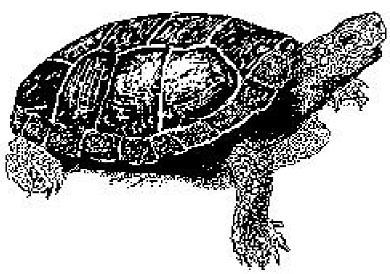
WESTERN POND TURTLE (*Clemmys marmorata*). Natural History.

Don T. Ashton, Amy J. Lind, and Kary E. Schlick.
USDA Forest Service, Pacific Southwest Research Station,
Redwood Sciences Laboratory, 1700 Bayview Drive, Arcata CA 95521.

The following is a literature review augmented with personal observations from several years of study of this species along a 39 mile stretch of the main stem of the Trinity River, Trinity County, California. The study area extended from Lewiston Dam downstream to the confluence with the North Fork Trinity River at Helena. Research was conducted by personnel at the Redwood Sciences Laboratory with funding from the USDI Bureau of Reclamation.



OUTLINE

1. DESCRIPTION

The western pond turtle (*Clemmys marmorata*) reaches a maximum length of 210 mm and its weight may exceed 1200 g. Their color and markings vary geographically, ontogenetically, and sexually (Holland 1994). They are usually dark brown to olive dorsally, often with darker reticulations. Ventrally, they are yellowish, sometimes with dark blotches in centers of the plasteral shields (Storm et al. 1995).

Clemmys marmorata displays sexual dimorphism at maturity. In the Trinity River, secondary sexual characteristics are present by the time animals attain a carapace length (CL) of 125 mm (Reese 1996, Holland pers. comm.). Further south, *C. marmorata* reach maturity at a smaller size, 110 - 120 mm CL (Holland 1994). Holland

(1994) found over 20 significantly different sexually dimorphic characteristics, but the gender of adults can be distinguished reliably using just a few these (Fig. 1).

The degree of dimorphism is variable for each character and each individual, but generally adult males tend to have a flatter carapace (i), concave plastron posteriorly (h),

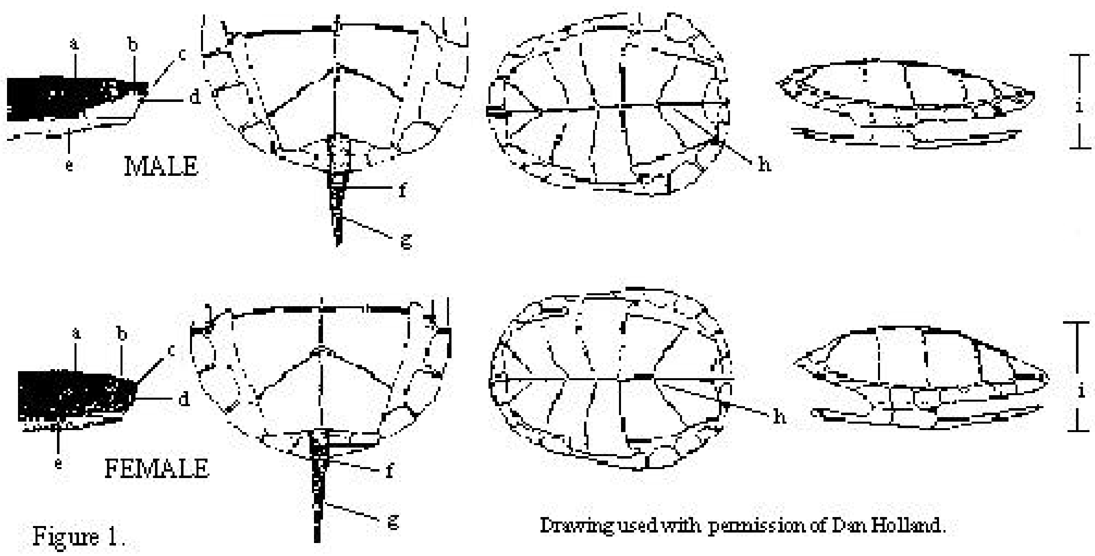


Figure 1. Drawing used with permission of Dan Holland.

thicker tail base (g) with the cloacal opening at or beyond the margin of the carapace (f), larger head (a) with a longer nose (b) and pointier snout (c), and a larger neck with yellow or whitish chin and throat (e). Adult females tend to have a higher, domed carapace (i), flatter plastron, thinner tail base (g) with the cloacal opening at or within the margin of the carapace (f), blunt snout (c), mustache-like markings on the upper jaw (d), and dark markings on the chin and throat (e). No single characteristic is 100% reliable, so it is best to look at several characters per individual for gender determination. Juveniles (< 125 m CL) of both sexes tend to resemble females.

Hatchlings measure 25 - 31 mm CL and weigh 3 - 7 g at the time of emergence from the nest and they tend to be a lighter brown, darkening with age (Holland 1994). The shell is soft and pliable and their tail is relatively long. For more description and pictures see Nussbaum et al.(1983), Stebbins (1985), and Storm et al. (1995). For a more complete description of geographic variation see Holland (1991).

2. TAXONOMY

Western pond turtles are in the family Emydidae. Specimens collected from the Puget Sound area in 1841 were first described as *Emys marmorata* by Steilacoom, and later by Baird and Girard (1852). The first use of *Clemmys marmorata* was by Strauch (1862). In 1945, two subspecies were recognized, the northwestern pond turtle (*Clemmys marmorata marmorata*) and the southwestern pond turtle (*Clemmys marmorata pallida*) (Seeliger 1945). Holland (1994) suggests there are three morphologically distinct species currently recognized as *Clemmys marmorata*. These roughly correspond to the previously described subspecies and a third undescribed species from the Columbia River Gorge. As of June 1997, the genetic and morphological analysis needed to resolve the species/subspecies status was not yet complete (Holland pers. comm.).

3. RANGE and DISTRIBUTION

Fossil evidence shows *C. marmorata* have existed in the western United States since at least the late Pliocene (Hay 1908). The historic range of *C. marmorata* included the Pacific slope from Puget Sound to Sierra San Pedro Martir in Baja California Norte and isolated inland populations in Washington, Oregon, California, Nevada, and Idaho.

Some of these isolated populations may represent introductions (Holland 1994). *Clemmys marmorata* have an elevational range from sea level to about 2000 m (ca. 6700'), but are uncommon anywhere above about 1500 m (ca. 5000') (Holland 1994). For range maps see Stebbins (1985), Jennings and Hayes (1994).

The northwestern subspecies, *C. m. marmorata* occurs throughout the Trinity River Basin and is found in or near the main stem, larger tributaries, vernal pools, ponds, and lakes, including Lewiston and Claire-Engle Lakes (Reese 1996, pers. observ.). In the main stem Trinity River, *C. m. marmorata* is widespread, but the population density is low and distribution is clustered, with areas of use separated by areas of non-use (Reese 1996).

Reese (1996) determined the *C. m. marmorata* population density for the main stem study area to be 6.33 turtles per hectare. With the same methods, Reese (1996) estimated the population density for the south fork of the Trinity River (from Surprise Creek to Sandy Bar) at 12.33 turtles per hectare. In earlier studies, Bury (1972) estimated a population density of ca. 750 turtles per hectare in a nearby creek in Trinity County, and Holland (1994) reports densities up to ca. 3700 turtles per hectare at a site in southern California.

4. REPRODUCTION and GROWTH

Mating takes place underwater. Possible courtship behavior reported by Holland (1988) describes an interaction between a male and a female turtle in late August. The reported interaction involved multiple scratching of the anterior edge the female's carapace by the male's fore limbs, followed by the female raising her posterior end up off the substrate. Copulation was not observed, and the male turtle noticed the observer after about five minutes and fled (Holland 1988). Holland (1988) goes on to say, "Copulation has been observed in the field in mid-June in Southern California, and in captive specimens in late August and early September." Observations of turtles courting on the main stem of the Trinity River and the timing of oviposition, suggest mating may be concentrated in early spring (Reese 1996). In the Trinity River, eggs are detectable in females by May and nesting occurs in June and July. Adult females of several turtle species can store sperm for months or years (Gist and Jones 1989, Galbraith 1993).

The majority of mature females in a given population oviposit every other year, although some turtles oviposit in consecutive years. Reports of double-clutching also exist for locales throughout the range of this species (Holland 1994, Goodman 1996, Reese 1996). Known clutch size ranges from three to thirteen, with most clutches containing four to seven eggs (Holland 1994).

Oviposition occurs on land, usually above the flood plain, up to several hundred meters from water. For nesting, gravid (with eggs) females tend to seek out open areas with sparse, low vegetation (annual grasses and herbs), low slope angle, and dry hard soil. After voiding her bladder to soften the soil, the female excavates a pear-shaped nest chamber with her hind feet. Eggs are deposited and the nest chamber is plugged by kneading wet soil and vegetative fragments into the throat of the nest chamber (Holland 1994, Reese 1996). Females seem to be able to delay oviposition if disturbed (Holland 1994, pers. observ.), and "nesting benches" may have many "false scrapes." Nest site philopatry has been observed in several species of turtles and there is some evidence to suggest nest site philopatry is exhibited by *C. marmorata*, but has not been proven (Holland 1994).

Eggs are hard shelled and oval in shape, measuring 31 - 38 mm long by 20 - 24 mm wide and weighing 8 - 10 g (Holland 1994). Incubation takes about three months and overall hatching rates are about 70% (Holland 1994). In northern California, hatching occurs in the fall and the hatchlings usually remain in the nest chamber over the winter and emerge in spring (Holland 1994, Reese 1996). In southern and central California, some hatchlings may emerge from the nest chamber in the fall, while others over-winter in the nest chamber and emerge in spring (Holland 1994). Hatchlings over-wintering in the nest chamber receive nourishment from an umbilical yolk sack (Voight 1963, Holland 1994).

Ontogeny, environmental conditions, geography, and individual variation all contribute to the variable growth rates seen in this species. Growth rates are highest in hatchlings, which can almost double in size by the end of the first growing season (Holland 1991). Generally, the growth rate decreases each successive year and by the end of the eighth year the average growth rate drops to less than 0.4 mm/month or less, with some adults growing extremely slow (Holland 1991). An adult female recaptured after 11 years only grew 0.8 mm in that time (Holland 1991). Average growth rates for the first few years of life estimated by two researchers are listed in Table 1.

Table 1.

(GROWTH SEASON)	(REESE UNPUB. DATA)	(HOLLAND 1994)
first season	6.12 mm/month	3.29 mm/month
second season	3.20 mm/month	1.95 mm/month
third season	1.90 mm/month	0.64 mm/month
fourth season	1.25 mm/month	0.89 mm/month

Growth rates may also be regulated by environmental factors, such as water temperature and variation in prey base (Goodman 1997, Holland pers. comm.). Geographic variation in growth rates may be attributable to environmental factors, as well as phylogenic variation across the range. In the southern portions of the *C. marmorata* range females reach maturity at a smaller size (110 - 120 mm CL) than females to the north (125 mm CL in the Trinity River Basin, 130+ mm CL in the Rogue River Basin) (Holland 1994). Males mature at a smaller size than females from the same region (Holland 1994).

With so much variation in growth rates, using size to estimate age only offers a rough approximation, so age structure studies often rely on counting annuli on the plastral shields (Zug 1991). Counting annuli is based on the assumption that one growth ring is added each season, although this assumption may not be valid. Annuli are the result of alternating periods of maximum growth and minimum growth. In areas with little seasonal variation, growth spurts will be correlated with periodic abundance of prey, which may have several peaks in a year. Cold water releases from dams may also slow growth during peak periods, distorting the annuli record. Annuli are more reliable in areas with strong seasonal patterns, such as the Trinity River. Even here, the reliability of counting annuli decreases as the age of the turtle increases for two reasons. Older turtles grow more slowly, so the new annuli are narrower each year, and abrasion of the plastron, over time, may wear off the annuli or render them unreadable, especially in rocky environments.

Maximum life span in the wild has not been determined with certainty, but Holland (1991) estimates it may be 50 to 70 years. Long term mark-recapture studies have documented turtles approximately 40 years old (Bury and Holland unpub. data) and an anecdotal account exists of a turtle that was marked as an adult being recovered some 50 years later (Holland 1991).

5. FOOD HABITS

Clemmys marmorata is considered a dietary generalist, but it does not select food items based on general availability (Bury 1986). They prefer live prey, which they capture by opportunistic foraging tactics, but will also scavenge carrion and browse on plant material. Prey items are ingested in the water; it appears this species is unable to swallow in air (Holland 1994). Preferred food items include aquatic insect larvae, crustaceans (cladocerans and crayfish), and annelids. Small vertebrates (including *Rana boylii* tadpoles and egg masses) have been found during gut content analysis of *C. marmorata*, but it is unclear whether these were ingested as prey or carrion (Bury 1986; Holland 1994). *Clemmys marmorata* have been observed feeding on carcasses of mammals, birds, reptiles, amphibians, and fish (Holland 1994). Consumption of plant material is less frequent, although adult females are most likely to engage in herbivory (Bury 1986). Post-partum females have been observed to ingest large amounts of tule (*Scirpus* sp.) and cattail roots (*Typha latifolia*) (Holland 1994). Foraging has also been noted on pond lily inflorescences (*Nuphar polysepalum*) (Evenden 1948), willow and alder catkins, ditch grass inflorescences, and green filamentous algae (Holland 1994). Seston and other small animals are abundant in filamentous algae and may supplement the diet when other animal prey items are scarce (Bury 1986). *Clemmys marmorata* may also feed on *Daphnia* sp. and other small invertebrates in the water column by neustophagia, a modified form of gape-and-suck feeding (Holland 1994). Upon hatching, hatchlings have an umbilical yolk sac, which provides nourishment in the early stages of growth (Voight 1963, Holland 1991). Later, the hatchling diet consists mainly of the aquatic larvae of small insects, such as mosquitoes, other small invertebrates, and nekton (Holland 1994). For a detailed discussion of feeding ecology see Bury (1986).

6. MOVEMENT and DISPERSAL

Clemmys marmorata exhibit a high degree of site fidelity, in both aquatic and terrestrial environments. In the aquatic environment, *C. marmorata* utilize a home range on the order of several hundred meters (Holland 1994), with males using a larger aquatic home range than females. Individuals may occasionally make sporadic long-distance aquatic movements outside their home range (Holland 1994). Reese (1996) suggested that sporadic, long-distance movements may constitute dispersal, and male mate searching, and if they span long distances, may facilitate genetic dispersal.

Although primarily considered an aquatic turtle (Nussbaum et al. 1983), *C. marmorata* may spend half the year or more on land in some environments. Overland journeys between multiple bodies of water, often round trip, have been recorded (Reese 1996). It is unclear if access to mates, food resources, basking sites, cover, or predator avoidance prompt this behavior (Reese 1996). Response to drought conditions can initiate terrestrial movements to other aquatic habitats or estivation sites. In lentic environments, *C. marmorata* often over-winter underwater, buried in mud, however in lotic environments, complete departure from the aquatic environment is the norm (Reese 1996, Goodman 1997). These turtles leave the watercourse in the fall to over-winter burrowed in duff or soil. This may represent an adaptive response to the high flow conditions of winter in riverine systems.

Radio-telemetry studies have shown individuals often return to the same terrestrial over-wintering site each fall (Reese 1996, Goodman 1996). Reese (1996) determined the average distance of over-wintering sites from the watercourse to be 167 meters. During terrestrial over-wintering, turtles may emerge to bask on sunny days, and may even move to new over-wintering sites (Reese 1996, Goodman 1996). After over-wintering, turtles may congregate in vernal pools before returning to the river in the springtime. This may allow them to take advantage of warmer, more productive waters, while high flow conditions still exist in the river.

Overland movement is also associated with nesting behavior, usually in June and July in Trinity County (Reese 1996). Gravid females usually leave the water to nest on land in the late afternoon, returning to the water by morning, although this is quite variable. Nest sites have been found as far as 400 meters from the water (Reese 1996).

Reese (1996) found that over the summer months (May - September), juvenile turtles have an average maximum movement of approximately 84 meters. Their mean weekly aquatic travel is 19.9 meters. Their home range is smaller than adults, but larger than previously recognized and also includes terrestrial components (Reese 1996). Juveniles sometimes travel back and forth between low-flow portions of the river and adjacent ponds. These journeys may be motivated by thermal preferences, the distribution of food resources, swimming abilities, and/or predator avoidance (Congdon 1992). Reese (1996) views the Trinity River juvenile movement data as preliminary and recommends research on vernal pools, ponds, oxbows, and other adjacent wetland or tributary habitats in future studies.

7. PREDATION and MORTALITY

a. Predators

Raccoon (*Procyon lotor*), coyote (*Canis latrans*), grey fox *(Urocyon cineroargenteus*), feral and domestic dogs (*Canis familiaris*), black bear (*Euarctos americanus*), river otter (*Lutra canadensis*), mink (*Mustela vison*), osprey, bald eagle, bullfrog (*Rana catesbiana*), and largemouth bass (*Micropterus salmoides*) are known to prey on *C. marmorata* (Holland 1994). Suspected predators include giant water bugs (Belastomatidae), rainbow trout (*Oncorhynchus mykiss*), squawfish (*Ptychocheilus* spp.), channel catfish (*Ictalurus punctatus*), smallmouth bass (*Micropterus dolimeiui*), northern red-legged frog (*Rana aurora aurora*), California red-legged frog (*Rana aurora draytonii*), two-striped garter snake (*Thamnophis hammondi*), giant garter snake (*Thamnophis gigas*), great blue heron (*Ardea herodias*), black-crowned night heron (*Nycticorax nycoticorax*), golden eagle (*Aquila chrysaetos*), red-shouldered hawk (*Buteo lineatus*), red fox (*Vulpes fulva*), beaver (*Castor canadensis*), and nutria (*Myocastor coypu*) (Holland 1994). Adult turtles often show scarring on the shell and/or missing limbs, indicating attempted predation. Holland (1994) found six-fold greater scarring rate on females and attributed it to greater exposure to predators during nesting movements. In Lewiston Lake (Trinity County) a turtle was found with a mammalian canine tooth embedded in the carapace (pers. observ.).

Hatchlings are especially vulnerable to predators, because their shell is soft and they can be swallowed whole. Overland movements from the nest site to the aquatic habitat are exposed to a wide range of terrestrial predators. Upon arrival at preferred aquatic microhabitats, exotic aquatic predators, like bullfrogs (*Rana catesbeiana*) and largemouth bass (*Micropterus salmoides*), can be especially effective at reducing recruitment in this species (Holland 1994). Spotted skunks (*Spilogale putorius*), raccoons (*Procyon lotor*), and coyotes (*Canis latrans*) are known to seek out turtle nests and consume the eggs (Holland 1994). Suspected nest predators include opossum (*Didelphis virginianus*), red fox (*Vulpes fulva*), grey fox (*Urocyon cinereoargenteus*), raven (*Corvus corax*), common crow (*Corvus brachyrhynchos*), yellow-bellied racer (*Coluber constrictor*), gopher snake (*Pituophis melanoleucus*), common kingsnake (*Lampropeltis getulus*), California mountain kingsnake (*Lampropeltis zonata*), and possibly small rodents such gophers (*Thomomys* spp.) By driving out larger predators, human influences can cause local increases in small carnivore populations ("meso-predator release") (Soule` 1988), possibly resulting in greater predation on nests and younger turtles. This has been documented in sea turtle populations (Ehrhart 1979). There is evidence to suggest snakes and rodents may also prey on turtle eggs (Rathbun 1993). In some areas, most of the nests (90 to 99%) in a given year are predated (Holland 1994).

b. Parasites

Parasites known to use *C. marmorata* as a host include trematodes, helminths, nematodes, lungworms, and leeches (Holland 1994). Leeches were present on 7 to 10% of the turtles examined from a series of sites in northern California (Holland 1991). Substantial numbers of nematodes have be found in the guts of *C. m. marmorata* from northern California (Bury 1986)

c. Disease

Reports on epidemic diseases in *C. marmorata* are limited. Holland (1994) describes several outbreaks of an Upper Respiratory Disease-like syndrome (URD) that have been reported this decade. In 1990, a URD outbreak in Washington resulted in losses of up to 40% of the animals in the infected population (Holland 1994). In 1993, Holland (1994) recovered 42 carcasses from a lake in Tehama County, California. The condition of the carcasses did not allow necropsy, but conditions were similar to those noted in the 1990 URD outbreak in Washington. In 1993, a single *C. marmorata* carcass was found near Eugene, Oregon, exhibiting symptoms of URD. Randy Sisk (pers. comm.) observed an outbreak in an Oregon pond in 1996. The method of disease introduction to these populations is unknown, but in the Washington and Eugene cases exotic turtles are known to have been introduced into the WPT population and may have acted as vectors (Holland 1994). The causal agent of Upper Respiratory Disease may be viral or mycoplasmal, but it has not been identified with certainty (Holland 1994). Care should be taken by field biologists to avoid the spread of this or other contagiums.

d. Drought

Severe drought can have a significant negative impact on *C. marmorata* populations. The 1987-1992 drought in California reduced southern and central state populations by up to 85% (Holland 1994). Estivation occurs in response to drought. *Clemmys marmorata* utilizing a vernal pool in Napa County moved upland and burrowed into leaf litter when the pond dried up (Reese 1996). Goodman (1997) observed *C. marmorata* estivating upland when adjacent sections of the creek were dry. Estivation may also occur in response to unseasonally cold water releases from upstream dams (Goodman 1997).

e. Flooding

Clemmys marmorata are not especially strong swimmers and can be washed downstream in high flows. Over-wintering on land may be an adaptation for *C. marmorata* in lotic systems to escape winter high flows. Turtle nests may be inundated during floods. The eggshell of *C. marmorata* absorbs water and, in wet conditions, eggs can explode from internal pressure (Claessen 1980, Feldman 1982). Eggs incubated on saturated vermiculite failed to develop (Feldman 1982).

f. Fire

Fire can kill turtles over-wintering on land and hatchlings still in the nest. Fire can also have adverse effects on the aquatic environment and macroinvertebrate prey base by increasing siltation (Holland 1991). In at least two separate incidents fire fighting operations have resulted in direct mortality of turtles as they were scooped up in a water bucket during aerial operations (heli-dipping) and fatally dropped onto hot spots (Holland 1994).

8. HABITAT

Clemmys marmorata utilize a wide variety of permanent and ephemeral aquatic habitats, and may spend a significant amount of time in upland terrestrial habitats as well. Aquatic habitats with access to areas of deep slow water with underwater refugia and emergent basking sites are favored by adult and juvenile turtles. Hatchlings are relatively poor swimmers and tend to seek areas with slow, shallow, warmer water, often with emergent vegetation.

Younger turtles appear to have more specialized aquatic habitat requirements than adult turtles. Reese (1996) found basking site characteristics were similar between juveniles and adults with respect to water depth and perch diameter, but differed in flow characteristics. Juveniles used basking sites in lower flow areas than adults, and their disproportionate representation in ponds adjacent to the river suggest a strong association with low-velocity and/or warm waters (Reese 1996). This is reasonable, given the higher metabolic rates and poorer swimming ability conferred by their small body size. Lentic waters offer a situation where juveniles can maneuver more effectively to forage and reach refugia. Juveniles were found in areas with water temperatures of 12 to 33 degrees Celsius, while adults used areas with temperatures from 10 to 17 degrees Celsius. Reese's (1996) analysis of habitat characteristics showed that side channels are slightly more suitable for juveniles than the river itself, because they offer lower flows. Given that juvenile habitat was found to be much more limited in the river than adult habitat, some fish habitat restoration projects may be more beneficial to juveniles.

Hatchling turtles may have even more stringent microhabitat requirements than juveniles or adults. Hatchlings are most commonly associated with shallow, warm water, free of predacious aquatic vertebrates, with at least some aquatic vegetation (Reese 1996, Holland 1994).

Terrestrial habitat requirements are variable throughout the range, but must include basking sites and nesting habitat. In most areas, terrestrial over-wintering habitat is also required (Reese 1996). While emergent basking sites are preferred because they offer some protection from terrestrial predators and ofter quick escapes to deep water, terrestrial basking sites are also utilized. Terrestrial basking sites include mud banks, rocks, logs, and root wads on the bank, but are never far from water. Nesting occurs terrestrially, usually in open low-slope areas a few meters to over a hundred meters from the watercourse. The nest site has good exposure to the sun and compact soil (Holland 1994, Reese 1996). Over-wintering can be aquatic or terrestrial (Holland 1994). Terrestrial over-wintering site characteristics are highly variable, but the microsite usually includes a thick duff layer (Holland 1994).

9. CONSERVATION

a. Status

Currently, *C. marmorata* has no federal status (Goodman 1997). A petition for federal endangered listing was submitted in January 1992. On 4 August 1993, the United States Fish and Wildlife Service (USFWS) found listing was “not warranted” at that time, because the taxon was not in danger of extinction in the foreseeable future (Reese 1996, Goodman 1997).

Clemmys marmorata is considered a “State Species of Special Concern” by the California Department of Fish and Game (CDFG). Jennings and Hayes (1994) recommend “State Endangered” status for *C. marmorata* in Southern California from the Salinas River south along the coastal slopes and from the Mokelumme River south in the San Joaquin hydrographic basin, and “State Threatened” status in the rest of California, including the Trinity River Basin. Although this status is still pending, the CDFG has reduced the possession limit from two turtles to zero turtles (Goodman 1996).

b. Threats

Currently, loss of habitat is probably the greatest anthropogenic threat to *C. marmorata* range wide. Grazing, conversion of wetlands to farmland, water diversions, irrigation, channelization, dams, mining, logging, urbanization, and population fragmentation all can have significant negative impacts to turtle populations and are discussed in detail by Holland (1991). Basking, foraging, nesting, and other behaviors can be significantly limited by human presence, including foot, bicycle, boat, motor vehicle traffic (Holland 1991).

Incidental catch by fisherman may account for significant losses in some areas. Turtles have been caught on a variety of tackle including floating and bottom-set baits, trolled baits, and bass plugs (Holland 1991). At a site in Oregon, Holland (1991) found 3.6% of the turtles captured in an eight week period had ingested fishhooks. At a site in the southern Sierra Nevada ca. 6% of the turtles captured showed signs of trauma due to removal of hooks, had hooks in place, or were found dead with fishhooks embedded in the esophagus or stomach (Holland 1991). Turtles that don't die from trauma associated with ingestion of fishing tackle probably starve to death. Holland (1991) recorded a 10% weight loss in less than two weeks in a marked turtle after it ingested a fishhook and noted that other turtles with fishhooks tended to be below normal weight for their size.

Encounters with automobiles may also contribute significantly to mortality. Roads parallel to the watercourse tend to produce higher rates of trauma and mortality than roads that intersect the watercourse (Holland 1991). Turtles are hit by traffic when moving to and from the watercourse during terrestrial journeys, such as over-wintering or nesting movements (Holland 1991). Hatchlings on their way from the nest to water are also at risk from vehicular traffic (Holland 1991). Puddles and wet tire tracks on dirt roads may provide warm, shallow water microhabitat conditions attractive to hatchlings, increasing their exposure to the danger of vehicular traffic.

Commercial harvest of *C. marmorata* was extensive in California from at least the 1870's to ca. 1930's. Millions of turtles were sold in San Francisco markets for human consumption (Holland 1991), probably resulting in significant declines in many *C. marmorata* populations (Holland 1991). Commerical harvest of *C. marmorata* is now prohibited in all states where this species lives.

Illegal collection of *C. marmorata* for the pet trade does occur, but at what level remains undetermined (Holland 1991, Bury pers. comm.). There has been a ban on the sale and/or exhibition of native reptiles and amphibians since the early 1980's (Holland 1991). Although it is illegal to keep *C. marmorata* as a pet, or in a private collection, in the state of California, illegal collection persists in some areas (Holland 1991, Bury pers. comm.).

Death by gunshot wound is also a significant threat to *C. marmorata* in some areas (Holland 1991). Several "reasons" for shooting turtles have been noted by Holland (1991). Some sportsman incorrectly assume these turtles prey on game fish and waterfowl and they shoot them to take this supposed pressure off their game species of choice. Turtles are also shot by private landowners that fear they may lose certain property rights if this species is granted federal threatened or endangered status. There are also reports of shooting turtles for "fun" or target practice (Holland 1991).

Chemical spills pose a threat to *C. marmorata* populations near highways and industrial areas. Holland (1994) reports there were several contaminant spills into aquatic habitats inhabited by *C. marmorata* in Oregon during 1993. This includes a diesel spill that impacted 50 to 100 turtles, resulting in the death of some animals, and physiological complications in many others, including liver and nervous system damage. Bury (1972) studied the effects of biocontaminants on *C. marmorata* following a diesel spill into a northern California creek. He found at least one dead turtle and surviving turtles had swollen eyes and necks, and movements appeared uncoordinated. About a month later, 30 turtles were captured in the spill area, which had sloughed off pieces of epidermis on their appendages, and their eyes and necks were swollen. In recent years, northern California has experienced a number of contaminant spills into aquatic systems, for example the 1991 herbicide spill into the Upper Sacramento River at Cantara, and a latex paint spill into the Smith River off Highway 199 in the mid-90's. Contaminant spills and pollution can kill turtles directly, or indirectly by removing prey base, degrading habitat quality, and/or increasing the risk of disease (Holland 1991)

c. Threats in the Trinity River Basin

In the Trinity River Basin, primary threats to *C. marmorata* include loss of habitat, predation, and incidental loss. Alteration of the riverine habitat due to downstream effects of the dam has reduced the availability of suitable hatchling habitat (Reese 1996). Human encroachment, including residential construction along the riverbanks has reduced availability of historic nesting areas. Logging and construction operations can destroy nests and disturb nesting females.

Human development may also have an effect on predation by both mesopredator release of native species and creation of conditions favoring introduced predatory species. Bullfrogs (*Rana catesbiana*) are known to eat hatchling turtles, they occupy the same types of wetland habitats and have been introduced to the Trinity River, but direct interaction between these species on the Trinity River has not been studied specifically. Corkran and Thoms (1996) suggest that wetland restoration projects may be bullfrog nurseries. Dan Holland (pers. comm.) agrees, most restoration projects definitely have potential to be bullfrog nurseries. Monitoring of project sites for the presence of bullfrogs should be continued.

Unnatural highflow events (dam releases at inappropriate times) may also adversely affect local populations by lowering temperatures and altering aquatic habitat characteristics (Goodman 1997, pers observ.).

The close proximity of State Highway 299 to the Trinity River poses the threat of toxic spills into the river. There are no restrictions on the type of materials which can be transported on Highway 299 as long as approved containers and transport methods are used (California Highway Patrol Commercial Unit (916) 225-2515 pers. comm.). Spillage of contaminants into the Trinity River during transportation could severely impact the already sparse *C. marmorata* populations. This threat is most eminent between Junction City and the North Fork confluence at Helena, and near Douglas City, where State Highway 299 runs along side the river.

The current level of illegal collection of *C. m. marmorata* from the Trinity River, for food or pets, is unknown. Scientific collection of this species has been minimal in recent years.

LITERATURE CITED

BURY, R. B. 1972. The effects of diesel fuel on a stream fauna. California Department of Fish & Game Bull. 58:291-295.

BURY, R. B. 1986. Feeding ecology of the turtle, *Clemmys marmorata*. Journal of Herpetology, Vol. 20, No. 4, pp.515-521.

CAGLE, F. R. 1939. A system of marking turtles for future identification. Copeia 1939:170-172.

CORKRAN, C. C. and C. Thoms. 1996. Amphibians of Oregon, Washington, and British Columbia: A field identification guide. Vancouver. Lone Pine Publishing. 175 pp.

ERHART, L. M. 1979. Reproductive characteristics and management potential of the sea turtle rookery at Canaveral National seashore, Florida. Pp.397-399 In: Proceedings of the first national conference on research in National Parks, New Orleans, Louisiana 1976. R. M. Linn (ed.).

EVENDEN, F. G., Jr. 1948. Distribution of the turtles of of western Oregon. Herpetologica 4:201-204.

FELDMAN, M. 1982. Notes on reproduction in *Clemmys marmorata*. Herpetological Review 13:10-11.

GALBRAITH, D. A. 1993. Mini review: multiple paternity and sperm storage in turtles. Herpetol. J. 3:117-124.

GIST, D. H., and J. M. Jones. 1989. Storage of sperm in the oviducts of turtles. Journal of Morphology 199:379-384.

GOODMAN, R. H. 1997. The biology of the southwestern pond turtle (*Clemmys marmorata pallida*) in the Chino Hills State Park and the west fork of the San Gabriel River. Master's thesis, California State Polytechnic University, Pomona, CA. 81 pp.

HAY, O. P. 1908. The fossil turtles of North America. Carnegie Institute of Washington, Washington, D.C.

HOLLAND, D. C. 1982. Notes on reproduction in *Clemmys marmorata*. Herpetological Review 13(1):10.

HOLLAND, D. C. 1988. *Clemmys marmorata*. Western pond turtle: Behavior. Herp. Review 19:87-88.

HOLLAND, D. C. 1991. A synopsis of the ecology and status of the western pond turtle (*Clemmys marmorata*) in 1991. Prepared for the USFWS, National Ecology Research Center, San Simeon Field Station.

HOLLAND, D. C. 1994. The western pond turtle: habitat and history. ODFG final report.

JENNINGS, M. R. and M. P. Hayes. 1994. Amphibian and reptiles species of special concern in California. CDFG Final Report.

NUSSBAUM, R. A., E. D. Brodie, Jr., R. M. Storm. 1983. Amphibians & reptiles of the Pacific Northwest. University Press of Idaho. 332 pp.

RATHBUN, G. B., N. R. Siepel, and D. C. Holland. 1992. Nesting behavior and movement in the western pond turtle, *Clemmys marmorata*. SW Natur. 37:319-324.

RATHBUN, G. B., M. R. Jennings, T. G. Murphey, and N. R. Siepel. 1993. Status and ecology of sensitive aquatic vertebrates in the lower San Simeon and Pico Creeks, San Luis Obispo County, California. Final Report under Cooperative Agreement 14-16-0009-91-1909 between

U. S. Fish and Wildlife Service and California Department of Parks and Recreation. Publ. No. PB93-230779, National Technical Information Service, Springfield, VA. ix + 103 pp.

REESE, D. A. 1996. Comparative demography and habitat use of western pond turtles in Northern California: The effects of damming and related alterations. Unpublished Ph.D. Dissertation, University of California, Berkeley. 253 pp.

SEELIGER, L. M. 1945. Variation in the Pacific mud turtle *Clemmys marmorata*. SW Naturalist 37:319-324.

SOULE, M. E., D. T. Bolger, A. C. Alberts, J. Wright, M. Sorice, and S. Hill. 1988. Reconstructed dynamics of rapid extinctions of chaparral-requiring birds in urban habitat islands. Conservation Biology 2(1):75-92.

STEBBINS, R. C. 1985. A field guide to western reptiles and amphibians. Peterson field guide series, Houghton Mifflin Company, Boston.

STORM, R. M., W. P. Leonard, H. A. Brown, R. B. Bury, D. M. Darda, L. V. Diller, and C. R. Peterson. 1995. Reptiles of Washington and Oregon. Seattle Audubon Society. 176 pp.

VOIGHT, V. F. 1963. Picta, the painted turtle. G. P. Putman's Son's. New York, N.Y. 63 pp.

ZUG, G. R. 1991. Age determination in reptiles. Society for the Study of Amphibians and Reptiles, Herpetological Circular No. 20.