Volume III, Chapter 10
Western Pond Turtle

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10.0 Western Pond Turtle *(Clemmys marmorata)*

10.1 Introduction

The western pond turtle *(Clemmys marmorata)* is listed by Washington as an endangered species. It was petitioned in 1992 for federal listing, but in 1993 the USFWS found that listing was not warranted.

This highly aquatic turtle occurs in streams, ponds, lakes, and permanent and ephemeral wetlands. Although pond turtles spend much of their lives in water, they require terrestrial habitats for nesting. They also often overwinter on land, disperse via overland routes, and may spend part of the warmest months in aestivation on land. Pond turtles are generally wary, but they may be seen basking on emergent or floating vegetation, logs, rocks, and occasionally mud or sand banks. Nesting occurs from May to mid-July in soils with scant vegetative cover. They usually nest within 325 ft (100 m) of water, but occasionally up to 1,300 ft (400 m) away. Western pond turtles are long-lived, with some reaching an estimated maximum life span of 50 to 70 years, and require more than 10 years to attain sexual maturity.

The historic range of the western pond turtle extended from the Puget Sound lowlands in Washington south to Baja California. Western pond turtles were essentially extirpated in the Puget lowlands by the 1980s. Their present range in Washington is thought to be composed of two small populations in Skamania and Klickitat Counties, and a small pond complex in Pierce County where they were recently reintroduced from captive bred stock. The total number of western pond turtles in known Washington populations is estimated at only 250-350 individuals. Additional turtles may still occur in wetlands that have not been surveyed in western Washington and the Columbia Gorge.

The western pond turtle is declining throughout most of its range and is highly vulnerable to extirpation in Washington. They are still abundant in northern California and southern Oregon wherever there are relatively few people. The species requires a continued recovery program to ensure its survival in the state until sources of excessive mortality can be reduced or eliminated.

The initial cause of the decline in western pond turtle numbers in Washington may have been commercial exploitation for food. Western pond turtle populations cannot be sustained under exploitation, due to their low rate of recruitment and lower densities at the northern portion of the range. Pond turtles never recovered from this decline, in part, due to concurrent or subsequent alteration and loss of habitat. Wetlands were filled for residential and industrial development, particularly in the Puget Sound region. Dam construction and water diversion projects reduced available habitat and isolated populations. Introduced predators such as bullfrogs and warm-water fish probably took a toll on hatchlings and young turtles. Human disturbance may have kept females from crossing over land to lay eggs, or may have reduced the amount of time spent basking, which in turn, may be important for egg maturation. Loss of lakeside emergent wetland vegetation to grazing and trampling may have made habitat less suitable for hatchlings and juveniles. Successional changes through fire suppression on native grasslands may have resulted in excessive shade on nesting grounds.

10.2 Taxonomy

The western pond turtle has been known variously as the Pacific pond turtle, western mud turtle, Pacific mud turtle, Pacific terrapin, and Pacific freshwater turtle. It is a member of the order Testudines and the family Emydidae.

The type specimens of the western pond turtle were collected during the U.S. Exploring Expedition in 1841 in the vicinity of Puget Sound, and were described by Baird and Girard (1852) as *Emysmarmorat*a. The first use of the combination *Clemmys marmorata* was by Strauch (1862). Based upon examination of 158 specimens from throughout the range of the species (Washington and Nevada excluded), Seeliger (1945) divided the species into two subspecies: the northwestern pond turtle *(C. m. marmorat*a) and the southwestern pond turtle *(C. m. pallid*a). The northwestern subspecies is found from the Sacramento Valley, California northward to Puget Sound. The southwestern subspecies is found from the vicinity of Monterey, California southward to Baja California Norte. The area of the San Joaquin Valley, California is considered a zone of intergradation.

In 1992, the Washington Department of Wildlife supported a study of genetic variation within western pond turtle populations using DNA fingerprinting. Gray (1995) found that turtles in the Columbia Gorge region of Washington and Oregon had very high genetic similarity within sites and significant genetic divergence between sites. She concluded this was an indication of lack of dispersal and gene flow between sites. Her results indicated a significant genetic difference between northern populations in Washington and Oregon, and southern California populations. She found no genetic subdivision between turtles from the Puget Sound region and the Willamette Valley, and a small genetic subdivision between Puget Sound/Willamette Valley turtles, and Columbia Gorge turtles. She also stated that the level of genetic variation within the Puget Sound region may have been overestimated due to small sample sizes.

Janzen *et al.* (1997) used a mitochondrial DNA technique to evaluate the molecular phylogeography of the western pond turtle. They found low levels of genetic differences among populations of northern pond turtles. They conducted a more detailed analysis of turtles in Oregon, and found that there were small genotypic differences within Oregon populations of turtles. Of particular note, turtles in the Willamette Valley were slightly different from turtles in the Columbia Gorge in Oregon.

Considering the work of both Gray (1995) and Janzen *et al.* (1997), there is an indication that the Willamette Valley turtles are more similar to Puget Sound turtles than Columbia Gorge

turtles. In addition, these genetic studies support morphological differences suggested by Holland (1992) between Columbia Gorge and Puget Sound turtles.

10.3 Description

The western pond turtle is a medium-sized turtle, dark brown or olive above without dark reticulations or streaking and a yellowish plastron (underside), sometimes with dark blotches in the centers of the scutes (Storm and Leonard 1995). Maximum size varies geographically, with the largest animals (210 mm or 8.2 in) occurring in the northern part of the range. Turtles become sexually mature at a carapace (dorsal or top shell) length of about 120 mm (Nussbaum *et al*. 1983). Large animals may exceed 1 kg (2.2 lb) in mass. In a series of 45 adults from Klickitat County the mean weight of males was 554 g (1.2 lb) and the mean weight of non-gravid females was 504 g (1.1 lb) (D. Holland, unpubl. data). Non-gravid females of a given carapace length are usually significantly heavier than males (Holland 1985a). Hatchlings are 1.0-1.22 in (25-31 mm) in length and weigh from 0.11-0.25 oz (3-7 g) (D. Holland and F. Slavens, unpubl. data).

Color varies geographically and with age. In general, animals in the northern part of the range are darker in overall coloration. The ground color of the carapace (dorsal or top shell) is generally dark brown or black, but may be reddish in a small percentage of females. In some extremely old males the melanin in the carapace becomes mottled in appearance. The carapace may be unmarked, or may possess a series of fine black radii or lines extending outward from the growth center of each shield. These lines may be darker than the ground color of the carapace and often surround small yellow-gold flecks. The plastron is generally cream to yellow in color, with varying degrees of black or brown mottling (Storm and Leonard 1995).

Head and neck coloration varies sexually and geographically and changes during the life cycle. Small animals and females typically have dark flecks or rosette-like markings (often referred to as a "paisley print") on the head, sides of the neck, and throat (Storm and Leonard 1995). Females tend to retain these markings throughout life, whereas males usually become progressively darker on the head and sides of the neck, while the throat becomes white or cream-yellow. Hatchlings are generally dark brown-olive, with prominent mottling on the head and neck.

Western pond turtles are sexually dimorphic. In general, the female has a smaller head, less heavily-angled snout, relatively higher and rounder carapace, and a thinner tail. Males have a slightly concave plastron. In northern populations, males reach a larger maximum size than females (Holland and Bury 1998).

10.4 Distribution

10.4.1 North America

The western pond turtle historically ranged from the vicinity of Puget Sound in Washington south to the Sierra San Pedro Martirs in Baja California Norte (Figure 10-1). Most populations occurred west of the Sierra/Cascade crest.

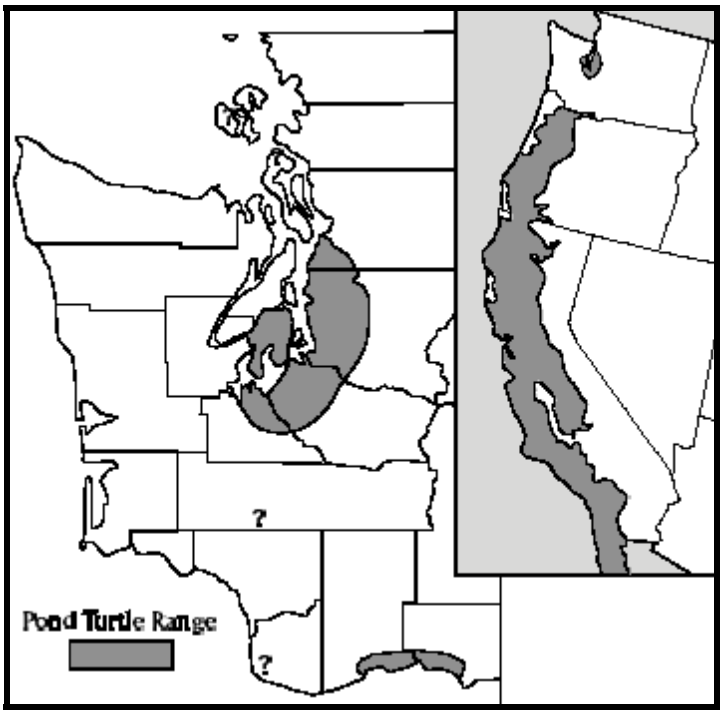

Figure 10-1. Approximate historic range of the western pond turtle in Washington (circa 1850), and in North America (inset). ?= records that may have resulted from human transport.

10.4.2 Washington

10.4.2.1 Past

Fossils assigned to this species are known from Pleistocene strata in the vicinity of White Bluffs in south-central Washington (Brattstrom and Sturn 1959 in Gustafson 1978), indicating that western pond turtles once had a wider range than present. Additional populations along the Columbia River may have been lost in recent decades because dam construction may have eliminated suitable habitats within the last 70 years.

Areas surrounding Puget Sound probably were incapable of supporting western pond turtles prior to approximately 10-11,000 years ago due to extensive glaciation. D. Holland (pers. comm.) suspects turtles in this area arrived about 9-10,000 years ago through the Puget Trough from the Willamette drainage, and suggests a pyroclastic event from Mount Rainier about 4,700 years ago isolated the Puget Sound population. Reconstructing the range of this species is difficult because turtles are often transported by people and they may be found in areas where native populations have never existed. Western pond turtle populations have been documented from the south Puget Sound lowlands (Suckley and Cooper 1860) and the Columbia River Gorge (Slater 1962). Reliable records of western pond turtles suggest a broad distribution in the western half of Washington State, but most records pertain to single turtles, either collected or observed, and some unknown subset of these records probably reflect human translocations.

There are 19 western pond turtle specimens from Washington in museum collections (**Error! Reference source not found.**). Sixteen are from the Puget Sound area (Figure 10-2) (representing eight distinct locations), two are from the vicinity of Lyle, Klickitat County, and one is from San Juan Island, San Juan County. The turtles collected in San Juan and Clark Counties may have been moved by people, because they were quite distant from any known

populations. A. Flynt obtained the first record of the species from the Columbia River Gorge when he found the turtles near Lyle (Slater 1962).

Table 10-1. Western pond turtle specimens collected in Washington. Information assembled from Milner (1986), Holland (1991b), and WDFW data.

Locality	County	Date	Collector	Comments	Specimen[a]
Steilacoom, Puget Sound		1841	US Exploring	Holotype	USNM 007700
Puget Sound		1841	Expedition	Cotype	USNM 008800
Puget Sound		1841	"	Cotype	USNM 00759400
Puget Sound		1841	"	Cotype	USNM 00759500
Puget Sound		1841	"	Cotype	USNM 00759600
Puget Sound		1841	"	Cotype	USNM 00131830
Fort Steilacoom		1853-1860	J. G. Cooper	Gravid female	MCZ 42200
Lk Washington, Tacoma	Pierce	Apr 1891			ANSP 3986
Talbot Marsh, McChord AFB	Pierce	23 May 1937	J. R. Slater	Imm. female	PSM 3020
Talbot Marsh, McChord AFB	Pierce	18 April 1939	H. Myhrman		PSM 3621
Meridian Lake	King	20 Jun 1948	W. Hagerman		PSM 4992
Long Lake	Thurston	10 May 1950	S. M.		PSM 6300
Sportsman's Lake	Pierce	12 Oct 1951	H. Myhrman		PSM 4971
Meydenbauer Bay, Lk Wash	King	9 Aug 1952	M. Johnson		PSM 8189
Bay Lake	Pierce	23 Mar 1956	Anon.		CRCM 57-244
San Juan Island	San Juan	26 Aug 1960	J. Berger	Transported?	UI 48370
W of Lyle	Klickitat	7 June 1960	A. Flynt		AMNH 84331
W of Lyle	Klickitat	7 June 1960	A. Flynt		PSM 8233
Lake Washington	King	1963	Anon.		UWBM 20332
Salmon Crk, Vancouver Lk	Clark	1963	E. Nelson	Found dead	CCC
Salmon Crk N of Kid Valley	Lewis	10 June 1993	B. Bicknell	Photo voucher	UWBM

[a] Holdings as follows: American Museum of Natural History, New York (AMNH); Academy of Natural Sciences, Philadelphia (ANSP); Clark Community College (no museum), Vancouver, Washington (CCC); Charles R. Conner Museum, Washington State University, Pullman (CRCM); Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts (MCZ); James R. Slater Museum of Natural History, University of Puget Sound, Tacoma, Washington (PSM); University of Illinois, Urbana-Champaign (UI); National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM); Thomas Burke Memorial Washington State Museum, University of Washington, Seattle (UWBM).

There are recent reports of pond turtles from south Puget Sound (Table 10-2), as well as recent reports of two animals from the vicinity of Vancouver Lake, Clark County (**Error! Reference source not found.**). A 1993 photograph of an animal was taken in Lewis County (**Error! Reference source not found.**). D. Blackburn (D. Holland, pers. comm.) was shown the shell of an animal found dead in 1989 in this area and one specimen exists in the collection of Clark Community College. The Lewis County and San Juan Island records came from areas where no populations have ever been found. Another record consists of a plastron fragment found during archaeological excavation of 500 year old shell middens at Cornet Bay on the north end of Whidbey Island (Weasma 1991). This location is 50 miles north of the northernmost historical records, and may have been transported and eaten at the site. A conservative interpretation of historic distribution relies on accounts that give observations of turtles in significant numbers and locations with multiple records. However, with little information available, an accurate depiction of the species' distribution is not possible.

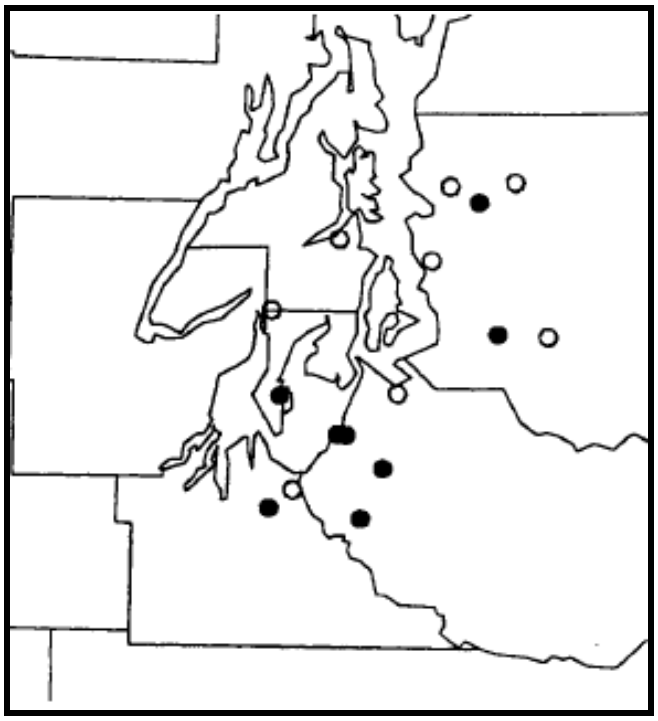

Figure 10-2. Museum records (solid dots) and recent sightings (open dots) of western pond turtles in the Puget Sound region.

Table 10-2. Western pond turtle sight records in the Puget Sound lowlands, Washington, 1980–1997.

Locality	County	Date	Observer	Comments
Kitsap Lk roadside	Kitsap	1983/84	L. Bomstead	Taken to pond at Bomstead home.
Crossing hwy 901[a]	King	30 Oct 1987	J. Pryal	Released in Lk Sammamish
Tacoma City waterway[b]	Pierce	15 July 1987	J. Slipp	Adult male
Lake Garret, Brien	King	July 1988	M. Jolivet	Old bullet hole in carapace, died
Port Orchard[b]	Kitsap	May 1991	G. McIntyre	Died 30 June, 1991
McAllister Crk, under I-5[a]	Thurston	May 1991	R. Van Deman	Released at Nisqually NWR
Wapato Creek, Fife[b]	Pierce	May 1992	S. Siebers	Adult female
Kent Kangley Rd[b]	King	7 July 1992	M. Flatt	Adult male, estimated 5 years
Under Hwy 520, Lk Wash	King	21 June 1992	L. Shaftel	Adult female, 7 inches long
Koeneman Lk (Fern Lk)	Kitsap	1 June 1992	D. Payne	Adult male

[a] Photos examined by WDFW biologist

[b] Captive Breeding Program

10.5 Life History & Habitat Requirements

10.5.1 Behavioral Characteristics

10.5.1.1 General

Western pond turtles spend a considerable amount of time engaged in thermo-regulatory behavior. When out of water, turtles seek warmth from the sun in an activity known as emergent basking. Emergent basking has been noted in all months of the year in some areas, but generally increases in frequency through the spring to a peak in early to mid-June. Emergent basking declines in summer until September, when another peak is observed. Turtles also seek thermally-suitable micro-habitats in the water to engage in an activity known as aquatic basking (Holland

1985a). In these situations turtles are typically found concealed in or under masses of floating vegetation or algae, or in shallow water relatively close to shore. This behavior varies by site and season. In general, aquatic basking peaks in early to mid-July in most areas and declines by early September.

Western pond turtles often engage in aggressive interactions while emergent basking (Bury and Wolfheim 1973). A ritualized intention to bite called the "open-mouth gesture" is the most common aggressive behavior. Aggressive behavior seems to maintain spacing on basking sites and may be used to settle disputes over preferred sites (Bury and Wolfheim 1973).

Western pond turtles are wary, with a well-developed sense of sight and a moderate sense of hearing (Holland 1985a). The initiation of escape behavior varies with the individual and circumstances, but often occurs when a perceived threat is 325 ft (100 m) distant or more. If turtles are surprised in shallow water with no nearby refuge they may remain motionless. Turtles surprised while engaged in aquatic basking simply withdraw their heads and limbs and remain motionless. Pond turtles can be habituated to human presence through repeated interaction (R.B. Bury, pers. comm.).

In the spring, early summer, and autumn most turtle activity is diurnal. Nocturnal activity primarily occurs in the summer (Holland and Bury 1998). During the summer the species may be most active in early morning and evening, and inactive during the heat of the day. Western pond turtle activity may persist throughout the year in some parts of their range.

10.5.1.2 Overwintering

"Overwintering" refers to periods of reduced or no activity during the winter and may include periods of a hibernation-like state of reduced physiological activity. Western pond turtles overwinter from mid-October or November to March or April. Pond turtles may overwinter on land as much as 1,600 ft 500 m) from the nearest watercourse, and they sometimes change sites during the season (Holland 1994, Slavens 1992a). During a study in California, 10 of 12 pond turtles overwintered at upland sites (Reese and Welsh 1997). Preliminary observations from turtles in a pond environment suggest that juveniles overwinter in the water (Slavens 1995). Turtles that overwinter under water may change sites and may form aggregations. Holland (1994) observed pond turtles in winter swimming under ice, and recorded an aggregation of 43 turtles in a one square meter area in the Willamette Valley of Oregon. Aggregations in shallows under ice were also described at Old Fort Lake in Pierce County in the mid 1800s by an employee of the Hudson's Bay Company (see Strahle 1994). Stream-dwelling pond turtles may be more likely to overwinter on land than pond-dwelling turtles (R.B. Bury, pers. comm.)

10.5.1.3 Aestivation

Aestivation is an inactive state that turtles may enter in the hottest weeks of the year or to avoid short-term drought conditions or drying of a water body. During a telemetry study in Washington, pond turtles moved onto land and burrowed under logs or leaves and remained inactive for days or months (Slavens 1995). One female went onto land 5 times between 9 August and 1 October and returned to water after 2-9 days each time. Aestivation merged with hibernation for one female who was in the same upland location from 11 Aug - 2 Feb, and was next found in the water on 29 March (Slavens 1995).

10.5.1.4 Foraging

Western pond turtles locate food by sight or by smell, and appear to spend considerable amounts of time foraging. Under normal conditions feeding behavior is solitary. However, large numbers of individuals may gather at a vertebrate carcass and aggressive interactions are common under these conditions (D. Holland, unpubl. data). Western pond turtles are apparently incapable of swallowing in air, so food must be swallowed in the water. Animals normally forage along the bottom of water bodies, searching carefully in submerged leaf litter and other detritus. They may also forage on items on the surface or feed in the water column under special circumstances (Holland 1985b). Nocturnal foraging has been observed during the summer months in central California (Holland 1985a).

10.5.1.5 Diet

Western pond turtles are dietary generalists. They prey heavily on aquatic invertebrates, such as the larvae of beetles, stoneflies, caddisflies, dragonflies and other insects (Bury 1986, Holland 1994). Bury (1986) notes that pond turtles in a stream environment in northern California may occasionally take small fish and frogs. Holland (1985a) found two vertebrate prey items in over 500 stomach flushings of animals from the central coast of California, but it is thought that these were scavenged because turtles frequently feed on carrion. Scavenging has been noted on the carcasses of various mammals, birds, reptiles, amphibians and bony fishes. Where bullfrogs (*Rana catesbeiana*) occur with western pond turtles, there is no evidence that turtles feed on either larval or post-metamorphic bullfrogs, although they may feed on their carcasses (D. Holland, pers. comm.). Unpalatable elements in the skin of bullfrogs may deter predation by pond turtles.

Use of plants appears to be limited except in the case of post-partum females, who may ingest large quantities of cattail (*Typha spp*.) or bulrush (*Scirpus spp*.) roots at certain seasons (Holland 1985a). Water lily pods and alder (*Alnus spp*.) catkins are also eaten (Holland and Bury 1998). In certain circumstances, turtles may eat large quantities of filamentous green algae (Holland 1991b), which they ingest while trying to eat live prey (R. B. Bury, pers. comm.).

10.5.1.6 Home Range

Western pond turtles in a stream environment in northern California had average home ranges of about 2.47 ac (1 ha) for adult males, 0.62 ac (0.25 ha) for adult females, and 1 ac (0.4 ha) for juveniles (Bury 1979, Holland and Bury 1998). Considerable overlap in home ranges of individuals of both sexes occurred in this area. Preliminary information from the Columbia Gorge indicates turtles may have larger home ranges in Washington (Slavens, pers. comm.).

10.5.1.7 Movements

Most western pond turtles are somewhat sedentary, although they are capable of moving significant distances and occasionally travel several hundred meters in just a few days (Bury 1979). Daily movements in a California stream averaged 150 m/day for males, and 21 m/day for gravid females (Holland 1994, summarized in Holland and Bury 1998). In an Oregon lake, daily movements averaged 640 ft/day (194.5 m/day) for males, 606 ft/day (185.5 m) for gravid females, and 616 ft/day (188.7 m) for non-gravid females. Some turtles have moved over 3.1 mi (5 km) within a stream (Holland 1994).

Most movements on land are associated with nesting, overwintering or aestivation, although other types of movements also occur. Gravid females typically make multiple trips onto

land (Reese and Welsh 1997, K. Slavens, pers. comm.). Reese and Welsh (1997) reported travel to overwintering sites as far as 0.3 mi (500 m) from a California river, and speculated that overwintering away from the river may have been an adaptation to avoid winter flooding. Slavens (1995) reported movements between wetlands in Washington: a male turtle that was captured and then released in a different wetland moved 0.5 mi (800 m) back to the original site. Male turtles have been encountered moving overland in spring, possibly searching for females. K. Slavens (pers. comm.) reports capturing males several times in different ponds during April of the same year. A juvenile turtle moved 656 ft (200 m) between ponds either overland or through a stream, and another juvenile was observed moving overland between ponds. Some turtles move between ponds on an annual basis, moving to larger ponds as water levels recede (Slavens 1995).

Females may move considerable distances from the water to nest. In Washington distances of up to 614 ft (187 m) are known (Holland 1991a), but distances of 65-325 ft (20-100 m) are more typical (Slavens, unpubl. data). Distances as little as 10 ft (3 m) and as great as 1,300 ft (400 m) away from, and 300 ft (92 m) above the watercourse have been recorded (Storer 1930, Holland 1994).

10.5.1.8 Interspecific Relationships

The western pond turtle occurs sympatrically with the western painted turtle (*Chrysemys picta belli*) in northern Oregon and at one of the two Columbia River Gorge localities in Washington (Nordby 1992; D. Holland, pers. comm.). The two species are frequently observed basking together, and they may utilize the same prey base. In areas where thermally desirable emergent basking sites are limited, competition for these sites may occur when population densities are high (Bury and Wolfheim 1973, D. Holland, unpubl. data). Competition for available prey may occur between western pond turtles and introduced fish species (Holland and Bury 1998). Western pond turtles may also interact with introduced turtles (D. Holland, pers. obs.) and other animal species. Aggressive interactions with two-striped garter snakes (*Thamnophis hammondi*) and several species of birds have been noted in California (Holland 1985a). Western pond turtles are preyed on by a variety of species.

10.5.2 Habitat Requirements

10.5.2.1 Aquatic

The western pond turtle is associated with a variety of aquatic habitats, both permanent and intermittent. They are found from sea level to approximately 4,500 ft (1,375 m), but all records for Washington are below 985 ft (300 m) in elevation. The name western "pond" turtle is something of a misnomer, as ponds are relatively scarce throughout most of the range of this species, and the turtles are more often associated with rivers and streams. They are usually rare or absent in reservoirs, impoundments, canals, or other bodies of water heavily altered by humans. However, in Washington and many areas of Oregon the species is found in ponds and small lakes.

Historically, western pond turtles occurred in large numbers in the warm, shallow lakes and sloughs on the floor of the San Joaquin and Sacramento valleys of California (Holland 1991b). This species reaches its highest densities in the few remaining areas that approximate these habitat conditions.

Western pond turtles inhabit some of the larger rivers within their range (e.g., the Sacramento, Klamath, and Willamette), but are usually restricted to areas near the banks or in adjacent backwater habitats where the current is relatively slow and abundant emergent basking

sites and refugia exist. They may be found in slower moving streams where emergent basking sites are available, but generally avoid heavily shaded areas. In some areas of California, intermittent streams hold sizeable populations. Turtles are also known to use ephemeral pools. They tolerate brackish water, and along the California coast they often coexist with brackish-water fish species such as sculpins (*Leptocottus armatus and Cottus sp*.) (Holland 1991b).

Habitats used by western pond turtles may have a variety of substrates including solid rock, boulders, cobbles, gravel, sand, mud, decaying vegetation, and combinations of these. In many areas turtles are found in rocky streams with little or no emergent vegetation. In other areas they occur in slow-moving streams or backwaters with abundant emergent vegetation such as cattails or bulrush (*Scirpus spp*.) (Holland 1991c). In certain coastal streams of California they occur in areas with no emergent vegetation but abundant submerged vegetation, most typically ditch grass (*Ruppia maritima*). In the northern parts of the range, pond lilies (*Nuphar spp*.) or arrow weed (*Sagittaria spp*.) are often the dominant aquatic macrophytes. In disturbed habitats large mats of filamentous algae may be the only aquatic vegetation present. Dense growths of woody vegetation along the edges of a watercourse may shade potential emergent basking sites, and make habitats unsuitable for pond turtles.

Turtles have been observed to be active in water temperatures as low as 37°F (1-2°C) and as high as 100°F (38°C) (Holland 1991c, Holland 1994). In general, turtles avoid prolonged exposure to water above 95°F (35°C). Visibility through water in areas inhabited by turtles may range from less than 6 in (15 cm) to more than 33 ft (10 m).

10.5.2.2 Basking Sites

Western pond turtles spend a considerable amount of time basking, and they are more abundant in habitats that have basking sites (Holland and Bury 1998). Turtles may use a variety of sites for emergent basking, such as rocks, sand, mud, downed logs, submerged branches of near-shore vegetation, and emergent or submerged aquatic vegetation. Turtles are also known to bask on planks, barrels, abandoned autos, the carcasses of large mammals, and other items.

10.5.2.3 Refugia

Western pond turtles are associated with areas that contain underwater refugia, and are rarely found more than a few meters from a refuge of some sort (Holland and Bury 1998). These refugia may consist of rocks of various sizes, submerged logs or branches, submerged vegetation, or holes or undercut areas along the bank. When escaping, turtles swim rapidly toward the bottom of the water body and hide in or under nearby refugia. In some cases animals attempt to burrow into the substrate. Turtles also occasionally hide in thick vegetation or holes at the edge of the watercourse.

10.5.2.4 Uplands

Western pond turtles use upland areas for dispersal, to nest, to overwinter, and to aestivate. Overland movements may occur during spring and fall migrations to and from upland overwintering sites, or may be in response to drying of the water body, or for other reasons not presently understood (Holland 1991b). Males may make overland movements in search of females (K. Slavens, pers. comm.). In a California study, Reese and Welsh (1997) reported use of terrestrial habitats by male turtles in 10 months of the year, and by females in all months. Many turtles overwinter on land at sites up to 0.3 mi (500 m) from the water. Overwintering sites tend to have a deep layer of duff or leaf litter under trees or shrubs, and some turtles return to the

same site each year (Holland 1994, Holland and Bury 1998, K. Slavens, pers. comm.). Reese and Welsh (1997) reported that 10 turtles overwintered at upland sites a mean distance of 666 ft (203 m) from the water. Turtles burrowed into deep leaf or needle litter at sites beyond the riparian zone in woodlands with 15-90% canopy cover. Most of the overwintering sites were on relatively cool north or east facing slopes.

In Klickitat County, Washington, 10 of 15 overwintering sites were on slopes of 5-15°. Nine of these had an east or west aspect, and one had a north aspect (K. Slavens, pers. comm.). Of the five remaining sites; one was a west slope of 25°, and four were on south, east, or north slopes of 40-45°. One site was only 3 ft (1 m) from the high water mark in March. All the sites had 80-90% shrub and tree canopy coverage. Virtually all overwintering sites were beneath or near Oregon white oak (Quercus garryana). Two turtles were dug in under logs, and the remaining 13 were under small shrubs (K. Slavens, pers. comm.).

Reese and Welsh (1997) reported that gravid females in their study were highly terrestrial, though the presence of researchers may have affected turtle activities. They noted that during the nesting season, the air temperature was consistently higher than the water temperature. They speculated that female turtles may use uplands prior to oviposition for its thermal advantage. Most nest sites discovered have been in dry, well-drained soils with significant clay/silt content and low slope (< 15°) (Holland 1994, Reese and Welsh 1997).

In Washington, pond turtles use wetlands that have open uplands, such as oak-pine savanna, prairie, or pastures. Human-caused fires may have been beneficial to turtles historically by maintaining open areas for nesting. Suppression has resulted in an increase in the distribution and cover of coniferous trees such as Douglas fir (Crawford and Hall 1997). A reduction in fires since white settlement has dramatically altered native grassland habitat. In the south Puget Sound region, less than 10 percent of historical grassland habitat remains (Crawford and Hall 1997). Successional changes in grassland and oak woodland habitat may have played a major role in the decline of western pond turtles.

Turtles usually nest in open areas with good sun exposure that are dominated by grasses and herbaceous vegetation, with few shrubs or trees close by. Exposure varies, but typically is south or southwest (Holland 1991b). The distance from water for 275 nests in California averaged 149 ft (45.6 m) (range 5-1,326 ft (1.5-402 m) (Holland and Bury 1998). In Washington, nest sites have all been less than 614 ft (187 m) from the water (Holland 1991a). Some female turtles seem to exhibit nest site fidelity (Holland and Bury 1998). The degree of nest site fidelity exhibited in an area may be related to the relative abundance of nesting habitat (K. Slavens, pers. comm.).

10.6 Population Dynamics

10.6.1 Reproduction

Courtship and mating behavior have been observed from February to November (Holland 1988, Holland and Bury 1998). Age and size at development of secondary sexual characteristics varies geographically (D. Holland, unpubl. data), but these are generally evident in both sexes by the time an animal reaches 110 mm (4.3 in) carapace length. The time required for males to achieve sexual maturity is not known, but is thought to be at least 10-12 years in Washington. In a sample of 10 gravid females from the Klickitat County population, the smallest animal was 5.63 in (143 mm) carapace length, and approximately 14-17 years of age (Holland 1991c).

However, females as small as 4.3 in (111 mm) with an approximate age of 6-7 years have been observed carrying eggs in southern California (Holland 1994).

When preparing to lay eggs, females typically leave the water in late afternoon or early evening and travel distances generally up to 325 ft (100 m) to nest (Slavens 1995). Females moisten the soil around the nest by urinating prior to digging the nest chamber. Excavating the flask-shaped nest may require several hours and the female commonly remains on or near the nest site overnight.

In Washington's Columbia Gorge populations, most females that were monitored in successive years nested each year (K. Slavens, pers. comm.). Holland and Bury (1998) report that in northern areas, most females only deposit eggs in alternate years. In central and southern California females produce eggs every year and two clutches in some years (Holland and Bury 1998). Double-clutching by wild females has been observed in Washington during 1996, 1997, and 1998 (K. Slavens, unpubl. data). In Washington, clutches have been laid between May 31 and July 9 (n=41) with a peak in mid-June (Figure 10-3). Clutch size ranges from 2-13 eggs and is positively correlated with body size. Mean clutch size for 36 wild nests from Washington was 6.64 (SD ±1.57, range 2-10) (F. & K. Slavens, WDFW, unpubl. data).

Eggs average 1.34 in (34 mm) in length, 0.83 in (21 mm) in diameter, and 0.28-0.35 oz (8-10 g) in weight (Holland 1994). Hatching rate of fertile eggs in the Pacific Northwest seems to be dependent on the weather during the incubation period. Unusually cold wet weather can cause total nesting failure (Slavens 1995). In 10 nests in Washington, incubation time varied from 95 to 127 days (Holland 1991a, Slavens 1995). Incubation time in captivity is 73-132 days (Lardie 1975, Feldman 1982). Hatchlings from Washington average 0.18-0.25 oz (5-7 g) in weight and 1.1-1.2 in (27-31 mm) in carapace length (F. Slavens, unpubl. data). In southern California, some hatchlings leave the nest in early fall. Field observations to date indicate that in the northern parts of the species' range, hatchlings overwinter in the nest (Holland 1994, Reese and Welsh 1997, F. & K. Slavens, pers. comm.).

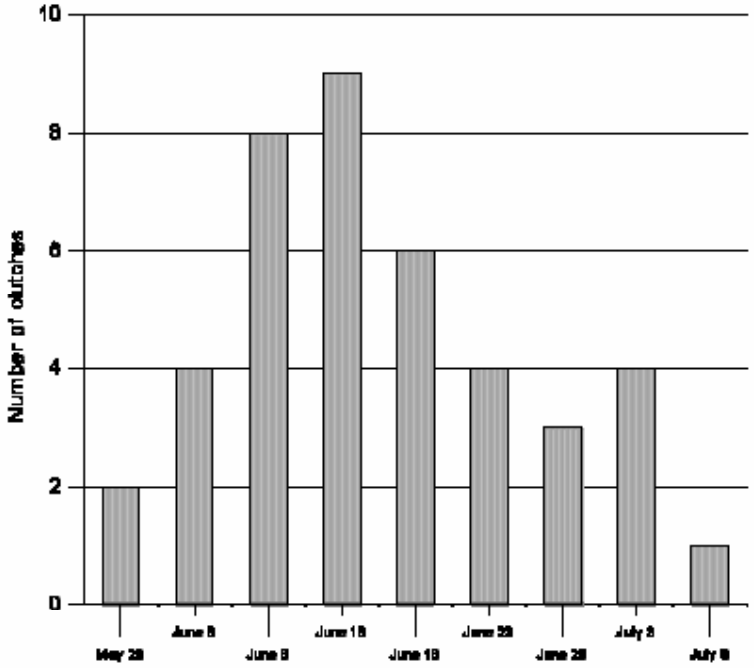

Figure 10-3. Timing of western pond turtle oviposition in five day intervals in the Columbia River gorge, 1990–97 (K. Slavens unpubl. data).

10.6.2 Mortality

Preliminary analyses by D. Holland (unpubl. data) suggest mortality is high in the younger (less than 6-8 years) age classes. Under undisturbed conditions possibly only 10-15% of the animals that hatch in a given year survive until the end of the first year. Survival from the first to second and second to third year is similarly low, but increases slightly by the fourth and fifth years (Holland unpubl. data). R. S. Bury (pers. comm.) reports only slight mortality after year 3 for pond turtles in a northern California study. Survivorship apparently continues to increase until the attainment of sexual maturity. Exact rates of turnover in the adult portion of the population are not known, but probably average 3-5% per year in undisturbed populations (D. Holland, unpubl. data). The average life expectancy of adults is not known. The maximum age achieved by animals in the wild is at least 42 years (D. Holland and R. B. Bury, unpubl. data). The estimated maximum life-span based upon an extrapolation from known adult growth rates is 50-70 years (D. Holland, unpubl. data), which approximates that of the ecologically similar Blanding's turtle (*Emydoidea blandingi*) in Michigan (Congdon *et al.* 1993).

10.6.2.1 Predation

Bullfrogs prey on juvenile western pond turtles (Moyle 1973). Bullfrogs are native to the eastern United States, but have become abundant and widely distributed in the west since their introduction to Idaho in the 1890s, and to Oregon in the 1920s (Lampman 1946). They currently are found throughout the range of the western pond turtle (Bury and Whelan 1985). Bullfrogs may be an important predator on hatchlings because both frequent shallow water habitat. Holland (1991b) has observed a reduction in the abundance of juvenile western pond turtles in areas with bullfrogs (Figure 10-4). Predation by bullfrogs and other predators may be responsible for the lack of juveniles in many pond turtle populations. Largemouth bass (*Micropterus salmoides*), another widely introduced species, also preys on juvenile pond turtles (Holland 1991b). However, observations by Holland (1991b) indicate that the impact of bass may not be as important as that of bullfrogs, perhaps because bass do not frequent the shallows as much as bullfrogs.

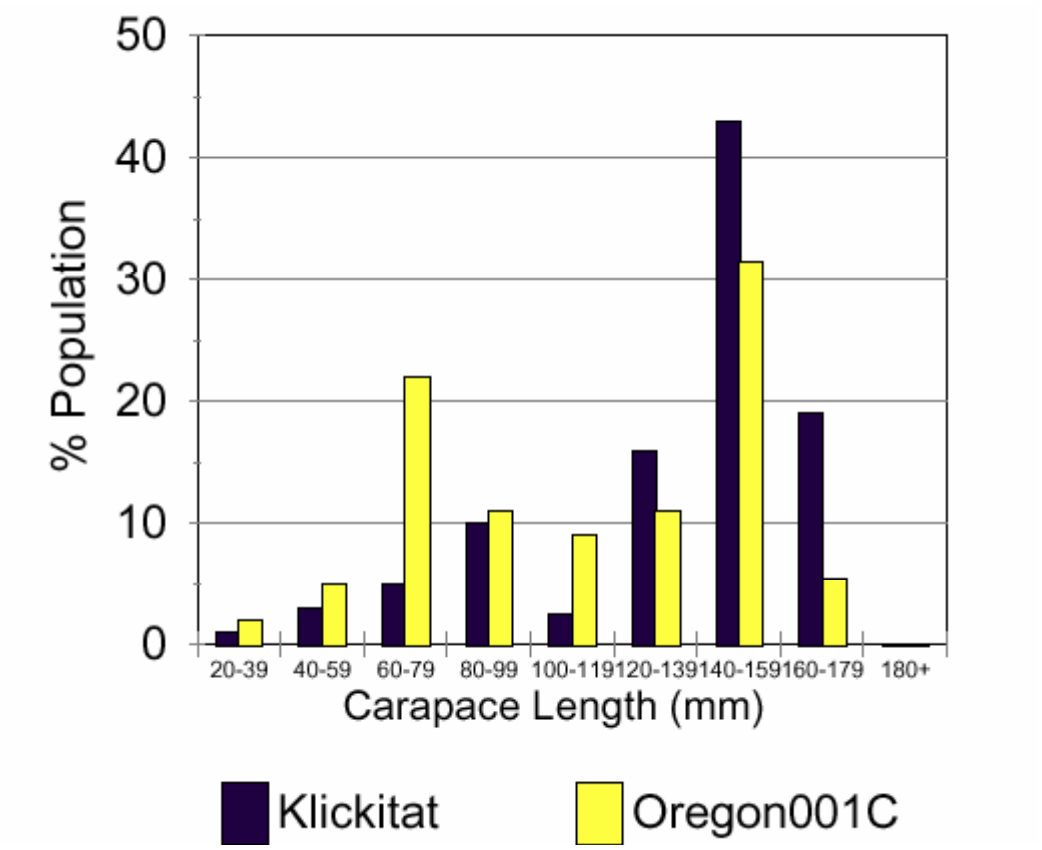

Figure 10-4. Size class composition of western pond turtles where bullfrogs are present (Klickitat County, n=84, 1987-90) and absent (Oregon site 001C, n=54, 1991) (from Holland 1991b:42).

Black bears (*Ursus americanus*) and coyotes (*Canis latrans*) completely eliminated a southern California pond turtle population when drying of a stream forced overland movement by the turtles (S. Sweet, pers. comm. to D. Holland). Raccoons (*Procyon lotor*) preyed on two adults from the Klickitat County population in 1991-92. In 1992, 97 of 106 western pond turtle nests monitored in Oregon were depredated, probably by raccoons or skunks (Holland 1993). River otters (*Lutra canadensis*) are known to prey on western pond turtles (Manning 1990). Holland and Bury (1998) reported 10 pond turtle carcasses and over 20 live turtles with missing limbs along a 3 km stretch of stream and attributed this to river otters. Holland (1994) lists five additional known predators: bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), gray fox (*Urocyon cinereoargenteus*), mink (*Mustela vison*), and dog.

Suspected predators include bobcat (*Lynx rufus*), great blue heron (*Ardea herodias*), black-crowned night-heron (*Nycticorax nycticorax*), golden eagle (*Aquila chrysaetos*), red-shouldered hawk (*Buteo lineatus*), giant garter snake (*Thamnophis gigas*), two-striped garter snake, California red-legged frog (*Rana aurora draytonii*), rainbow trout (*Oncorhynchus mykiss*) and channel catfish (*Ictalurus punctatus*) (Holland 1994). Predation by humans may take the form of wanton shooting, capture by hook and line fishing or entanglement in nets, collection for the pet trade (Bury 1982; D. Holland, pers. obs.) or collection for food (M. P. Hayes and S. Sweet, pers. comm. to D. Holland).

10.6.2.2 Drought

A prolonged drought in California (1985-1990) apparently resulted in declines of up to 85 percent in some pond turtle populations and the outright elimination of others (D. Holland, unpubl. data). Drought may function as a direct mortality factor by eliminating the habitat or prey base required by turtles for survival. Without adequate body fat reserves normally produced by late-season feeding, turtles may be unable to survive the stress of overwintering.

10.6.2.3 Disease and parasites

A syndrome similar to upper respiratory disease caused a decline in the Klickitat County population in 1990. The causal agent is not known with certainty, but may have been a virus or mycoplasma, transmitted from one or more introduced turtles. Western pond turtles essentially have evolved in isolation from most other turtle species for most of their history. Non-native species may introduce pathogenic agents to which western pond turtles have never been exposed, or have inherent resistance to. If this is the case, the introduction of non-native species, particularly from unhealthy captive situations, (e.g., red-eared slider) may have catastrophic consequences for western pond turtle populations. A herpes-like virus has been reported to kill captive western pond turtles in California (Frye et al. 1977).

The effect of parasites on western pond turtle populations is unknown. The only known ecto-parasites are leeches (Placobodella sp.) found on specimens from northern California and central Oregon (Holland 1991b). Endo-parasites include nematodes (Bury 1986) and lungworms (Holland 1991b). Ingles (1930) reported a trematode (Telorchis sp.) from western pond turtles. Thatcher (1954), reported 7 species of helminthes from western pond turtles.

10.7 Population Density

Western pond turtles may reach the highest densities of any emydid turtle and may have been the dominant element of the vertebrate biomass of some aquatic communities on the west coast (Holland 1991b). They historically occurred in large numbers in warm shallow lakes and sloughs such as in the San Joaquin and Sacramento valleys of California. Pond turtle densities range widely, from a low of five turtles per acre (2/ha), to, at one site, an estimated 3,700 turtles /acre (1,500/ha) (Holland 1991b). Pond turtle densities in a few sites have been calculated at over 1,000 turtles/ha (405 turtles/ac) of water surface (Holland 1991b), but typically are found at much lower densities.

10.8 Population Status

The western pond turtle is declining in numbers throughout its range, particularly in Washington, northern Oregon, southern California, and Baja California. It is now common only in a fraction of its original range (Holland and Bury 1998).

10.8.1 Past

The western pond turtle was once abundant in California, Oregon, and locally in Washington. They were commercially marketed for food with annual sales in San Francisco in the 1890s averaging $18,000 (Smith 1895). Exploitation and habitat destruction dramatically reduced pond turtle populations.

No historic data are available on the size or dynamics of populations in the Columbia River Gorge or Puget Sound regions. Cooper (1860) noted that turtles were "common in freshwater ponds and rivers west of the Cascades," a point questioned by Storer (1937), who

stated that if this was the case, "specimens should be forthcoming." Three possibilities may explain the scarcity of specimens: 1) the wary nature of the species precluded extensive collection; 2) the species was uncommon or present in low numbers due to various limiting factors at the terminus of its range; and/or 3) a dramatic reduction in the size of population(s) in this area occurred prior to the initiation of extensive collecting efforts that began with the activities of J. Slater in the 1930s.

10.8.1.1 Puget Sound

Western pond turtles were probably locally common to abundant in the south Puget Sound area. Edward Huggins (Strahle 1994) gave an account of securing dozens of turtles that could be seen “congregated in large numbers” under the ice at Old Fort Lake, near Dupont, Pierce County in the 1860s. Indians recall accounts of gathering turtle eggs at Nisqually Lake where turtles were abundant, and the Nisqually name for the lake translates to “place where the turtles came from.” The Puget Sound population was apparently large enough to support commercial collecting activities for the restaurant trade during the late 1800s (M. Jennings, pers. comm. to D. Holland). Due to the low rate of recruitment, pond turtle populations cannot sustain the increased mortality to adults from exploitation. Holland (1991c) examined historic localities in the Puget Sound area and concluded that commercial collection could easily have eliminated or severely reduced populations in certain habitats. Habitat alteration probably also played a significant role in localized declines. By the 1930s populations were probably severely reduced from levels present 50-100 years earlier (Owen 1940).

Pond turtles appear to have continued to decline throughout this century. In King County, turtles were seen during the 1950s at each end of Sammamish Slough, and one was collected at Lake Meridian (Milner 1986). Meydenbauer Bay near Bellevue supported turtles in the 1960s. In Seattle, individuals were reported near Northgate, in West Seattle, and at Haller Lake during the 1960s and 1970s. In Pierce County, western pond turtles were found on and around Fort Lewis and McChord Air Force Base. Spanaway and Halvorson marshes, and Muck, Sequalitchew, American, Lewis, Spanaway, Bay, and Chambers lakes all had resident turtles (Milner 1986). The south Tacoma swamp and Talbot Marsh on McChord Air Force Base both supported turtles. Another turtle site, the headwaters of Murray Creek, was inhabited in the 1940s but was altered and channelized later. A specimen was collected in 1951 at “Sportsman’s Lake”, which Milner (1986) identified as Shaver Lake, but this location is not certain. Turtles observed at several other Pierce County sites were not identified to species (Milner 1986). In Thurston County, a pond turtle was collected at Long Lake, eggs were collected from a site north of Olympia, and adults were observed in Lacey during the 1940s and at Patterson (also called Pattison) Lake in 1969. In Kitsap County one was found near Kitsap Lake in the early 1980s (Milner 1986).

Western pond turtles had effectively been extirpated in the region by the 1980s. Surveys of 56 wetlands by Milner (1986) failed to find any western pond turtle populations in the Puget Sound area. An old male with a bullet hole in its carapace was found at Lake Garret in Burien in 1988, but died in captivity. Another adult pond turtle was found crossing a road under I-5 near McAllister Creek in May 1991. This turtle was released on Nisqually National Wildlife Refuge. This individual, which was identified by a chipped shell, was recaptured in April 1992 (Vicencio and Van Deman 1992). Extensive surveys and incidental sightings in 1991-92 revealed a few isolated individual turtles in King, Kitsap, and Thurston Counties; no turtles were detected in Mason County (Table 10-3) (Nordby 1992).

Table 10-3. Results of 1992 western pond turtle surveys in Washington (compiled from Nordby 1992).

County	Sites surveyed	Sites with pond turtles	Adult pond turtles	Juvenile pond turtles	Painted turtles	Red-eared Sliders
Skamania	39	10	23	2	288	—
Klickitat	6	2	33	8	4	—
Clark	15	0	—	—	150	—
King	14	1	1	—	5	5
Pierce	7	0	—	—	—	7
Kitsap	5	1	1	—	3	—
Thurston	1	1	1	—	—	—
Mason	1	0	—	—	—	—
Total	*88*	*15*	*59*	*10*	*450*	*12*

Forrester and Storre (1992) reported three possible western pond turtle sightings at Sequalitchew Lake on Fort Lewis, Pierce County in 1991, but follow-up surveys found no pond turtles (R.B. Bury, pers. comm.). Subsequent surveys of 24 wetlands on Fort Lewis involved a total of 303 site visits and 258 trap nights, but no additional western pond turtle sightings were recorded (Stringer 1992, Bury 1993). An animal seen on several occasions near Stan Sayres hydroplane pits on Lake Washington was reported to be a western pond turtle (P.D. Boersma and S. Andelman, pers. comm.); follow-up trapping at this location in 1995 produced many introduced turtles, but no western pond turtles. In recent years, WDFW staff obtained five western pond turtles: near Tacoma (1987), Port Orchard (1991), Fife (1992), Ravensdale (1992), and Kid Valley (1993). These individual turtles have to be considered of unknown origin, because they may have been transported to the area by people from Oregon or California. Genetic comparisons with museum specimens may determine their origins. No functioning populations were found anywhere in the Puget Sound region and it was concluded that the species was effectively extirpated from the area.

10.8.1.2 Columbia Gorge

The Klickitat population was estimated to total about 108 turtles in 1986 (Zimmerman 1986). At the beginning of 1990, the Klickitat County population was estimated to number between 60-80 animals (Holland 1991a). Subsequent data indicate the 1990 population was over 96 turtles. Measurements of carapace lengths indicated the population was moderately adult-biased, with about 78% of the animals over 4.5 in (120 mm) (Holland 1991a), compared to 55-70% under normal circumstances (Holland and Bury 1998). This indicated that recruitment may be low and the population may be in decline (Holland 1991a). Head-starting of juvenile turtles was initiated in an effort to augment juvenile survival.

In early to mid-1990, the Klickitat County population was decimated by an unknown pathogen, and at least 36 animals died. To curb the spread of the disease and to treat sick animals, 32 adult and subadult animals were removed from the ponds and treated at the Woodland Park (WPZ) and Pt. Defiance zoos. Based on spring 1991 surveys, at least 45 turtles survived the 1990 disease outbreak at the Klickitat County lake/pond complex (Slavens 1992a). Fourteen of the turtles that were treated at WPZ survived. These, along with 17 head-started juveniles, were returned to the wild in July and August 1991. After the release of an additional 9 head-starts in 1992 and 4 known mortalities (2 killed by a raccoon, 1 by an auto, 1 unknown; Slavens 1992b) the Klickitat population was estimated at 70 in 1992. In 1994, 52 turtles were captured in the pond complex and 12 were observed at the lake. This mark and re-capture effort

resulted in a 1994 estimate of 117 turtles in the Klickitat population (Slavens, pers. comm., in Scott 1995a).

The Skamania County population was surveyed repeatedly between 1990 and 1994 (Scott 1995b). During 1992 surveys, 26 turtles were detected at 12 sites, and during 1994, 39 turtles were found at over 14 different sites. The 1994 estimate for Skamania and Klickitat Counties combined was 156 turtles (39 in Skamania County, 117 in Klickitat County).

10.8.2 Present

Only about 250-350 western pond turtles are known to remain in the wild in Washington (Table 10-4). Most of these are in the Columbia Gorge, and approximately half are young turtles from the head-starting and captive rearing program. Of 21 head-started turtles released at a Puget Sound reintroduction site in Lakewood in 1996-1997, at least 14 turtles remained alive in spring 1998. An additional 5 were released in summer 1998. Two old males of unknown geographic origin were released to wetlands at Northwest Trek in 1996. A few additional scattered old adults may remain in the Puget Sound area, but no reproductive populations have been found.

Table 10-4. Numbers of western pond turtles at three locations in Washington, 1998

Location	# turtles present, 1996	Releases, 1997–98 (head starts and captive bred)	Total
Columbia River Gorge			
Klickitat	89[a]	87	176
Skamania	49[b]	60	109
Puget Sound lowlands			
Lakewood	15[c]	11	<26
Total	*153+*	*158*	*311±*[d]

[a] 1996 estimate using the Jolly-Seber mark-recapture method (Bender, unpubl. data).

[b] High count from 1984 - 1994 basking surveys (Scott 1995)

[c] Headstarts

[d] Plus unknown number of unmarked turtles, minus at least 3 known mortalities.

10.9 Habitat Status

A number of factors have contributed to the decline in habitat for western pond turtles. Wetland draining, filling, and development eliminated much habitat during the past century. Milner (1986) reported that several historic western pond turtle sites were altered or the shoreline was developed in the past 50 years. Many have been dredged, channelized, filled, or drained. According to conservative estimates, 33-50% of wetlands present during pre-settlement times were lost in Washington (Canning and Stevens 1990). Wetland losses in urbanized areas around Puget Sound were 90-98%. Historical analysis indicates an 82% loss of wetlands for Pierce County, and 70% for the Lake Washington area (Boule *et al.* 1993). Diversion of water for irrigation and other purposes has also eliminated or altered turtle habitat. The construction of dams and creation of reservoirs has been detrimental to western pond turtles by altering water flow in drainages, inundating habitat behind dams and reservoirs, and creating habitat suitable for the spread of non-native species (bullfrogs, warmwater fishes) that are harmful to western pond turtles. Additionally, dams and their associated reservoirs may have fragmented populations by creating barriers to dispersal (Holland 1991b). On the Trinity River, California, a dam increased sedimentation, decreased water temperatures, increased canopy cover, and increased water velocities (Reese and Welsh 1998a). These factors may negatively impact juvenile turtles (Reese and Welsh 1998b). Grazing or trampling of emergent vegetation may

have modified aquatic and riparian habitats to the extent that they became less suitable for hatchlings and juveniles (Holland 1991b).

The harmful effects of habitat alterations were not limited to watercourses, because western pond turtles nest and overwinter in the uplands. Urban, residential, and agricultural development of upland habitats within 325 ft (100 m) of waterbodies effectively eliminated historical nesting areas. Pond turtles need open sunny locations for basking and nesting. Fire suppression may have reduced the amount of habitat available by allowing the invasion of Douglas fir into Puget prairies and oak-pine woodlands and increasing the shading of the forest floor.

The area occupied by known populations of western pond turtles in Washington totals slightly over 1.5 mi (2.4 km). One population is restricted to a complex of ponds in Skamania County and the other occurs in a lake and pond complex in Klickitat County. Most of the Klickitat County habitat has been purchased by WDFW. The Skamania County habitat is in private and U.S. Forest Service ownership and most of it is within the Columbia River Gorge National Scenic Area. The two populations are separated by a road distance of about 17 mi (27 km).

10.9.1 Klickitat County

The Klickitat County lake site can be characterized as moderately disturbed. The lake was slightly modified within the last 20-30 years to increase its size and water storage capacity. The area surrounding the lake was historically grazed by livestock, which has been limited in recent years. The area immediately surrounding the lake shows signs of prolonged human use in the form of a small abandoned pump-house, vehicle track-ways, and footpaths. A road located about 16 ft (5 m) above and 35-50 ft (10-15 m) east of the eastern shore of the lake allows a direct view of the lake and potential access. Traffic on this road was observed to average 2-3 vehicles per hour during late May to early June 1990, and shooting in the general vicinity of turtles was observed at least once in this period. Similar activities were noted previously by the former landowner. To a limited extent, turtles appear to be somewhat acclimated to the presence of traffic on this road and the effects of disturbance of this type are unknown.

The lake has contained brown bullheads (*Ictalurus nebulosus*) since at least the 1940s and was stocked with largemouth bass and bluegill (*Lepomis macrochirus*) by a local sportsman in the late 1970s or early 1980s (D. Anderson, pers. comm.). The presence of fish encouraged recreational use of the lake by local fishers, which was permitted by the landowner until summer 1990. Recreational fishing may have had a significant effect on the turtle population through incidental capture and interruption of normal basking activities.

Large numbers of bullfrogs also occur at the lake and may be responsible for the apparent lack of recruitment in this population. Despite control efforts, frogs and tadpoles remain in the lake. Emergent vegetation in the lake is limited. There are relatively few areas where water depth and clarity allow for growth of emergents. Emergent basking sites for turtles in the form of logs or fallen trees were very limited at this location before artificial rafts were installed in 1991-92.

Immediately south of the lake site are five ponds that hold the majority of the turtles in this population. The ponds, like the lake, are located in a mixed oak/pine/grassland habitat, with Oregon white oak and ponderosa pine (*Pinus ponderosa*) dominant. Bullfrogs exist in all ponds on this site and brown bullheads are present in the two largest ponds described below. While the area around the lake lacks surface rock formations, numerous basalt outcrops and rock piles are present throughout the pond site. Of the five ponds that hold turtles on this site, one is artificial

(permanent) and four are natural (two are permanent ponds formed by natural basaltic sinkholes and two are ephemeral). Studies of the turtles in this population have revealed only one instance of movement between the pond complex and the lake. A turtle that had been translocated from one of the ponds to the lake moved 800 m back to the pond complex. However, it is probable that turtles historically moved freely within this system. The lake and pond complex are considered an ecological unit.

The artificial pond was created by excavation in the mid-1970s. It is relatively shallow, with a depth in most areas of about 3-5 ft (1-1.4 m), and currently has a thick growth of native and exotic water lilies. There is a small patch of emergent vegetation in the form of cattails on the north shore and it is surrounded by a fringe of willows (*Salix sp*.) and oaks. The area immediately around the pond is lightly disturbed.

The four natural ponds are located south of the artificial pond. Three of them occur along the base of a small basalt bench. This area was historically used for seasonal cattle grazing which was discontinued in the early 1980s. The two westernmost ponds are permanent but the smaller eastern pond is ephemeral, and frequently dries up by July. All of these ponds are used by turtles. The eastern pond is less than 6.5 ft (2 m) deep, covers about 500-600 ft (150-180 m) and has abundant emergent vegetation in the form of rushes and sedges, as well as seasonal growths of aquatic angiosperms (*Ranunculus sp*.). There is a horse trail about 66 ft (20 m) south of the south shore of the pond. This area can be categorized as lightly disturbed.

The middle and western ponds are considerably larger, at 0.6-0.8 ac (0.25-0.32 ha) and 1 ac (0.4 ha), respectively, and deeper, at about 8.2 ft (2.5 m). They support abundant growths of pond lilies and arrow weed. Small patches of cattails exist on the south and west shore of the western pond. Emergent basking sites in the form of downed logs are present in both ponds, but are more abundant in the western pond. The area around both ponds can be characterized as lightly disturbed to undisturbed.

On the basalt bench above these three ponds, and about 325 ft (100 m) north-northwest of the western pond, is an ephemeral pond that is seasonally utilized by turtles. It is less than 3 ft (1 m) deep, covers more than 0.37 ac (0.15 ha), and has abundant emergent vegetation. This pond usually dries up by July.

10.9.2 Skamania County

The Skamania County population exists in an extensive lake, pond and wetland complex within a forest and pastureland environment. The area can be characterized as lightly to moderately disturbed. Nearly all of the wetlands contain bullfrogs. Some of these ponds were colonized by a native water fern (*Azolla sp*.) in 1997-98 that rapidly formed a thick mat over the ponds' surfaces. The affect that this habitat change will have on the turtles is unknown.

Although turtles have been seen in a number of places in this complex, there are four primary ponds occupied by western pond turtles. At least two of the ponds are artificial. These are relatively small, between 0.5-0.75 ac (0.2-0.3 ha), with mud substrates, abundant submerged vegetation, limited emergent vegetation and relatively few emergent basking sites.

Approximately 0.25 mi (0.4 km) west are two additional ponds. One covers less than 1,650 ft (500 m), is at least 13 ft (4 m) deep, and apparently holds water year-round. The area can be characterized as moderately disturbed. Approximately 500 ft (150 m) north of this pond is another pond of about (0.6-0.75 ac (2.5-3 ha) in area that holds both painted turtles and pond turtles. The origin of this pond is uncertain, as it may represent a natural pond that has been

enlarged by diking. The grassland around the pond was moderately grazed until recently and there is little or no emergent vegetation on the periphery. Emergent basking sites in the form of downed logs are abundant.

10.9.3 Puget Sound

Many of the wetlands at Fort Lewis have a history of human alterations such as drainage, farming, and re-flooding. Stringer (1992) found that many wetlands have few or no natural emergent basking sites and most marshes have banks overgrown with reed canary-grass (*Phalaris arundinacea*) and cattails. Most wetlands also have populations of bullfrogs and/or introduced warmwater fish. Recreational use may be a limiting factor at some lakes. American and Sequalitchew lakes are heavily used for recreation and are surrounded by residential areas, though Sequalitchew has coves that are relatively isolated from disturbance (Forrester and Storre 1992). In spite of these factors, Bury (1993) believed several waterways on the military reservation had fair to excellent habitat conditions for western pond turtles and the reasons for their rarity or absence are unknown.

A small complex of three man-made ponds near Lakewood, Pierce County, was selected for the first re-introduction in the Puget Sound area. It is located in a 12+ ac (5 ha) fenced compound owned by WDFW. The ponds are fed by a small perennial creek. The ponds are small (less than 1 ha total area) and the reintroduction project is considered a pilot for future projects.

10.10 Conservation Status

10.10.1 Legal Status

In Washington, the western pond turtle was listed as a sensitive species by the Department of Wildlife in 1981. This status was changed to threatened in 1983. The pond turtle was classified under WAC 232-12-014 as an endangered species in November 1993. Unless allowed by special permit, western pond turtles may not be collected, harassed, possessed (live or dead), or sold.

The Columbia Gorge National Scenic Area Management Plan has placed a number of identified pond turtle habitats in categories that will protect them from development and alteration. Wetland protection regulations, such as Section 404 of the federal Clean Water Act that regulates the discharge of fill, also applies to wetland habitat of pond turtles.

In 1992 a petition to list the western pond turtle under the federal Endangered Species Act was denied by USFWS because although the turtle has declined and is affected by human activity, it still occurs in 90% of its historic range and is not in danger of extinction or likely to become so in the foreseeable future (USFWS 1993a). Though the western pond turtle is not protected under the federal ESA, it is a species of special concern for the Pacific Ecosystem office of the USFWS.

The western pond turtle is listed as sensitive in Regions 5 (California) and 6 (Washington and Oregon) by the USFS. The western pond turtle is considered a critical species by the Oregon Department of Fish and Wildlife (their designation with most concern for a species), and a species of special concern by the California Department of Fish and Game. In these states and Nevada, western pond turtles may not be taken without a scientific collecting permit.

10.11 Factors Affecting Continued Existence

10.11.1 Natural Factors

The western pond turtle has a long life span, requires 10 or more years to reach reproductive age, and has a low rate of recruitment. The vagaries of Pacific Northwest weather probably result in high variation in hatching success. The combination of these factors makes this species especially sensitive to any increase in chronic sources of mortality or other factors that affect reproduction and recruitment. Even relatively minor reductions in recruitment can affect the long term viability of a population, but due to the long life span of this species, changes of this nature may not be immediately evident. Turtles may persist in an area for extended periods even after the population is no longer successfully reproducing.

10.11.2 Habitat Loss and Degradation

In the Puget Sound region, the western pond turtle was reduced to near extirpation by historical habitat loss and exploitation (Holland 1991c). Though wetlands are now generally protected by regulation, there are few wetlands with suitable surrounding upland habitat for pond turtles left in Puget Sound. Human population increases and concomitant development will continue to alter or eliminate habitat for nesting, increase the rate of predation on nesting females, nests, or hatchlings, and/or expose hatchlings to hazardous post-hatching conditions. Though depredated nests have not (either with or without predator exclosures) been found in the Columbia Gorge study areas, predation on nests of other turtle species is higher near ecological edges (Temple 1987), such as those created by human activities.

Alteration of aquatic habitats, by water diversion projects or similar situations, may impose considerable hazard and hardship on moving turtles and result in higher than normal levels of mortality. Overland movements by western pond turtles increase their vulnerability to predators and other mortality sources. Vehicular traffic on roads that traverse western pond turtle habitat may be an important mortality factor.

10.11.3 Interspecific Relationships

Introduced species have changed the ecological environment in the region for pond turtles. As significant predators on hatchling and small juvenile western pond turtles, non-native species such as bullfrogs and warm water fish seem to reduce survivorship and alter recruitment patterns. Raccoons are major predators on turtles and turtle eggs (Christiansen and Gallaway 1984), and may be abundant in suburban areas due to the absence of larger native predators and the availability of refuse, pet food, and other man-associated food sources.

The introduction of opossums from the southeastern United States added another potential predator of turtle nests and hatchlings. Opossums are known to eat hatchling painted turtles and snapping turtles (Hamilton 1958; cited in Gardner 1982). Opossums seem to be particularly suited to the mix of urban/suburban/rural habitat that now exists in the Puget Sound area; they are now very abundant and may pose a serious problem for recovery efforts. Opossums are not presently a problem for the Columbia Gorge populations.

Sunfish compete for invertebrate prey. Carp muddy previously clear waters (Lampman 1946). This can influence the densities of zooplankton that can be important in the diet of hatchlings and young turtles (see Holland 1985b). Carp alter aquatic habitat when feeding on submerged and emergent vegetation. Introduced turtles, such as sliders, snapping turtles (*Chelydra serpentina*), and painted turtles (in western Washington) may compete with pond turtles and expose them to diseases for which pond turtles have no resistance. The potential for

disease is greatly increased when sick pet turtles are released. In California, Oregon, and Nevada, a total of 17 species of exotic aquatic or semi-aquatic turtles have been found in pond turtle habitats (Holland and Bury 1998). Cattle trample and eat aquatic emergent vegetation that serves as habitat for hatchlings and they may crush nests. Dogs occasionally mutilate turtles (D. Holland, pers. obs.).

10.11.4 Disturbance

The western pond turtle appears to be relatively sensitive to disturbance. Disturbance may affect the frequency and duration of basking or foraging behavior, which may be particularly important for gravid females. Interruption of basking may lead to a delay in the maturation and deposition of eggs, leading to a decrease in hatching success or overwinter survival (Holland 1991c). Boat traffic and fishing may influence western pond turtle behavior or cause direct mortality.

10.11.5 Chemicals and Contaminants

The effect of biocontaminants on western pond turtles is largely unstudied. Bury (1972b) reported on the effects of a diesel spill on a California stream fauna. One western pond turtle was among the nearly 4,500 vertebrates killed and 30 pond turtles captured over 1 month after the spill had swollen necks and eyes, and sloughed off pieces of epidermis on their appendages. The 1993 Yonella Creek diesel spill in Oregon had negative effects on invertebrate food, habitat and health of western pond turtles. All 30 turtles recovered after the Yonella Creek diesel spill exhibited debilitating conditions that appeared to be the result of exposure to diesel fuel (USFWS 1993b). Given the long lifespan of turtles and their position as a tertiary consumer in the food chain, they may act as bio-accumulators of certain contaminants such as PCBs and heavy metals, a situation known to occur in other turtle species (e.g., common snapping turtle [Helwig and Hora 1983]).

Rotenone, a biodegradable substance extracted from a tropical plant, is commonly used in fishery management to eradicate fish species. Rotenone has been documented to kill amphibian adults and tadpoles, as well as turtles (Fontenot *et al*. 1994, McCoid and Bettoli 1996).

10.12 Inventory & Assessment of Existing Management Plans

10.12.1 Existing Management Strategies for the Bonneville Pool

- Western Pond Turtle Recovery Plan

The recovery plan identifies WDFW recovery goals for three populations of western pond turtle in the Bonneville Pool. Each of the three populations must reach at least 200 animals and meet conservation targets for age structure, reproduction, and habitat security. Currently, 80% of the recovery funding is provided by BPA. Uncertainty of future funding will be the limiting factor for achieving goals of the project. The WDFW is currently in its third contract year for this project. The minimum time anticipated for western pond turtle recovery is approximately 15 years.

10.12.2 Existing Management Strategies for the Lower Columbia River

- Provide for a fourth population of western pond turtles in the Columbia River Gorge below Bonneville Dam. A fourth population is needed to delist western pond turtle in Washington.
- Resurvey suitable western pond turtle habitat below the Bonneville Pool.

- Evaluate habitat for western pond turtle reintroduction project. Current reintroduction possibilities include the Steigerwald National Wildlife Refuge.
- Determine potential for existing population of western pond turtle in Vancouver lowlands (WDFW ownership).
- Determine feasibility of reintroduction of population in Vancouver lowlands.

10.13 Inventory & Assessment of Existing Restoration & Conservation Plans

10.13.1 Restoration & Conservation Projects: Columbia River Gorge Above Bonneville Dam

- Currently in the third year of BPA-funded western pond turtle recovery project in the Columbia River Gorge. This funding is part of Columbia River mainstem subbasin plan and is critical to maintaining the headstart program for augmentation of current populations in the Columbia River Gorge and the expansion of populations into suitable habitat. Key components are directed at implementing the WDFW recovery plan for the western pond turtle. Major focus is augmentation of existing western pond turtle populations in Skamania and Klickitat Counties. Reintroducing the third population at Pierce NWR to achieve conservation goals for downlisting western pond turtle in Washington. Included in the BPA project is funding for habitat improvement including improvement of nesting and basking habitat. In addition, WDFW and the USFS are involved with habitat acquisition projects in Klickitat and Skamania Counties. WDFW owns and manages approximately 250 acres of western pond turtle habitat in Klickitat County. The USFS has recently purchased approximately 100 acres of western pond turtle habitat in Skamania County.

10.13.2 Restoration & Conservation Projects: Below Bonneville Dam

- In the past five years, no work has been conducted on western pond turtles below Bonneville Dam.
- In 1992, WDFW conducted a comprehensive survey of wetland habitat below Bonneville Dam to the mouth of the Lewis River. No western pond turtles were found.

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