4	459849	3679212
			3/24/2010	48612602	Holland: 131	Adult	Male	258	128	84.3	43	103.1	459806	3679168
			3/24/2010	107636097	26 USGS	Adult	Male	298	129.7	112.8	99.7	44	459796	3679162
			3/24/2010	48599596	Holland: 5614	Adult	Male	328	130.5	95.9	47	112.7	459859	3679232
			3/24/2010	59548269	11 USGS	Adult	Male	–	–	–	–	–	459796	3679162
			3/24/2010	96828554	Holland: 2815	Adult	Male	–	–	–	–	–	459840	3679202
			3/25/2010	43111115	35 USGS	Adult	Male	148	102.2	80.7	34.5	90.5	459849	3679212
			3/25/2010	96851591	Holland: 1108	Adult	Female	228	112.5	90.2	43	98.5	459851	3679202
			3/25/2010	96844345	36 USGS	Adult	Female	242	114.8	98.8	40.5	102	459820	3679122
			3/25/2010	59798799	Holland: 260 or 270	Adult	Female	258	122.8	95	44	106.6	459806	3679168
			3/25/2010	59121261	1 USGS	Adult	Male	–	–	–	–	–	459849	3679205
			3/25/2010	48586049	22 USGS	Adult	Male	–	–	–	–	–	459806	3679168
			3/25/2010	107636097	26 USGS	Adult	Male	–	–	–	–	–	459833	3679193
			3/25/2010	20884629	27 USGS	Adult	Female	–	–	–	–	–	459806	3679159

[1] *Number corresponds with location on map, Figure 6*

[2] *Location obtained in WGS 84 datum, Zone 11S*

[2] *Hydrologic unit - a drainage area, based on the California Watershed Portal*

[3] *Hydrologic area - major subdivisions of hydrologic units, based on the California Watershed Portal*

Appendix 4 (cont). Western pond turtle capture data from Marine Corps Base Camp Pendleton, California in 2010.

Site Number[1]	Site Name	Portion of the Site	Date	PIT-tag Identification Number	Marginal Scute Identification Number	Age	Gender	Weight (g)	Carapace Length (mm)	Carapace Width (mm)	Carapace Height (mm)	Plastron Length (mm)	UTM Easting [2]	UTM Northing [2]
San Juan Watershed (hu)[5] - San Onofre (ha)[6]														
			3/25/2010	20850316	28 USGS	Adult	Male	–	–	–	–	–	459796	3679162
			3/25/2010	96833083	Holland: 136	Adult	Male	–	–	–	–	–	459849	3679212
			3/25/2010	20883092	Holland: 1606	Adult	Male	–	–	–	–	–	459851	3679202
			3/25/2010	96828554	Holland: 2815	Adult	Male	–	–	–	–	–	459849	3679205
			3/25/2010	20870874	Holland: 500 or 600	Adult	Male	–	–	–	–	–	459859	3679232
			3/25/2010	48599596	Holland: 5614	Adult	Male	–	–	–	–	–	459843	3679204
			3/25/2010	96812318	Holland: 5809	Adult	Female	332	–	–	–	–	459812	3679175
			3/25/2010	20835328	Holland: 959	Adult	Male	–	–	–	–	–	459849	3679212
			3/26/2010	48611569	37 USGS	Juvenile	Male	94	83.8	67.4	30	75.9	459849	3679212
			3/26/2010	48587636	38 USGS	Juvenile	Female	104	92.9	70	32	81.6	459827	3679114
			3/26/2010	48611815	Holland: 50	Adult	Female	218	114.3	80.5	41	104.1	459797	3679136
			3/26/2010	96812310	Holland: 200, 9, 800, 1600, ?10 and 3200	Adult	Male	330	129	96.3	47	119.1	459796	3679162
			3/26/2010	20884629	27 USGS	Adult	Female	–	–	–	–	–	459851	3679202
			3/26/2010	20850316	28 USGS	Adult	Male	–	–	–	–	–	459806	3679159
			3/26/2010	96833083	Holland: 136	Adult	Male	–	–	–	–	–	459843	3679204
			3/26/2010	96828554	Holland: 2815	Adult	Male	–	–	–	–	–	459806	3679159
7	Cockleburr Lagoon	All	5/1/2010	–	48 USGS	Juvenile	Female	64	75.7	60.7	26	67.5	459810	3679125
			5/1/2010	96818784	Holland: 130?	Adult	Male	220	113.8	89.3	41	94.3	459806	3679168
			5/1/2010	96828580	Holland: 5807	Adult	Male	202	114.9	83.9	40	94.8	459840	3679201
			5/1/2010	59554057	47 USGS	Adult	Male	268	122.6	88.9	44.5	104.3	459810	3679125
			5/1/2010	20883092	Holland:1616	Adult	Male	258	123.1	94	43	102.8	459840	3679201
			5/1/2010	107636097	26 USGS	Adult	Male	300	130	97.5	112.9	45	459804	3679128
			5/2/2010	48585035	49 USGS	Adult	Male	82	86.5	67.3	39	78.3	459831	3679187
			5/2/2010	20850316	28 USGS	Adult	Male	218	117	87.7	40	96.9	459812	3679119
			5/2/2010	63770590	Holland: 10	Adult	Male	214	119.9	86.3	39	104.8	459840	3679201
			5/3/2010	48590572	23 USGS	Juvenile	Male	104	89.4	69.7	31	81	459806	3679168
			5/3/2010	48615524	20 USGS	Juvenile	Female	128	95.1	72.2	34	82.7	459840	3679201
			5/3/2010	43119604	7 USGS	Adult	Male	188	113.2	87.9	38	95.3	459840	3679202
			5/3/2010	20850316	28 USGS	Adult	Male	206	117.5	87.3	40	96.9	459806	3679168
			5/3/2010	21004047	Holland: 2706 or 2709	Adult	Female	296	120.2	89.6	47	104	459804	3679128
			5/3/2010	43279351	4 USGS	Adult	Female	300	121.8	90.7	47	106.6	459812	3679119
			5/3/2010	20841358	5 USGS	Adult	Male	236	122.8	89.2	39	104.2	459804	3679128
			5/3/2010	59556309	Holland: 1229	Adult	Male	292	127.8	93.5	44	111.8	459840	3679202
			5/4/2010	48587636	38 USGS	Juvenile	Female	112	93.9	70.4	32.5	81.6	459850	3679204

[1] *Number corresponds with location on map, Figure 6*

[2] *Location obtained in WGS 84 datum, Zone 11S*

[2] *Hydrologic unit - a drainage area, based on the California Watershed Portal*

[3] *Hydrologic area - major subdivisions of hydrologic units, based on the California Watershed Portal*

Appendix 4 (cont). Western pond turtle capture data from Marine Corps Base Camp Pendleton, California in 2010.

Site Number[1]	Site Name	Portion of the Site	Date	PIT-tag Identification Number	Marginal Scute Identification Number	Age	Gender	Weight (g)	Carapace Length (mm)	Carapace Width (mm)	Carapace Height (mm)	Plastron Length (mm)	UTM Easting [2]	UTM Northing [2]
San Juan Watershed (hu)[5] - San Onofre (ha)[6]														
7	Cockleburr Lagoon	All	5/4/2010	20884629	27 USGS	Adult	Female	280	123.2	88.5	57.5	112.1	459804	3679128
			5/5/2010	48584607	50 USGS	Juvenile	Female	86	87.5	64.8	30	78.2	459840	3679201
			5/5/2010	48615524	20 USGS	Juvenile	Female	130	94.8	71.8	34	82.8	459840	3679201
			5/5/2010	20841358	5 USGS	Adult	Male	234	122.8	88.9	39	104.1	459840	3679201
			5/5/2010	20884629	27 USGS	Adult	Female	–	–	–	–	–	459810	3679125
			5/5/2010	48587636	38 USGS	Juvenile	Female	–	–	–	–	–	459812	3679119
			6/8/2010	–	800 USGS	Juvenile	–	22	48.7	40.4	20	40.9	459814	3679135
			6/8/2010	–	76 USGS	Juvenile	–	44	67.6	53.9	25	60.6	459856	3679205
			6/8/2010	–	48 USGS	Juvenile	–	58	74.1	58.9	37	63.8	459856	3679205
			6/8/2010	–	46 USGS	Juvenile	Male	64	76.8	58.7	38	66	459856	3679205
			6/8/2010	48612331	45 USGS	Juvenile	Female	76	80.9	65.6	38.5	71.5	459856	3679205
			6/8/2010	–	40 USGS	Juvenile	Female	106	84.7	66.7	32.5	74.7	459830	3679191
			6/8/2010	–	77 USGS	Juvenile	Female	90	86.1	67.4	32	76.7	459814	3679135
			6/8/2010	48588588	44 USGS	Juvenile	Female	112	88.4	69.3	33	82	459856	3679205
			6/8/2010	48587856	43 USGS	Juvenile	Female	106	92.2	72.7	31	80.8	459856	3679205
			6/8/2010	48585873	Holland: 2706	Juvenile	Male	142	95.9	70.5	36	82.1	459856	3679205
			6/8/2010	20863295	41 USGS	Adult	Male	214	117.3	86.7	38	102.4	459856	3679205
			6/8/2010	20850316	28 USGS	Adult	Male	192	117.7	88.3	40	96.5	459804	3679159
			6/8/2010	48586049	22 USGS	Adult	Male	222	120.1	89.2	42	102.3	459856	3679205
			6/8/2010	96840102	Holland: 400, ?100 or 200 and 7 or 8	Adult	Female	314	123	91.8	49	109.6	459804	3679159
			6/8/2010	59553296	40 USGS	Adult	Male	240	123.1	89.9	43	106.4	459856	3679205
			6/8/2010	107636097	26 USGS	Adult	Male	308	131.3	99.2	45	114.2	459814	3679135
			6/8/2010	20882804	42 USGS	Adult	Male	276	132.2	94.1	43	112.1	459856	3679205
			6/9/2010	–	80 USGS	Juvenile	–	8	35.7	32	16	29.6	459800	3679151
			6/9/2010	–	278 USGS	Juvenile	–	8	37.6	30	15	31.5	459799	3679142
			6/9/2010	–	81 USGS	Juvenile	–	36	62	51.5	23.5	50.8	459848	3679208
			6/9/2010	–	82 USGS	Juvenile	Female	58	71.2	58.5	27	62.4	459814	3679135
			6/9/2010	–	79 USGS	Juvenile	Male	82	79.6	68.4	69.9	30.5	459800	3679151
			6/9/2010	48587636	38 USGS	Juvenile	Female	110	94.5	71.6	32.5	82	459814	3679135
			6/9/2010	96846059	21 USGS	Adult	Male	178	103.6	78.5	39.5	90.6	459848	3679208
			6/9/2010	43269529	2 USGS	Adult	Male	150	106.8	81.5	36	92.2	459806	3679116
			6/9/2010	43119604	7 USGS	Adult	Male	196	113.2	89.2	39	95.8	459806	3679116
			6/9/2010	48605546	Holland: 137	Adult	Male	214	113.5	90.7	39	95.5	459804	3679159
			6/9/2010	96833083	Holland: 136	Adult	Male	254	117.8	90.9	43	101.9	459804	3679159

[1] *Number corresponds with location on map, Figure 6*

[2] *Location obtained in WGS 84 datum, Zone 11S*

[2] *Hydrologic unit - a drainage area, based on the California Watershed Portal*

[3] *Hydrologic area - major subdivisions of hydrologic units, based on the California Watershed Portal*

Appendix 4 (cont). Western pond turtle capture data from Marine Corps Base Camp Pendleton, California in 2010.

Site Number[1]	Site Name	Portion of the Site	Date	PIT-tag Identification Number	Marginal Scute Identification Number	Age	Gender	Weight (g)	Carapace Length (mm)	Carapace Width (mm)	Carapace Height (mm)	Plastron Length (mm)	UTM Easting [2]	UTM Northing [2]
San Juan Watershed (hu)[5] - San Onofre (ha)[6]														
7	Cockleburr Lagoon	All	6/9/2010	20850316	28 USGS	Adult	Male	194	118.3	88.9	41	96.7	459806	3679116
			6/9/2010	96845095	Holland: 1338?	Adult	Female	290	119.9	94.9	48	101.1	459809	3679144
			6/9/2010	59548269	11 USGS	Adult	Male	240	124.6	95.2	40	108.8	459804	3679159
			6/9/2010	107594033	78 USGS	Adult	Male	272	128	98.2	43	109.5	459809	3679144
			6/9/2010	96812318	Holland: 5809	Adult	Female	356	128.7	97.8	48.5	118.7	459858	3679180
			6/9/2010	20875548	Holland: 101	Adult	Female	298	128.9	92	48.5	109.1	459848	3679208
			6/9/2010	107636097	26 USGS	Adult	Male	308	131.6	101.7	47	113.6	459841	3679205
			6/9/2010	20882804	42 USGS	Adult	Male	–	–	–	–	–	459856	3679205
			6/9/2010	48587856	43 USGS	Juvenile	Female	–	–	–	–	–	459830	3679191
			6/9/2010	–	46 USGS	Juvenile	Female	–	–	–	–	–	459806	3679116
			6/10/2010	–	85 USGS	Juvenile	–	26	56.8	46.4	21.5	47	459809	3679144
			6/10/2010	48599602	83 USGS	Adult	Male	172	109.1	82.5	38	95.6	459841	3679205
			6/10/2010	59087597	84 USGS	Adult	Male	184	111	81.5	38	95.4	459809	3679144
			6/10/2010	96850860	17 USGS	Adult	Male	204	111.9	88.4	39	99.6	459809	3679144
			6/10/2010	20884629	27 USGS	Adult	Female	280	122.7	94.9	50	113.6	459841	3679205
			6/10/2010	20841358	5 USGS	Adult	Male	244	122.8	74.8	41	74.1	459848	3679208
			6/10/2010	96812318	Holland: 5809	Adult	Female	–	–	–	–	–	459809	3679144
			6/11/2010	–	90 USGS	Juvenile	–	8	34.7	30.3	15.6	28.7	459830	3679191
			6/11/2010	–	87 USGS	Juvenile	–	34	59.3	48.3	22.2	51.2	459800	3679151
			6/11/2010	48591568	86 USGS	Juvenile	Female	110	93.1	73.5	32	84.3	459830	3679191
			6/11/2010	48587636	38 USGS	Juvenile	Female	112	94.6	73.2	32.5	82.4	459806	3679116
			6/11/2010	48615524	20 USGS	Juvenile	Female	134	96.9	77.8	34	84.1	459856	3679205
			6/11/2010	96811806	19 USGS	Adult	Male	238	115.5	89.4	40	101.1	459804	3679159
			6/11/2010	43279351	4 USGS	Adult	Female	280	122.4	92.9	47	106.3	459814	3679135
			6/11/2010	63776590	Holland: 10	Adult	Male	218	122.7	88	39	104.9	459856	3679205
			6/11/2010	59556309	Holland: 1229	Adult	Male	298	128	95.1	44	112.2	459856	3679205
			6/11/2010	20882804	42 USGS	Adult	Male	–	–	–	–	–	459858	3679180
			7/19/2010	48585035	49 USGS	Juvenile	Male	94	90.4	69.9	31.5	79.5	459845	3679200
			7/20/2010	–	76 USGS	Juvenile	Female	44	67.5	53.5	24.5	59.9	459826	3679197
			7/20/2010	–	113 USGS	Juvenile	Female	60	73.8	62.4	27	64.1	459867	3679230
			7/20/2010	–	79 USGS	Juvenile	Female	80	79.8	67.2	29	65.3	459800	3679142
			7/20/2010	48613603	39 USGS	Juvenile	Male	98	85.1	64.5	32	73.8	459799	3679129
			7/20/2010	48587856	43 USGS	Juvenile	Female	100	92.1	70.2	30.5	80.4	459826	3679197
			7/20/2010	20849332	114 USGS	Adult	Male	120	92.8	77.2	54	82.5	459819	3679132

[1] *Number corresponds with location on map, Figure 6*

[2] *Location obtained in WGS 84 datum, Zone 11S*

[2] *Hydrologic unit - a drainage area, based on the California Watershed Portal*

[3] *Hydrologic area - major subdivisions of hydrologic units, based on the California Watershed Portal*

Appendix 4 (cont). Western pond turtle capture data from Marine Corps Base Camp Pendleton, California in 2010.

Site Number[1]	Site Name	Portion of the Site	Date	PIT-tag Identification Number	Marginal Scute Identification Number	Age	Gender	Weight (g)	Carapace Length (mm)	Carapace Width (mm)	Carapace Height (mm)	Plastron Length (mm)	UTM Easting [2]	UTM Northing [2]
San Juan Watershed (hu)[5] - San Onofre (ha)[6]														
7	Cockleburr Lagoon	All	7/20/2010	96845798	112 USGS	Adult	Male	158	103.4	75.7	36.5	91.7	459840	3679198
			7/20/2010	96846059	21 USGS	Adult	Male	182	104.4	80.1	39.5	90.4	459812	3679133
			7/20/2010	43111551	13 USGS	Adult	Male	188	110.2	89	37	94.8	459798	3679144
			7/20/2010	96850860	17 USGS	Adult	Male	210	112	89	39	99.7	459812	3679133
			7/20/2010	96828580	Holland: 5807	Adult	Male	208	116.5	85.2	40	94.6	459800	3679142
			7/20/2010	96833083	Holland: 136	Adult	Male	250	117.5	90.9	42	100.5	459867	3679230
			7/20/2010	48591801	Holland: 505 or 605	Adult	Male	244	119.1	83.4	42	105	459845	3679200
			7/20/2010	96840102	Holland: ?100, 200, 7, 8, 400	Adult	Female	298	121.6	90.8	46.5	108.6	459799	3679129
			7/20/2010	96828554	Holland: 2815	Adult	Male	236	122.1	91.1	42	107.3	459867	3679230
			7/20/2010	59798799	Holland: 260 or 270	Adult	Female	256	122.8	92.7	45	106.5	459819	3679132
			7/20/2010	59554057	47 USGS	Adult	Male	252	123.6	91.7	44.5	104	459819	3679132
			7/20/2010	20884629	27 USGS	Adult	Female	270	124.1	89.6	47	111.8	459799	3679129
			7/20/2010	59548269	11 USGS	Adult	Male	234	124.7	91	39	109.1	459812	3679133
			7/20/2010	59556309	Holland: 1229	Adult	Male	312	128.2	93.7	44	111.6	459799	3679129
			7/20/2010	107636097	26 USGS	Adult	Male	298	131.1	99	45	113.5	459867	3679230
			7/21/2010	–	76 USGS	Juvenile	Female	30	67.4	56	24	61.2	459798	3679144
			7/21/2010	43104363	12 USGS	Juvenile	Male	102	87.3	71.6	31	78.2	459812	3679133
			7/21/2010	48585873	Holland: 2706	Adult	Male	144	95.5	36	72.9	80.5	459840	3679198
			7/21/2010	59082377	117 USGS	Adult	Male	174	107.6	84.8	35	96.2	459812	3679133
			7/21/2010	96853332	8 USGS	Adult	Male	180	108.5	82.2	38	98.3	459812	3679133
			7/21/2010	59087597	84 USGS	Adult	Male	184	111.4	87.4	38	95.8	459867	3679230
			7/21/2010	48605546	Holland: 137	Adult	Male	204	113.4	89.4	37	97.5	459867	3679230
			7/21/2010	20863295	41 USGS	Adult	Male	200	117.1	88.5	37	104.2	459840	3679198
			7/21/2010	96833083	Holland: 136	Adult	Male	240	117.1	90.9	41	103.5	459867	3679230
			7/21/2010	96845095	Holland: 1338?	Adult	Female	272	119.5	94.8	46	102	459800	3679142
			7/21/2010	96840102	Holland: ?100, 200, 7, 8	Adult	Female	300	121.8	90.2	47	108.9	459819	3679132
			7/21/2010	59548269	11 USGS	Adult	Male	232	124.5	93.8	39	108.6	459812	3679133
			7/21/2010	20884629	27 USGS	Adult	Female	272	124.5	90.6	48	112.1	459795	3679143
			7/21/2010	59556309	Holland: 1229	Adult	Male	296	127.8	94.7	45	111.3	459798	3679144
			7/21/2010	20875548	Holland: 101	Adult	Female	306	128.4	91.7	46	109.7	459840	3679198
			7/21/2010	48599596	Holland: 5614	Adult	Male	332	129.2	36.2	46	115.6	459800	3679142
			7/21/2010	107636097	26 USGS	Adult	Male	292	132	98.4	44	115.6	459845	3679200
			7/21/2010	20868349	Holland: 870 or 872	Adult	Female	346	132.9	95.3	49	118	459840	3679198
			7/22/2010	53523637	Holland: 9	Juvenile	Female	70	80.7	68.6	30	71.1	459798	3679144

[1] *Number corresponds with location on map, Figure 6*

[2] *Location obtained in WGS 84 datum, Zone 11S*

[2] *Hydrologic unit - a drainage area, based on the California Watershed Portal*

[3] *Hydrologic area - major subdivisions of hydrologic units, based on the California Watershed Portal*

Appendix 4 (cont). Western pond turtle capture data from Marine Corps Base Camp Pendleton, California in 2010.

Site Number[1]	Site Name	Portion of the Site	Date	PIT-tag Identification Number	Marginal Scute Identification Number	Age	Gender	Weight (g)	Carapace Length (mm)	Carapace Width (mm)	Carapace Height (mm)	Plastron Length (mm)	UTM Easting [2]	UTM Northing [2]
San Juan Watershed (hu)[5] - San Onofre (ha)[6]														
7	Cockleburr Lagoon	All	7/22/2010	48588588	44 USGS	Adult	Female	110	89	71.4	34.5	82.4	459867	3679230
			7/22/2010	48585873	Holland: 2706	Adult	Male	144	96.5	70.5	35.5	80.7	459826	3679197
			7/22/2010	48591801	Holland: 505 or 605	Adult	Male	130	97.1	60.8	42	82.7	459867	3679230
			7/22/2010	20852894	119 USGS	Adult	Male	150	102.9	83.2	37	90.1	459795	3679143
			7/22/2010	96845798	112 USGS	Adult	Male	156	103.6	75.8	36	91.7	459800	3679142
			7/22/2010	53546275	120 USGS	Adult	Male	196	110.8	89.6	39	97.5	459800	3679142
			7/22/2010	43111551	13 USGS	Adult	Male	190	111.2	88.6	38	95.2	459799	3679127
			7/22/2010	96850860	17 USGS	Adult	Male	206	112.4	83.7	39	99.6	459800	3679142
			7/22/2010	96851591	Holland: 1108	Adult	Female	214	112.8	86.2	43.5	99.6	459800	3679142
			7/22/2010	48605546	Holland: 137	Adult	Male	190	113.5	89.3	38	95.4	459826	3679197
			7/22/2010	53564091	118 USGS	Adult	Male	210	113.9	91.1	40	100.4	459826	3679197
			7/22/2010	59573317	121 USGS	Adult	Male	210	114.8	86.2	37	100.8	459840	3679198
			7/22/2010	96828580	Holland: 5807	Adult	Male	206	116.7	90.5	41	95.7	459826	3679197
			7/22/2010	96833083	Holland: 136	Adult	Male	246	117.4	90	41	101.4	459800	3679142
			7/22/2010	21004047	Holland: 2706 or 2708	Adult	Female	264	121.4	89.8	47.5	104.1	459826	3679197
			7/22/2010	53541114	122 USGS	Adult	Male	252	121.5	88.7	41.5	102.8	459867	3679230
			7/22/2010	59553296	40 USGS	Adult	Male	240	123	91.3	43	104	459867	3679230
			7/22/2010	20884629	27 USGS	Adult	Female	254	124.4	94.3	47.5	112	459826	3679197
			7/22/2010	107594033	78 USGS	Adult	Male	272	127.7	97.8	42.5	109.3	459845	3679200
			7/22/2010	59556309	Holland: 1229	Adult	Male	304	127.9	94.9	46	112.4	459845	3679200
			7/22/2010	96812318	Holland: 5809	Adult	Female	332	130	97.4	47	118.2	459800	3679142
			7/22/2010	107636097	26 USGS	Adult	Male	290	131.2	97.9	45	113.2	459800	3679142
			7/22/2010	43109892	Holland: 1320 or 1322	Adult	Female	340	133.7	106	49	123.3	459867	3679230
			7/23/2010	20852894	119 USGS	Adult	Male	–	102.2	–	–	–	459812	3679133
			7/23/2010	96846059	21 USGS	Adult	Male	174	103.5	79.6	38	90.6	459799	3679127
			7/23/2010	96850524	9 USGS	Adult	Male	166	107.1	78.6	36	91.4	459826	3679197
			7/23/2010	59573317	121 USGS	Adult	Male	217	116.2	85.6	40	100.6	459799	3679127
			7/23/2010	43279351	4 USGS	Adult	Female	280	121.9	93.9	46	106.1	459812	3679133
			7/23/2010	96812318	Holland: 5809	Adult	Female	347	128.8	97	47	118.1	459845	3679200
			7/23/2010	59553296	40 USGS	Adult	Male	–	–	–	–	–	459826	3679197
			7/23/2010	48588588	44 USGS	Juvenile	Female	–	–	–	–	–	459798	3679144
			7/23/2010	20875548	Holland: 101	Adult	Female	–	–	–	–	–	459826	3679197
			7/23/2010	59556309	Holland: 1229	Adult	Male	–	–	–	–	–	459840	3679198
			7/23/2010	96845095	Holland: 1338?	Adult	Female	–	–	–	–	–	459799	3679127

[1] *Number corresponds with location on map, Figure 6*

[2] *Location obtained in WGS 84 datum, Zone 11S*

[2] *Hydrologic unit - a drainage area, based on the California Watershed Portal*

[3] *Hydrologic area - major subdivisions of hydrologic units, based on the California Watershed Portal*

Appendix 4 (cont). Western pond turtle capture data from Marine Corps Base Camp Pendleton, California in 2010.

Site Number[1]	Site Name	Portion of the Site	Date	PIT-tag Identification Number	Marginal Scute Identification Number	Age	Gender	Weight (g)	Carapace Length (mm)	Carapace Width (mm)	Carapace Height (mm)	Plastron Length (mm)	UTM Easting [2]	UTM Northing [2]
San Juan Watershed (hu)[5] - San Onofre (ha)[6]														
7	Cockleburr Lagoon	All	7/23/2010	96833083	Holland: 136	Adult	Male	–	–	–	–	–	459799	3679127
			7/23/2010	48585873	Holland: 2706	Adult	Male	–	–	–	–	–	459826	3679197
			7/23/2010	96828554	Holland: 2815	Adult	Male	–	–	–	–	–	459845	3679200
			7/23/2010	45599596	Holland: 4600 or 4610	Adult	Male	–	–	–	–	–	459826	3679197
9	Las Flores Lagoon	All	4/8/2010	48607553	43 USGS	Adult	Male	326	137.3	103	49	118	456978	3683512
			4/9/2010	48595338	Holland: 850	Adult	Female	514	150.5	112.1	57.5	135	457008	3683476
			6/29/2010	–	430 USGS	Adult	Male	370	136.4	99.2	49	109.7	456993	3683520
			6/29/2010	–	100 USGS	Adult	Male	350	136.9	101.3	48	116.7	456840	3683557
			6/29/2010	48610001	99 USGS	Adult	Male	360	141.2	107.1	49	119	456993	3683520
			6/30/2010	48610580	102 USGS	Adult	Male	390	142.8	106.5	51	113.3	456993	3683520
			6/30/2010	48611598	103 USGS	Adult	Male	415	153.3	109.4	52	129.6	456863	3683525
			6/30/2010	48610001	99 USGS	Adult	Male	–	–	–	–	–	457014	3683487
			7/21/2010	48608080	100 USGS	Adult	Male	340	136	100	47	117.5	456983	3683507
			7/22/2010	20881605	Holland: 440	Adult	Male	370	136.6	98.5	50	109.8	456945	3683515
			7/22/2010	48595338	Holland: 850	Adult	Female	520	150.4	112.4	57	135	456933	3683529
Santa Margarita Watershed (hu)[3] - Ysidora (ha)[4]														
14a	Santa Margarita River	Lower	5/25/2010	48600807	62 USGS	Adult	Female	215	120.8	91.3	41	109.2	464910	3680557
			5/25/2010	48595858	61 USGS	Adult	Female	320	127.7	97.9	46	115.9	464892	3680575
			5/25/2010	48587064	63 USGS	Adult	Male	325	138.8	99.9	50	117.3	464910	3680557
			5/25/2010	48605518	65 USGS	Adult	Male	515	158.6	120.2	52	133.9	464881	3680582
			5/25/2010	48600289	55 USGS	Adult	Male	490	158.8	112.3	52	132.8	463804	3677636
			5/25/2010	–	64 USGS	Adult	Female	720	167	118.7	64	146.5	464881	3680582
			5/26/2010	48607801	110 USGS	Adult	Male	380	143.4	99.1	47	121.8	464881	3680582
			5/26/2010	48606608	109 USGS	Adult	Male	390	143.6	102.1	48.5	118.1	464334	3677925
			5/26/2010	48612563	111 USGS	Adult	Female	400	145.7	108.2	46	128.8	464892	3680575
			5/26/2010	48605522	108 USGS	Adult	Female	650	160.4	119.9	164.5	140.2	464196	3677780
			5/26/2010	48607857	107 USGS	Adult	Female	530	162	115.8	58.5	143.7	463884	3677624
			5/26/2010	48605518	65 USGS	Adult	Male	–	–	–	–	–	464910	3680557
			7/13/2010	48607052	Holland: 1249	Adult	Male	300	126.8	97.6	45	104.5	464898	3680575
			7/13/2010	48600807	62 USGS	Adult	Female	240	127.3	93.1	42	113.4	464893	3680553
			7/14/2010	48612563	111 USGS	Adult	Female	418	147.9	115.7	48	130.8	464898	3680575
			7/14/2010	48605518	65 USGS	Adult	Male	520	162.5	120	52	134	464898	3680575

[1] *Number corresponds with location on map, Figure 6*

[2] *Location obtained in WGS 84 datum, Zone 11S*

[2] *Hydrologic unit - a drainage area, based on the California Watershed Portal*

[3] *Hydrologic area - major subdivisions of hydrologic units, based on the California Watershed Portal*

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Appendix 4 (cont). Western pond turtle capture data from Marine Corps Base Camp Pendleton, California in 2010.

Site Number[1]	Site Name	Portion of the Site	Date	PIT-tag Identification Number	Marginal Scute Identification Number	Age	Gender	Weight (g)	Carapace Length (mm)	Carapace Width (mm)	Carapace Height (mm)	Plastron Length (mm)	UTM Easting [2]	UTM Northing [2]
Santa Margarita Watershed (hu)[3] - Ysidora and DeLuz (ha)[4]														
14b	Santa Margarita River	Middle[5]	5/6/2010	–	–	Adult	Female	–	170	94		144	469144	3688797
			6/17/2010	48592894	92 USGS	Adult	Male	476	150.2	117.5	52	126.2	469226	3689085
14c	Santa Margarita River	Upper[6]	5/19/2010	48611116	54 USGS	Adult	Male	290	132.6	95.8	45.3	114.6	475235	3695310
			6/3/2010	–	400 USGS	Adult	Female	–	–	–	–	–	471493	3693415
			6/15/2010	48589100	89 USGS	Adult	Female	268	128.7	91.8	45	109.1	475052	3695530
			6/15/2010	48615037	91 USGS	Adult	Female	494	147.3	108.5	60	132	475052	3695530
			7/13/2010	48611081	104 USGS	Adult	Male	280	124.4	97.1	42	101.5	475026	3695525
			7/14/2010	48589036	105 USGS	Adult	Male	450	146.2	113.9	48	124.8	475269	3695239

[1] *Number corresponds with location on map, Figure 6*

[2] *Location obtained in WGS 84 datum, Zone 11S*

[2] *Hydrologic unit - a drainage area, based on the California Watershed Portal*

[3] *Hydrologic area - major subdivisions of hydrologic units, based on the California Watershed Portal*

[4] *Within the Ysidora hydrologic area*

[5] *Within the DeLuz hydrologic area*