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Ecology of the Jamaican Slider Turtle (*Trachemys terrapen*), with Implications for Conservation and Management

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ABSTRACT. – **We investigated populations of the Jamaican slider turtle (*Trachemys terrapen*), a species apparently endemic to Jamaica and the only native freshwater turtle species known to occur there. We captured 54 turtles at four sites (three along the southern coast and one in the northwest) representing a variety of habitats, including a permanently ponded wetland, farm ponds, and a stream in karst landscape. Turtles were also found in a series of seasonal ponds where they retreat into cave refugia during dry periods when caves remain flooded, thus allowing the slider population to exist in this seasonally arid landscape. We did not observe or capture turtles during limited sampling in a large river or a brackish mangrove swamp. Individuals from the northwest population (n = 12) were morphologically distinct from turtles captured along the south coast (n = 42) and descriptions provided in the literature for *T. terrapen*. Jamaican slider turtles are harvested incidentally by local residents wherever they are found, and concentrated populations, such as those in cave refugia, are heavily exploited. Our preliminary research suggests that *T. terrapen* is a highly threatened species needing conservation action in order to ensure its persistence.**

KEY WORDS. – **Reptilia; Testudines; Emydidae; *Trachemys terrapen*; *Trachemys scripta elegans*; turtle; distribution; ecology; conservation; status; natural history; Jamaica; West Indies**

Although the Caribbean is regarded as one of the world's top 25 biodiversity hotspots and is high in reptile endemism (Myers et al., 2000), it is depauperate in freshwater turtle diversity. The most current taxonomic classification suggests that the freshwater turtle fauna consists entirely of four species of *Trachemys*, each of which is endemic to the following major islands in the Caribbean: *T. decorata* on Hispaniola, *T. decussata* on Cuba and Cayman Islands, *T. stejnegeri* on Hispaniola and Puerto Rico, and *T. terrapen* on Jamaica (Seidel, 1996).

Naturally occurring populations of the Jamaican slider turtle (*T. terrapen*) are endemic to the island of Jamaica, where it is the only native freshwater turtle species (Seidel, 1988, 1996). Slider turtles judged to be taxonomically indistinct from Jamaican sliders are also reported from several small islands in the central Bahamas (Cat, Eleuthra, Andros, and Paradise islands) (Iverson, 1992) and presumably represent human introductions (Seidel, 1988, 1996). The population on Cat Island was previously recognized as the distinct taxon *T. felis* (Barbour, 1935) but was later placed in synonymy with *T. terrapen* (Seidel and Adkins, 1987). Although *T. terrapen* is apparently widespread in Jamaica, the species' distribution and ecology in Jamaica are relatively poorly known.

Trachemys terrapen is one of the largest of the Antillean slider species with a maximum carapace length greater than 300 mm in females and 200 mm in males (Seidel, 1988; Schwartz and Henderson, 1991). Adults have a uniformly brown or olive carapace and an unmarked yellow to tan plastron. Posterior carapacial flaring is evident and, among the West Indian slider species, appears unique to *T. terrapen*. Juveniles may have some plastral pattern that usually fades with age. The skin tends towards gray or brown and the red supratemporal stripe found in other *Trachemys* is typically absent. The foreclaws of males can be relatively short, as in some Meso-American *Trachemys*, yet the snout is short, as in North American *Trachemys* (Barbour and Carr, 1940).

Jamaican sliders have been described as occurring in duckweed-covered ponds (Barbour and Carr, 1940). Seidel (1988) reported *T. terrapen* to inhabit permanent bodies of freshwater, including rivers, streams, ponds, and swamps at low elevations. Jamaican sliders have been observed basking (Barbour and Carr, 1940) and have been suggested to burrow on land under substrate during dry seasons (Seidel, 1996).

Information on the current biological status of *T. terrapen* and its threats has not been updated since 1996. The IUCN Red List of Threatened Animals (IUCN, 1996) listed *T. terrapen* as Vulnerable with the reasons for concern as Category B1 (small distribution and perhaps severely fragmented) and Category B2c (continuing to decline due to losses in area, extent, or quality of habitat). The current Red List status (IUCN, 2004) remains the same. Although Jamaican sliders are harvested for human consumption, the level of harvest is unregulated and unknown (RKB, *pers. obs.*). Barbour and Carr (1940) cited Browne (1756) as stating "...it [*T. terrapen*] is often served up at gentlemen's tables in that island [Jamaica] and looked upon as delicate wholesome food by many people."

Figure 1. Distribution of *T. terrapen* in Jamaica. Parishes in which *T. terrapen* had been previously reported are shaded. Dots represent localities where *T. terrapen* was documented during this study; the square shows the location (Kingston area) we sampled but did not observe *T. terrapen*.

The importation and invasive establishment of other *Trachemys* species, such as *T. scripta elegans* from the USA, is suspected and could represent a threat to the conservation of *T. terrapen*, either through hybridization or competition for habitat. Studies to date have not considered the natural history or ecology of *T. terrapen*, but have instead focused on phylogenetic relationships between *T. terrapen* and other West Indian *Trachemys* (Seidel and Adkins, 1987; Seidel, 1996).

We conducted a preliminary study on the distribution and ecology of *T. terrapen* on the island of Jamaica. The goals were to: 1) add to the known distribution of the Jamaican slider turtle and revisit historical sites, 2) investigate the ecology of the species, particularly habitat use, 3) identify threats, especially harvest, and 4) recommend possible conservation and management strategies.

METHODS

Localities from which *T. terrapen* had been historically documented prior to this study were obtained from the following sources: University of Michigan Museum of Zoology, National Museum of Natural History, Jamaica's Conservation Data Centre (part of the The Nature Conservancy's Natural Heritage Network), Seidel (1988), and Iverson (1992).

Our study was conducted in the southern and northwestern regions of Jamaica during 6-19 December 1997. We visited historical collection locations and areas from which the species was previously unreported. We used a variety of survey methods to document the occurrence of *T. terrapen*, including basking surveys, snorkeling, muddling, spelunking, searching for shells, and trapping with partially submerged 1.2 m x 0.6 m hoop nets baited with sardines. Survey methods varied at each location depending on habitat characteristics. At each location, we also interviewed landowners and local residents to estimate harvest levels in the area and to determine the level of local knowledge of the species and its natural history.

Each captured turtle was weighed (nearest 5 g), measured (carapace length [CL] and plastron length [PL] at midline to nearest mm), photographed, permanently marked by notching unique combinations of marginal scutes with a metal file (Cagle, 1939), and subsequently released at the point of capture. Distribution records documented during this study were reported to the Conservation Data Centre (CDC; Kingston, Jamaica). Shells found during the survey were deposited with the Institute of Jamaica, Natural History Division, Kingston, Jamaica.

Study Sites

Jamaica is located ca. 145 km south of Cuba and 161 km west of Haiti, and is ca. 230 km long and 80 km wide (10,940 km^2), making it the third largest island in the Caribbean. The landscape is limestone-dominated and the climate has been described as a seasonal tropical maritime climate (Crombie, 1999). As a result of human activity, only about 11% of the native vegetation remains (Myers et al., 2000).

We captured slider turtles in four regions of Jamaica (Fig. 1)—three populations along the southern coast (Old Harbour, Treasure Beach, and Black River) and a fourth population in the northwest (Windsor). Although trapping efforts were made in the Kingston area, no turtles were captured. In the descriptions below of each study site, we use the names of the aquatic features assigned by local residents when known.

Old Harbour, St. Catherine Parish. — We surveyed two man-made ponds, built in the early 1970s. The ponds were located in an acacia grove on the property of Brompton Farms, north of the town of Old Harbour in south-central Jamaica. Pond 1 was a large, shallow wetland with little to no emergent vegetation and, according to local residents, dries every year. The banks of the pond had signs of extensive trampling and grazing by cattle. Pond 2 was a large permanently ponded wetland containing hyacinth (*Eichornia crassipes*) and bordered by rushes, and also contained fish.

Treasure Beach, St. Elizabeth Parish. — The Treasure Beach area in southwestern Jamaica contained a series of seasonal ponds and springs separated by roads and farmland. Dominant terrestrial plant species included acacia (*Prosopis juniflora* and *Acacia tortuosa*), lignum vitae (*Guiacum officianale*), logwood (*Haematoxylon campechianum*; introduced), and seaside mahoe (*Hibiscus tiliaceus*). Due to the extensive drought at the time, most of the seasonal ponds

Figure 2. Salt Spring Hole in Treasure Beach area, St. Elizabeth Parish, Jamaica. a) Cave interior. Researcher, waist-deep in water, with *T. terrapen* in hand. Photo by D. Booher. b) Cave entrance. Entrance is usually inundated, but during our study only a small puddle, heavily trampled by cattle, remained. Photo by D. Booher.

were dry or too shallow to use turtle traps. Sampling was limited to two cave springs, which were located among the complex of seasonal ponds.

Dick's Hole was a "blue hole" that consisted of a karst spring that emerged from under a rocky ledge to form a small pool. The pool and its margins were heavily trampled by cattle and the water was murky with a deep, thick mud layer underneath. The entrance to the cave spring was almost completely submerged, limiting human access. The vegetation on the rocky outcrops above the spring was cactus-thorn scrub (see Asprey and Robbins, 1953).

Salt Spring Hole (also called Alligator Hole because local residents said crocodiles had occurred there in the past) consisted of a small cave inundated by a stream resurgence. Inside the cave (Fig. 2a), a gravel bottom lead to a pool of clear water approximately 1 m deep above a thick layer of mud approximately 0.5 m deep. The room inside the cave was 15 m by 12 m in size, with at least one small, impassable tunnel leading to the stream source. Under non-drought conditions, the cave entrance (Fig. 2b) is completely submerged and water forms a large seasonal pond outside the cave entrance, which is then used by cattle.

Black River Area, St. Elizabeth Parish. — We surveyed five localities and several habitat types in the Black River area of southern Jamaica, including brackish mangrove swamps, a river, and associated seasonal and farm ponds.

The brackish mangrove swamp and Pond 3 were near Salt Spring River. Pond 3 was a big shallow marsh-like pond, with a hardpan bottom, abundant algae, rushes, and other emergent vegetation.

We surveyed the main channel of the Punches River and also several ponds within the river's floodplain at the town of Punches. The Punches River (Fig. 3) is a tidal freshwater river with a deep and narrow (2 m wide) main channel dominated by hyacinths. Ivan's Pond (Fig. 4) was a small permanent sinkhole, 1–1.5 m deep, with a soft mud bottom; emergent vegetation was abundant and dominated by hyacinth. Bennett's Pond (Fig. 5) was a small, shallow farm pond dominated by cattails.

Windsor Area, Trelawney Parish. — We surveyed a short section of the Martha Brae River in the "Cockpit Country" near Windsor, in northwestern Jamaica. In the section we surveyed, the Martha Brae was a clear slow-moving limestone river (Fig. 6) that originated near Windsor Cave. Unlike the rivers in the other study areas described, the Martha Brae River drains to the north side of the island.

We also surveyed two ponds adjacent to the river. Pantrepant Pond 1 (Fig. 7) was a small (approximately 25 m

Figure 3. *Punches River, a freshwater tidal river and a tributary to* the Black River, St. Elizabeth Parish, Jamaica. Photo by D. Booher.

Figure 4. *Ivan's Pond, a sinkhole pond, Black River area, St.* Elizabeth Parish, Jamaica. Photo by K. Buhlmann.

Figure 5. Bennett's Pond, a farm pond, Black River area, St. Elizabeth Parish, Jamaica. Photo by K. Buhlmann.

Figure 6. A pool in the Martha Brae River near Windsor, Trelawney Parish, Jamaica. Photo by K. Buhlmann.

x 35 m) eutrophic, shallow pond with a thick muddy bottom. The only vegetation consisted of low grasses around the margin of the pond. Pantrepant Pond 2 was the biggest pond in the area. According to the owner, the pond never dries but the pond size at the time of the study (approx. 40 m x 40 m) was much smaller than normal due to drought. The center of the pond was about 1 m deep and had a thick muddy bottom. The dominant vegetation was thick, floating mats of para grass (*Panicum muticum*) found throughout the pond. Both ponds were located within a cattle pasture.

Kingston Area, St. Andrew Parish. — Our interest in the Kingston area was not only to document the distribution of *T. terrapen* but also to assess the likelihood of introduced *T. scripta elegans* becoming established in Jamaica. We considered Kingston, because of its large metropolitan population, the most likely place to capture *T. s. elegans*. We conducted surveys at two aquatic habitats in the Kingston area. Botanical Garden Pond was located in the Royal Botanical Gardens at Hope Zoo and, although fishing was not permitted, was routinely trespassed by fishermen. The pond was artificial and concrete-lined with a water depth of about 1m throughout. Some sections of the pond had dense mats of submerged vegetation. Mona Reservoir, the main reservoir for the Kingston Metropolitan Area, was a small impoundment owned by the National Water Commission. The reservoir had a capacity of approximately 2.65 billion L, with a circumference of 3 km. Large rocks completely lined the steep sides of the banks. Because access to the reservoir was restricted by a tall fence completely encircling the reservoir, we conducted basking surveys using binoculars. In addition to these field surveys, we visited a pet store to determine if *T. s. elegans* were sold locally.

RESULTS

Trachemys terrapen had been reported from at least 9 parishes in Jamaica prior to this study (Schwartz and Henderson, 1991). During two weeks of inventory, we documented *T. terrapen* at four localities in three parishes, including the first records for St. Elizabeth Parish (Fig. 1).

Figure 7. Pantrepant Pond 1, Windsor area, Trelawney Parish, Jamaica. Photo by K. Buhlmann.

We captured 50 *T. terrapen* and found 4 shells for a total of 22 females, 23 males, and 9 juveniles. Individuals ranged from 72–300 mm CL (Fig. 8) with females attaining larger sizes than males (largest female = 300 mm CL; largest male = 243 mm CL).

Morphology. — *Trachemys* collected at the three locations on the southern coast of Jamaica matched descriptions provided in the literature (Seidel, 1988) for *T. terrapen*. The characters are further illustrated in Fig. 9. *Trachemys* collected in northwestern Jamaica (Windsor Area) displayed some characteristics not typical of *T. terrapen*, including red

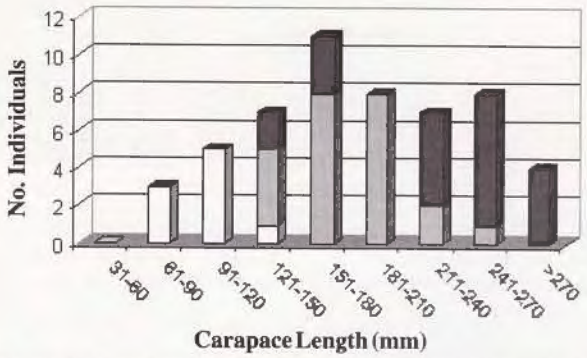

Figure 8. Size distribution (carapace length [CL] in mm) of *T. terrapen* ($n = 52$) captured at all survey sites during this study, by sex (white bars = juveniles, gray bars = males, black bars = females).

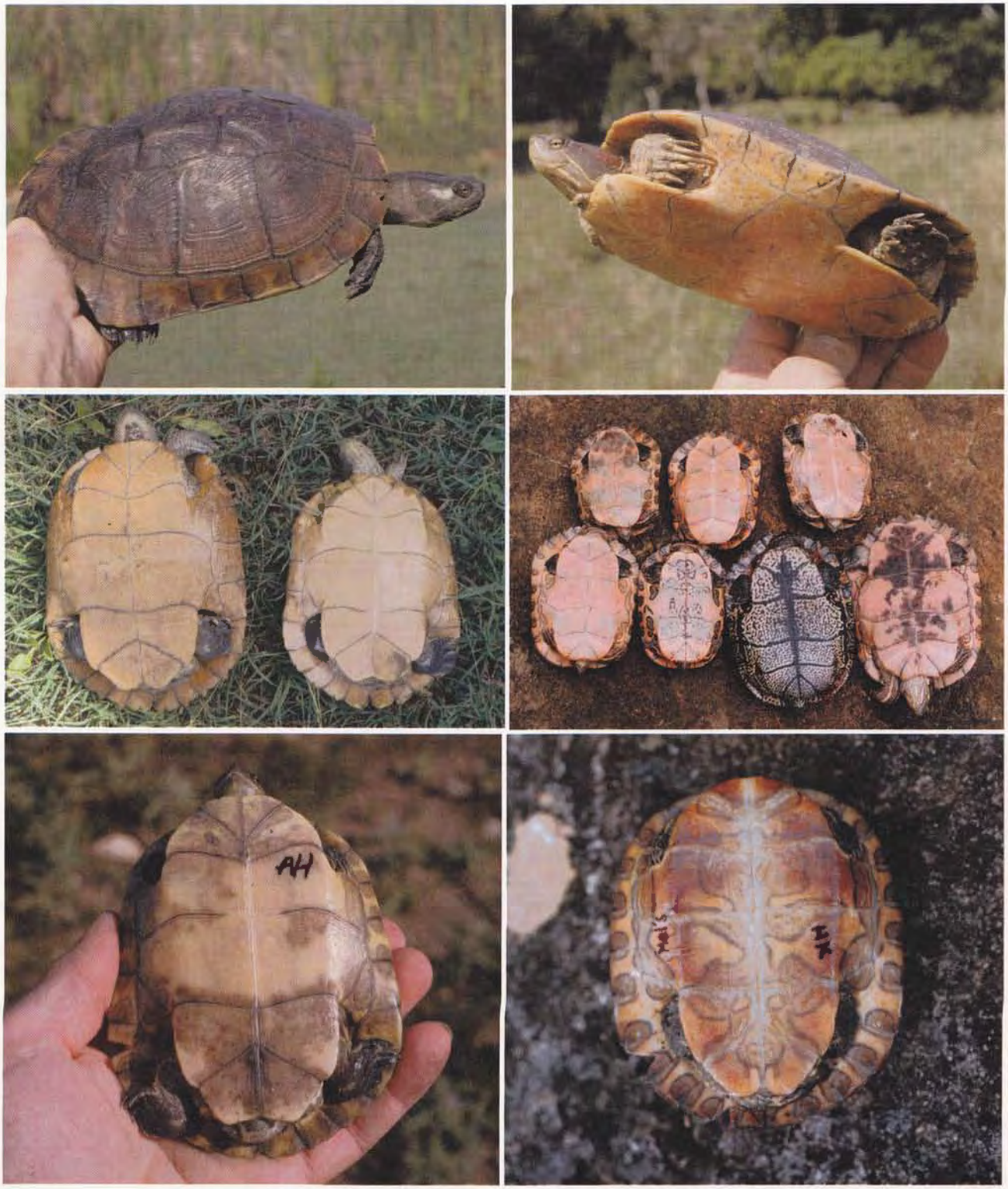

Figure 9. *Southern Jamaica*: *T. terrapen* showing classic characteristics described in the literature. a) Female from Black River, St. Elizabeth Parish. Note the brown carapace with rugose markings and flared posterior and the lack of supratemporal stripe. Photo by K. Buhlmann. b) View of unmarked plastron of two adults from Black River area, St. Elizabeth Parish. Photo by K. Buhlmann. c) Juvenile from Old Harbour, St. Catherine Parish. Plastrons, even in juveniles, were typically without pattern. Photo by K. Buhlmann.
(*Fig. 9 continued on next page*)

Figure 10. *Northwest Jamaica*: *T. terrapen* captured near Windsor, Trelawney Parish. a) Adult male with slightly elongated foreclaws, red supratemporal stripe, and faint ocelli on bridge. Photo by K. Buhlmann. b) Plastrons of several adults, showing variation in pattern. Turtles have distinct ocelli on their bridges or plastron, which is atypical of *T. terrapen* from the southern coast. Several turtles in the upper left corner have flaring of posterior carapace, a character supposedly unique to *T. terrapen*. The melanistic male has dark mottling over entire shell. Photo by D. Booher. c) Juvenile with a pronounced plastral pattern. Photo by D. Booher.
(*Fig. 10 continued on next page*)

Figure 9. (*continued*) *Southern Jamaica*: d) Melanistic male from Treasure Beach, St. Elizabeth Parish. Melanistic males had gray skin with few markings and white to horn-colored carapces with black pigment along the carapacial seams. Photo by D. Booher.

supratemporal head stripes evident even in adults, distinct ocelli on plastron, and dark flecking on shells of melanistic males (Fig. 10).

Old Harbour. — Five turtles (3 juveniles, 1 male, 1 female; 79–278 mm CL) were captured in traps at Pond 2 (permanent pond). The adult female had been pulled from the trap, purportedly because it had drowned, and was eaten by a local fisherman, who saved the shell for us. One turtle was seen basking in Pond 1 (seasonal pond), but no turtles were captured in traps. According to a farm employee, approximately 10 people regularly fish the ponds and harvest any turtles incidentally captured, but turtles are not targeted for capture. One *T. terrapen* (female, 300 mm CL) had been recently purchased in an Old Harbour market and was being maintained in captivity at the farm.

Treasure Beach. — Nineteen turtles were captured in Dick's Hole and Salt Spring Hole (1 juvenile, 8 males, 10 females; 123–278 mm CL), and an adult female kept in captivity by a local landowner was also examined. The one juvenile was a shell found on land near Dick's Hole. All other turtles were captured by muddling by hand in the spring-fed cave refugia, primarily in the water under rock ledges. According to local residents, both springs were once deeper and clear and are now threatened by trampling and contamination from cattle.

Local residents of Treasure Beach were clearly knowledgeable about the Jamaican slider and its ecology, recognizing that the species was long-lived. One resident described turtles leaving seasonal ponds when they dry, crossing roads toward the natural springs, and returning to ponds again when they fill. He also described capturing turtles under ledges in Dick's Hole during the dry season.

Unfortunately, because the local residents knew where to find these concentrated populations of *T. terrapen* when the ponds were dry, the populations were vulnerable to overharvesting. One landowner spoke of a "truckload of turtles being removed" on at least one occasion. In the Treasure Beach area, the Jamaican slider is also potentially impacted by habitat loss and fragmentation due to the many new developments in the area. The increased water demand also threatens the springs that serve as refugia during droughts.

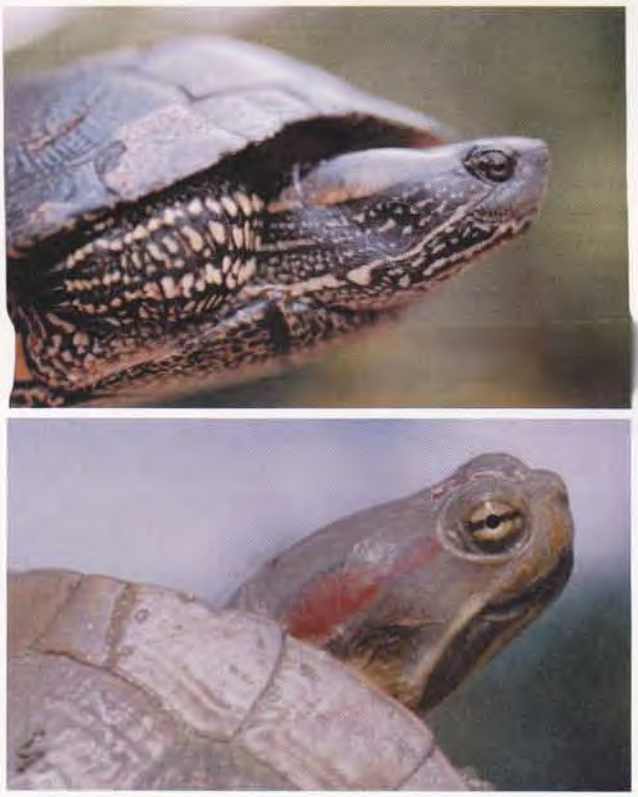

Figure 10. (*continued*) *Northwest Jamaica*: d) Melanistic male, showing black on white flecking on shell and skin and the red supratemporal stripe. Photo by D. Booher. e) Close-up view of head and red supratemporal stripe. Also note the short snout characteristic of *T. terrapen*. Photo by K. Buhlmann.

Black River Area. — Three turtles (1 male, 2 females; 173–273 mm CL) were captured in the Black River area. Turtles were captured in the two seasonal ponds in the floodplain of the Punches River, but none were observed or captured in the brackish mangrove swamp or the main channel of the Punches River.

Local residents reported that they rarely captured turtles during their fish trapping in the Punches River. Captured turtles are usually sold for meat, which at the time of the study was priced at $60J (or $1.75 US) per pound of meat and equivalent to the price of chicken. Residents seemed somewhat familiar with the habitat associations of the slider, reporting that turtles could be found in the Punches River "morass" (freshwater marsh), but not in the main channel of the river.

Windsor Area. — We captured 12 *T. terrapen* (9 males, 3 females; 133–228 mm CL) in the Martha Brae River. We also captured 11 turtles (3 males, 3 females, 5 juveniles; 72–214 mm CL) in the ponds on pasture land adjacent to the river. As described above, individuals captured in the Windsor area were morphologically distinct from the other study areas and from descriptions of *T. terrapen* in the literature.

In addition to turtles captured in traps, we obtained shells from two adult turtles that had been captured by a local

resident and subsequently eaten. The resident also reported using basking traps to capture the species. One resident reported making decorative carvings on turtle shells and selling them for $10 US.

Kingston Area. — No turtles were observed either in the Botanical Gardens Pond or Mona Reservoir. However, our traps at the Botanical Gardens Pond had been disturbed and perhaps their contents were removed. A few local residents reported seeing turtles in the reservoir, but none were observed basking during our survey. Few Kingston area residents that we interviewed were familiar with *T. terrapen*. Hatchling red-eared sliders were being sold in at least one Kingston pet store. The Hope Zoo receives as many as six *T. scripta elegans* per year from pet owners who are unwilling or unable to continue caring for them (RKB, *pers. obs.*). *Trachemys s. elegans* and *T. terrapen* held together in captivity at the Hope Zoo have produced hybrid offspring (RKB, *pers. obs.*).

DISCUSSION

Trachemys terrapen occupied a wide variety of habitats in Jamaica, including man-made ponds, seasonal ponds, springs, and streams. Although the species appears to be a habitat generalist, the common feature of all occupied habitats is access to permanent water during dry seasons or drought. For example, in the Windsor area, the permanent aquatic habitat is the Martha Brae River. In the Treasure Beach area, spring-fed cave refugia remain flooded and thus provide the ability for the slider population to exist in a seasonally arid landscape. We found no evidence to suggest that adult *T. terrapen* on Jamaica aestivate terrestrially, as has been mentioned in the literature (Seidel, 1996; referring to *T. terrapen* in the Bahamas), but instead move overland between aquatic habitats as has been reported for *T. scripta* (Morreale et al., 1984).

No hatchlings were found, but that is not unusual during a short-term survey. Few small-sized juveniles were captured, and none were encountered in the permanent water cave refugia used by adults. As expected, some of our sampling techniques (e.g., hoop traps) were less effective at sampling juvenile turtles, but smaller turtles, if present, should have been observed during basking surveys. We believe juveniles responded differently than adults to the drought and suspect that the juveniles may have been buried in the moist mud and vegetation of some of the grassy seasonal ponds.

In each of the study areas, local residents reported harvesting turtles incidentally whenever they were captured. In at least one location (Treasure Beach area), turtles were specifically targeted for harvest when they were concentrated in dry season refugia. Continued practice of such harvests will cause the extirpation of the species in the Treasure Beach area and other areas where populations exhibit similar responses to seasonal drying and occasional drought.

At each study site where *T. terrapen* was documented, turtle populations existed in a series of seasonal ponds separated by roads and farmland. In order to ensure the species' continued persistence at a given site, movement corridors between seasonal and permanent habitats need to be protected. In addition to habitat fragmentation, several other types of habitat degradation threaten *T. terrapen* in the areas we surveyed. Several springs and ponds occurred in heavily-grazed cattle pastures. As a result, the vegetation was severely trampled and water quality was degraded. A few springs had also experienced lowered water levels due to groundwater pumping.

One of the threats of most concern is the potential introduction and establishment of red-eared sliders (*T. s. elegans*) in freshwater habitats of Jamaica. Red-eared sliders have been introduced into freshwater habitats outside their normal range in the USA and in many locations around the world (Ernst et al., 1994). In some countries, the species has established reproducing populations and is commonly encountered in the wild (e.g., Taiwan; Chen and Lue, 1998). In Jamaica, hatchling red-eared sliders were being sold in pet stores in Kingston. Thus, it is quite likely that area residents, few of which were familiar with the Jamaican slider, could release unwanted captive red-eared sliders into Jamaica's freshwater habitats.

The most unexpected observation from the study was the morphological distinctness of turtles captured on the northwest coast (Windsor area) from turtles captured at the three southern sites. Because the focus of our brief investigation was to determine habitat use and threats to *T. terrapen*, we did not collect extensive morphological data on every specimen examined. However, based on our qualitative observations and photographs, the turtles we captured in southern Jamaica fit the classic *T. terrapen* characteristics described in the literature (Barbour and Carr, 1940; Lynn and Grant, 1940; Seidel, 1988; Schwartz and Henderson, 1991). In contrast, the Windsor area turtles exhibited some morphological characteristics (i.e., plastral ocelli, red supratemporal stripe) that have been attributed to other West Indian *Trachemys*, particularly *T. stejnegeri* from Hispaniola and Puerto Rico and *T. decussata* from Cuba and the Cayman Islands. Seidel (1988) noted similar differences between adult *Trachemys* from western and eastern Jamaica, which he attributed to the retention of juvenile pattern in the adults of western populations. Perhaps another possibility is that *Trachemys* populations on Jamaica's north coast have experienced introgression of *T. decussata* and/or *T. stejnegeri* genes, through human introduction or natural dispersal events. Alternatively, the red supratemporal stripes could possibly be a result of introduction of *T. s. elegans* genes into the population, although the Windsor area study site was the most remote area we surveyed and no *T. s. elegans* were documented during our study. Thus, genetic analysis will be required to determine the taxonomic relationship of the Windsor area population to *T. terrapen* populations on Jamaica's south coast and to other *Trachemys* species.

This study was one of the first natural history studies on *T. terrapen* and provided information on the habitat associa-

tions and current distribution of the species in Jamaica, as well as anecdotal information on harvest levels and potential threats. Additional research is needed to identify the habitat used by hatchlings and juveniles, the effects of harvest levels on population persistence, and movement patterns and landscape interactions. Further field surveys should be conducted to determine if *T. s. elegans* has become established in any freshwater habitats in Jamaica. A more detailed examination of the genetic and morphological differences between northwestern and southern populations of *T. terrapen* in Jamaica would help elucidate the morphological differences observed in this study.

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