Herpetological Conservation and Biology 17(3):612–622.
Submitted: 26 July 2021; Accepted: 28 November 2022; Published: 16 December 2022.

CONSERVATION STATUS OF THE HISPANIOLAN SLIDER, *TRACHEMYS DECORATA*, AT LAKE TROU CAÏMAN, EASTERN HAITI: FIRST DATA ON AN ENDEMIC, POORLY STUDIED, AND ENDANGERED SPECIES

JEFFEY M. PAUL[1,2], LENS J. SAINT-LOUIS[2], ANTHONY OLIVIER[3], WILSON CÉLESTIN[2,4], AND FRANK CÉZILLY[2,4,5,6]

[1]*UMR 7208 Biology of Aquatic Organisms and Ecosystems, Université des Antilles, Campus de Fouillole, BP 592, 97157, Pointe-à-Pitre, Guadeloupe*
[2]*Caribaea Initiative, Université des Antilles, Campus de Fouillole, BP 592, 97157, Pointe-à-Pitre, Guadeloupe*
[3]*Centre de Recherche de la Tour du Valat, Le Sambuc, 13200 Arles, France*
[4]*Université d'Etat d'Haïti, Faculté d'Agronomie et de Médecine Vétérinaire, Route Nationale numéro 1, Damien, Port-au-Prince, Haiti*
[5]*Université de Bourgogne-Franche Comté, Unité Mixte de Recherche, Centre National de la Recherche Scientifique, 6282 Biogéosciences, 6 Boulevard Gabriel 21000 Dijon, France*
[6]*Corresponding author, e-mail: frank.cezilly@caribaea.org*

Abstract.—**The Hispaniolan Slider (*Trachemys decorata*) is a freshwater turtle of conservation interest, endemic to the island of Hispaniola. Although the species is known to be threatened with habitat destruction, hybridization with congeneric species, and commercial harvesting, little information is available on natural populations. Here we report the results of a pilot study conducted at Lake Trou Caïman, Haïti. From October 2017 to February 2018, we captured 44 individuals (mostly in areas dominated by cattails, Typhaceae) and had access to 48 additional individuals held in captivity by fishers and local people. Captive individuals were significantly larger than wild-caught ones. Based on individuals with a carapace length > 100 mm, sex-ratio did not differ from parity in either wild-caught or captive individuals. Females tended to be larger and heavier than males. The frequency of damaged carapace or plastron and/or wounds was significantly higher in captive individuals compared to individuals freshly captured in the lake, indicating poor husbandry. About 10% of all individuals showed orange supratemporal stripes, suggestive of hybridization with the Central Antillean Slider (*T. stejnegeri*) or the Red-eared Slider (*T. scripta elegans*). Based on interviews with 31 local fishers, we estimated that at least 1,600 *T. decorata* are harvested each year at Lake Trou Caïman. We discuss our results in relation to the conservation and management of *T. decorata* in Haiti.**

Key Words.—bycatch; freshwater turtles; habitat use; harvest pressure; hybridization; management

INTRODUCTION

The Hispaniolan Slider (*Trachemys decorata*; Fig. 1) is a freshwater turtle of conservation interest endemic to the island of Hispaniola and is classified as Vulnerable on the Red List of Threatened Species of the International Union for Conservation of Nature (IUCN; Turtle Taxonomy Working Group 2017). The species distribution appears to be restricted to lakes in the Plaine de Cul de Sac/Valle de Neiba on both sides of the border between Haiti and the Dominican Republic, on the Tiburon peninsula in Haiti, and in the wetlands of the Jaragua National Park in the Dominican Republic (Seidel and Inchaustegui 1984; Fritz 1991; Powell et al. 2000). Reliable data, however, on their distribution, ecology and conservation status are limited, particularly in Haiti. Similar to other freshwater turtle species (Lyons et al. 2013; Meyer et al. 2014; Rhodin et al. 2018), *T. decorata* is exposed to several threats (Powell and Incháustegui 2009), including environmental degradation, habitat loss and fragmentation, hunting and trading, use in religious rituals, and the pet trade. In addition, the species is potentially exposed to genetic pollution through hybridization with the Hispaniola-endemic and congeneric Central Antillean Slider (*T. stejnegeri vicina*) and the invasive Red-eared Slider (*T. scripta elegans*), which is native to the USA (Parham et al. 2013), although no data on levels of hybridization in Haiti are available. In this context, we conducted a pilot study of *T. decorata* at Lake Trou Caïman, eastern Haiti, from October 2017 to February 2018, to assess the feasibility of a research and monitoring program aimed at documenting the behavioral ecology, population biology, and conservation of the species. In addition, we collected data on the exploitation of the *T. decorata* by local fishers and their subsequent use by the local

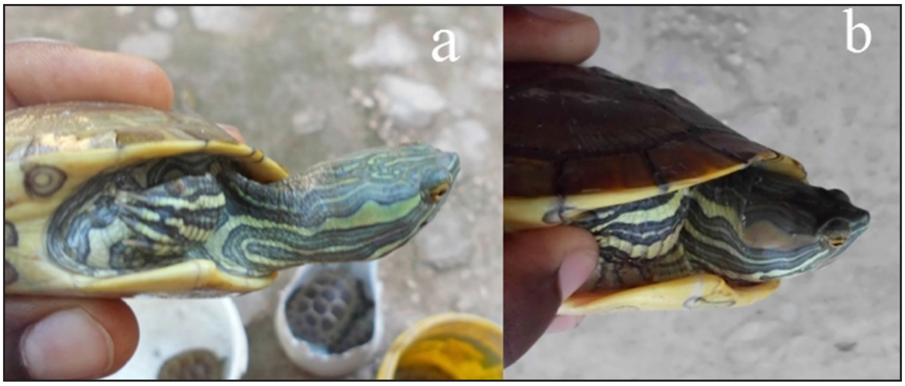

Figure 1. The Hispaniolan Slider (*Trachemys decorata*) from Haiti. Variation in the color of the supratemporal stripe include (a) yellow supratemporal stripe and (b) orange supratemporal stripe. (Photographed by Jeffey M. Paul).

population to evaluate the potential importance of harvest pressure on population dynamics.

Materials and Methods

Study site.—Lake Trou Caïman (18°37' to 18°39'N and 72°07' to 72°09'W) is a shallow brackish-water lake located about 81 km east-northeast of Port-au-Prince, the capital and largest city of Haiti, and near the village of Thomazeau (Sergile 2008; Saint-Louis et al. 2021; Fig. 2). The lake covers an area of 823 ha (8.23 km^2), with a perimeter of 12.05 km (Jeannot 2015). Situated 24 m above sea level, its depth varies from 0.27 to 0.84 m, owing to seasonal variation (Jeannot 2015). Mean salinity, mean conductivity, and mean pH of the lake are 8.3‰, 5.71 mS/cm, and 8.68, respectively (Jeannot 2015). The edges of Lake Trou Caïman are dominated by grassy and shrubby vegetation. In addition, xerophytic vegetation dominated by Honey Mesquite (*Prosopis juliflora*) is concentrated on the southern and western edges, whereas aquatic vegetation, dominated by Southern Cattail (*Typha dominigensis*) and, to a lesser extent, by rushes (*Juncus* sp.), characterize the northern and eastern banks. Riparian Mangroves (*Rhizophora mangle*) are also found on the northern edge of the lake, with a few young stands and remnants of Green Buttonwood Trees (*Canocarpus erectus*) exposed on the shore during periods of receding water levels. The rainy season at Lake Trou Caïman lasts from March to November, whereas the dry (and hottest) season lasts from December to February.

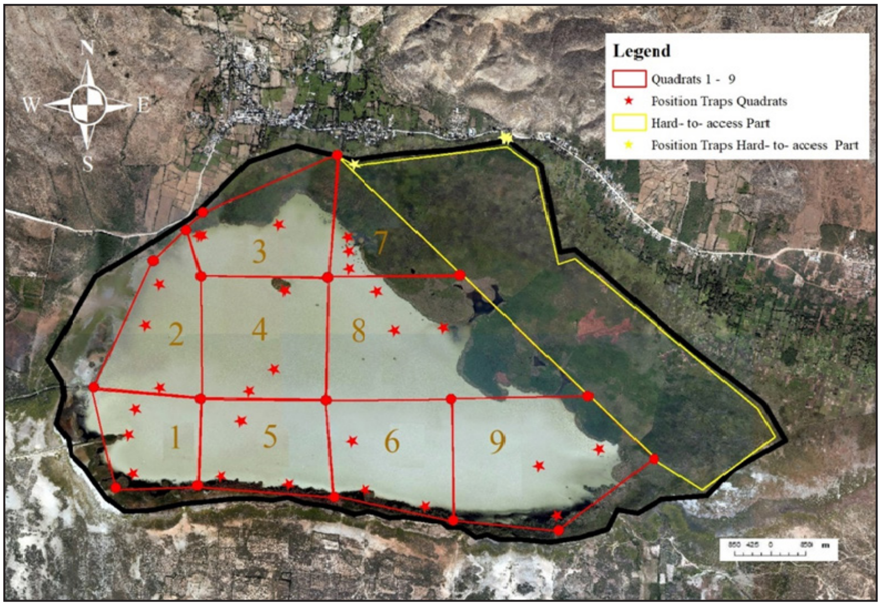

Figure 2. Map of Lake Trou Caïman, Haiti. The red lines show the limits of the nine trapping quadrats, whereas the yellow lines show the limits of the hard-to-access part of the lake. Red and yellow stars indicate the positions of the traps.

Field sampling.—The Hispaniolan Slider is a year-round resident at Lake Trou Caïman. Our study took place from late October 2017 to early February 2018, with daily capture sessions conducted over 62 consecutive sampling days from 4 December to 11 February, with an interruption of eight consecutive days at Christmas time. Because of spatial variation in the density and thickness of the vegetation, the degree of accessibility by foot or by boat varied among different parts of Lake Trou Caïman. We roughly subdivided the part of the lake accessible by boat into nine quadrats of, on average 0.589 km² (± 0.075 standard deviation), with limits set in relation to the morphology and borders of the lake (Fig. 2). The total surface covered by the nine quadrats was 5.305 km². We characterized all quadrats by the percentage of emergent cattail cover at the time of the study (estimated by eye). Within quadrats, we captured turtles using traditional fishing gear used by local fishers (i.e., conical fishing basket nets (modified fyke nets), fish-traps, and a trammel net; Fig. 3). Traditional, wood-framed, conical fishing basket nets were 75–80 cm long, 45–50 cm high, with a 40–45 cm outside diameter and an overall fish shape. They included nylon mesh (5–8 cm) leaders stretching out from the entrance, measuring 1.5 m in length and 1 m in width, and aimed at leading turtles into the net. The fish-traps were simple wooden conical baskets, without nets. We placed 18 fishing basket-nets and nine fish-traps in the accessible part of the lake. We assigned two fishing basket-nets and one fish-trap to each of the nine quadrats (Fig. 2). Fishing basket-nets and fish traps remained at the same exact locations throughout the study day and night and we checked them daily. We set traps so that there was room for turtles to emerge and breathe. During the same capture session, we also captured three turtles in the hard-to-access part of the lake outside of our quadrats, an approximately 1.9 km² area. Because of the high density of cattails, we sampled turtles in this particular area by accompanying locals through known access points and then setting two fishing basket-nets and two fish-traps that we also checked daily. We released all fish captured in our traps. In addition, we obtained additional wild-caught turtles from a local fisher working on the accessible part of the lake with a rectangular trammel net of 48 m maximum length, about 4–4.5 m wide, equipped with lead sinkers and with a mesh size of 0.15 m (Fig. 2). Finally, we contacted local people to gain access to turtles caught in the lake that were kept as pets or for religious purposes.

We marked each *T. decorata* freshly captured in the lake using a formula of unique indentations in the marginal scutes of the carapace (Cagle 1939). Following studies on other *Trachemys* species (Hays and McBee 2010; Gradela et al. 2017), we recorded weight to

Figure 3. Traditional fishing gear used by local fishers in Lake Trou Caïman, Haiti: (a) fish-traps; (b) fishing basket net; and (c) trammel net. (Photographed by Jeffey M. Paul).

the nearest 1 g using a Jadever Stainless Steel Digital Kitchen Scale (Model JK 02, Xiamen Jadever Scale Co., Ltd, Huli District, China) with a 0.01 g accuracy for turtles ≥ 200 g and a DIPSE Mini Digital Pocket Scale (SSR-Produkt GmbH & Co. KG, Oldenburg, Germany), with a 0.01 g accuracy for turtles < 200 g. We recorded the following shell measurements to the nearest 0.1 mm: maximum length and width of the carapace; length and width of plastron; and height of shell. We also recorded the width of the right ventral scale using a HOREX 2226522 Pocket caliper (Helios-Presser, Gammertingen, Germany) with a 0.1 mm accuracy for turtles > 150 mm carapace length, and a WIHA 41102 Dial Max Calliper (Wiha Werkzeuge Gmbh, Schonach, Germany) with a 0.1 mm accuracy for turtles ≤ 150 mm carapace length). In addition, we recorded the color of the supratemporal (postorbital) stripe, as a potential index of hybridization with congeneric invasive species (see Tuberville et al. 2005; Parham et al. 2013). Color was simply assigned visually, as the supratemporal stripe is typically yellow in *T. decorata* (Fig. 1), whereas it is red in *T. scripta elegans* and *T. stejnegeri* (Seidel 2002).

We also examined all individuals for supernumerary scute deformities, wounds, and scars. The development of supernumerary scutes in chelonians is a relatively common phenomenon that may be indicative of genetic anomalies or developmental alterations due to pollutants, inbreeding and outbreeding depression, or suboptimal environmental conditions during incubation (Ayres Fernández and Cordero Rivera 2004; Bujes and Verrastro 2007; Velo-Antón et al. 2011; McKnight and Ligon 2014; Loehr 2016). We followed the same processing methodology for captive individuals but we did not mark them.

Sex determination.—Substantial variation in age and size at sexual maturity can exist within and among populations of *Trachemys* species (Thomas 2006). In the absence of detailed information on the extent of sexual dimorphism in *T. decorata*, we relied on the position of the cloaca, located beyond the margin of the shell in males, to tentatively determine the sex of all individuals based upon studies of the congeneric, similarly sized *T. scripta* (Ernst et al. 1994; Rose and Manning 1996; Thomas 2006; Gradela et al. 2017). We did not rely on the length of forelimb claws as sexual dimorphism on this trait varies among *Trachemys* species (Bock et al. 2010). We restricted the statistical analysis of sexual dimorphism to individuals with maximum carapace lengths > 100 mm, based on variation in the size at maturity reported for the related *T. scripta* (Gibbons et al. 1981; Readel et al. 2008).

Estimation of harvest pressure.—To document the number of turtles caught by local fishers and the importance of turtles as a source of local income, we conducted in-person interviews of fishers (Pinello et al. 2017) between October 2017 and February 2018. We also visited sites around Lake Trou Caïman where turtles were sold. Because most local fishers are poorly literate, we asked questions in creole during face-to-face interviews lasting about 30 min (Acharya et al. 2013). As most fishers have a second occupation (see results), our panel of interviewed fishers was limited to the ones present at the lake at the time interviews were conducted. We prioritized open-ended questions to allow the participants to provide as much detailed information as possible (Turner 2010). Although we conducted interviews outside of peak fishing season, we asked each fisher to provide information about the average weekly amount of money obtained from the sale of turtles, as well as their average weekly gross income from fishing, estimated over the whole year. Additional questions concerned the gear used by fishers, the frequency of their fishing activity (in number of days per week and months per year), and the potential availability of additional sources of income. Our data on total income were restricted as not all interviewees were willing to provide this information. The confidentiality of each interview and the anonymity of the fishers were also preserved throughout the investigation.

Statistical analyses.—We used non-parametric tests (Siegel and Castellan 1988) for the analysis of traits departing from a normal distribution. We relied on binomial tests to assess significant departures from a balanced sex ratio in both freshly captured individuals and captive individuals, and to compare sex ratios between the two groups (Wilson and Hardy 2002). We compared body weight and body size using Mann-Whitney-Wilcoxon tests for two independent samples. We assessed the association among the percentage of cattail cover, quadrat size, and the number of turtles captured in each of the nine quadrats using a Kendall partial-correlation test (Siegel and Castellan 1988). We performed all statistical analyses in R (R core team 2014) and JMP 10.1 software programs. For all tests, $\alpha = 0.05$. We estimated the overall weekly number of turtles captured by fishers by dividing the reported total amount of money obtained from the turtle trade by the mean market price of a single turtle. We also estimated the importance of turtles in the local fishing industry by dividing the weekly income associated with the sale of turtles by the total weekly gross income of fishers that were willing to report these values.

RESULTS

Biological and ecological data.—Overall, we captured 38 turtles on the Lake over 62 daily capture sessions. We found four of them dead in fishing traps, whereas we observed no mortality with fish-nets. Cause of death was not identified. We obtained 10 more individuals caught in the lake from a local fisher. Of the 44 turtles captured alive, measured, and marked in the field, we recaptured only four (9.1%) during the course of the study (two only once and two twice, and always in the same quadrat where they were initially captured). In addition, we examined 48 individuals caught in the lake and kept in captivity by fishers, dealers, or in Vodou temples (peristyles) for morphology and sex ratio. The observed presence of fresh algae on the carapaces of 18 individuals suggested recent capture at Lake Trou Caïman.

All six body measurements and weight deviated from a normal distribution (Shapiro-Wilks test, $0.687 < W < 0.901$; $P < 0.001$ for all traits) and were highly correlated (Spearman rank correlation coefficient: $0.978 < r_s < 0.997$, $P < 0.001$ in all cases). Therefore, we only present data on carapace length and body weight. Overall, captive individuals had larger carapace lengths (median = 145 cm, interquartile range, 103.3–201.0 cm, n = 48) than freshly captured individuals (median = 101.5 cm, interquartile range, 83.3–124.6 cm, n = 44) and the differences were significant ($z = 3.979$, $P < 0.001$). Captive individuals were also heavier (median = 378 g, interquartile range, 155-966 g, n = 48) than freshly captured individuals (median = 146 g, interquartile range, 92–242 g, n = 44), and these differences were also significant ($z = 3.932$, $P < 0.001$). This was mainly due to the higher proportion of individuals with a carapace length < 100 mm among freshly captured individuals (47.7%) than among captive ones (22.9%; Fisher's Exact Test, $P = 0.016$).

We did not find any evidence of sexual maturity at size below 100 mm carapace length. Among individuals with a maximum carapace length > 100 mm, 12 freshly captured individuals were determined to be females and 11 were males (Binomial Test, $P = 0.5$), while 21 captive individuals were females and 16 males (binomial test, $P = 0.256$). The proportions of males and females did not differ between the two groups (Fisher's Exact Test, $P = 0.793$). Carapace length was significantly greater in individuals identified as females than in individuals identified as males among captive turtles ($z = 2.361$, $P = 0.018$). Similarly, females tended to be larger than males among freshly captured individuals, although the difference was not significant ($z = 0.800$, $P = 0.423$).

Overall, 42.4% of individuals showed supernumerary scutes; however, the proportion of individuals with supernumerary scales differed significantly between freshly captured individuals (29/44) and individuals kept in captivity (10/48; Fisher's exact test, $P < 0.001$). This difference was actually due to the fact that, overall, larger individuals (SBVS) were less likely to show supernumerary scutes (Logistic Regression, $P < 0.001$) and were in higher proportion among captive individuals. Individuals without supernumerary scutes were significantly larger than the ones with supernumerary scutes among captive individuals ($z = 3.313$, $P < 0.001$), whereas we observed no such difference among freshly captured individuals ($z = 0.495$, $P = 0.621$).

Several individuals had damaged or pierced plastrons and carapaces, and/or wounds on the head, tail or legs. The proportion of damaged individuals differed markedly between freshly captured individuals and captive individuals. We observed only two damaged individuals of the 44 freshly captured turtles (4.5%), compared to 25 of 48 captive ones (56.3%; Fisher's Exact Test, $P < 0.001$).

Overall, nine individuals (9.8%) showed orange supratemporal stripes, whereas all other had yellow stripes (Fig. 1), with no difference in proportions between turtles freshly captured and those captive ($P = 0.302$). The proportion of individuals with supernumerary scutes tended to be higher among individuals with orange stripes (66.7%, six of nine) compared to individuals with yellow ones (56.2%, 50 of 83) though this difference was not significant (Fisher's Exact Test, $P = 0.161$). In addition, two of nine individuals with orange stripes showed deformed scutes compared to a single turtle of 83 individuals with yellow stripes, and this difference was significant ($P = 0.025$). Combining the two probabilities (Sokal and Rohlf 1981), individuals with orange stripes differed significantly from individuals with yellow stripes in terms of frequency of anomalies ($\chi^2 = 11.07$, df = 4, $P = 0.026$).

We restricted the analysis of the influence of vegetation cover on the relative abundance of turtles to individuals captured in our traps within quadrats (Q1-Q9), thus ensuring a similar capture effort in each quadrat. Variation in the percentage of cattail cover among quadrats ranged from 10 to 80% (median = 20%), whereas the number of turtles captured within each quadrat ranged from zero to 16 (median = 1). There was a significant and positive relationship between the number of turtles captured in each quadrat and the percentage of cattail cover ($\tau = 0.889$, $P = 0.002$, n = 9; Fig. 4). There was no significant relationship between the number of turtles captured in each quadrat and quadrat area ($\tau = 0.365$, $P = 0.189$, n = 9), nor between percentage of cattail cover and quadrat size ($\tau = 0.261$, $P = 0.338$, n = 9).

Importance of turtles / estimation of harvest pressure.—Overall, information on harvest pressure collected at Lake Trou Caïman came from 62% (31/50) of the fishers working weekly on the lake. One fisher was making a living exclusively from fishing on the

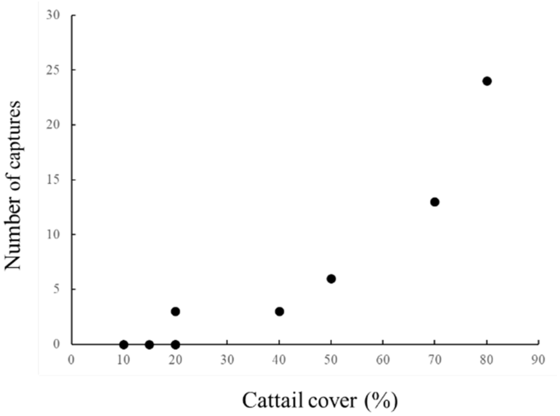

Figure 4. The relationship between the number of captured Hispaniolan Sliders (*Trachemys decorata*) and the percentage of cattail (Typhaceae) cover in quadrats at Lake Trou Caïman, Haiti.

lake, working six days per week and from 5–8 h per day. All other fishers complemented their income through other activities, such as building and selling fish traps, building and selling canoes, working as a carpenter or a lumberjack, escorting hunters or photographers, working part-time at a chicken meat production plant, working as a moto-taxi driver, or working opportunistically as a mason or as an employee at a construction site. Their fishing activity on the lake ranged from 4–48 h per week.

Overall, the median weekly amount of money obtained from the turtle trade amounted to 100 *gourdes* (about 1 $USD), ranging from 0–1,000 *gourdes* among fishers who agreed to be interviewed. The market price of a single turtle varied from between 50 and 100 *gourdes*, up to 400 *gourdes*, at the time of our study (2017–2018). Considering an average market price of 200 *gourdes*, the average weekly number of turtles captured by the 31 fishers taken together was estimated to be 36 at the time of our study. Only 35.5% (11/31) of the interviewed fishers agreed to answer to questions about their total income. Based on their answers, we estimated that the turtle trade amounted to an average of 8% of their individual total income, ranging from 0–31%. There was a significant and positive relationship between the weekly income obtained from the turtle trade and the total income per fisher among the fishers who reported income ($r_s = 0.919$, $P < 0.001$, n = 11).

Discussion

Although limited in duration and scope, our study brings new and original information about the *T. decorata* population at Lake Trou Caïman, and its exploitation by local fishers. The recapture rate of individually marked turtles was particularly low compared to previous studies of freshwater turtles (Roe et al. 2009; Hays and McBee 2010; Páez et al. 2015; Aparicio et al. 2018; Brito et al. 2018). This was due in large part to interference from some local fishers who occasionally visited our traps to collect the catch, or displaced or damaged them, thus affecting both capture and recapture rates and compromising this part of our study.

Based on individuals with carapace lengths > 100 mm, we did not observe any deviation from a balanced sex-ratio in either freshly captured or captive individuals. Among individuals for which we could determine sex, females tended to be larger than males, as observed in several other *Trachemys* species (Bock et al. 2010; Fagundes et al. 2010; Gibbons and Lovich 1990; Stuart and Ward 2009) and freshwater turtles more generally (Agha et al. 2017). Overall, captive individuals were significantly larger and heavier than wild-caught ones. On the one hand, this may be a result of high harvest pressure shortening the average life span of turtles such that most individuals do not live long enough in the wild to reach a large body size (Close and Seigel 1997). Customer demand for small, juvenile turtles, however, is more important than for large ones and juvenile turtles may succumb more quickly to the effects of poor husbandry than older adults (McRobert 1999), making them underrepresented among captive individuals. Local people often keep turtles in captivity temporarily, before selling them for various uses. Turtles used as pets are often poorly treated by young children, with little control by adults. Indeed, a large proportion of captive turtles showed injuries and wounds indicative of poor husbandry conditions. We observed several captive animals left in the mud, tied to a stake, or placed in tub filled with charcoal, with little to no food or care.

A notable proportion of individuals showed carapace anomalies, mainly in the form of supernumerary scutes. Indeed, the observed percentage of individuals with supernumerary scales among freshly captured individuals (42.4%) was well above what has been previously reported for Orbigny's Slider Turtle, *T. dorbigni* (9.2%, n = 98; Bujes and Verrastro 2007), or *T. scripta elegans* (about 5%, n = 144; Smith et al. 2020). Different factors may explain the observed pattern. Zimm et al. (2017) found that high temperatures can produce anomalous patterns in turtle scutes, particularly under dry conditions. A consistent reduction in rainfall has been observed over the Caribbean region over the last century, a trend that is projected to continue (Jury and Winter 2010), and, at a more local scale, shrinking of Lake Trou Caïman has been observed over the last decade, in direct relation to drought (Saint-Louis et al. 2021). The high proportion of individuals with supernumerary scutes might be the consequence of outbreeding or inbreeding depression. Veló-Anton et al. (2011) found no significant effect of climatic and soil moisture, or climatic temperature on the occurrence of carapace abnormalities the European Pond Turtle (*Emys* *orbicularis*) and concluded that the prevalence of scute anomalies among populations was due to inbreeding.

The presence of orange supratemporal stripes in about 10% of individuals is, however, suggestive of hybridization with *T. scripta elegans* and/or *T. stejnegeri* (see Tuberville et al. 2005). Interestingly, morphological anomalies were more frequent in such individuals. Several studies of hybridization in reptiles have reported morphological anomalies in hybrids (Cedeño-Vásquez et al. 2008; Vuillaume et al. 2015), including in freshwater turtles (Fong and Chen 2010; Xia et al. 2011). According to Parham et al. (2013), most *T. decorata* populations in the Dominican Republic are likely to be largely hybridized with *T. stejnegeri*; however, their study was limited to a few museums specimens. The same authors further speculated that genetically pure populations could be restricted to Haiti. Our results suggest that hybridization may already be affecting Haitian populations, at least at Lake Trou Caïman, which is situated relatively close to the border with the Dominican Republic. Coupling molecular investigations with detailed morphological analyses will be necessary to determine the extent of hybridization between *T. decorata* and congeneric species and assess to what extent genetically pure populations still exist in Haiti (see Georges et al. 2018). Such data will also be useful to establish diagnostic morphological characters allowing the identification of hybrids in the wild (Sos et al. 2008), and to assess the degree of gene flow between populations.

We observed a strong correlation between percentage of cattail cover and the number of turtles caught in our traps. Starking et al. (2018) reported that Blanding's Turtles (*Emydoidea blandingii*) use cattail habitat more than proportionally available. In contrast, Wieten et al. (2012) did not observe a disproportionate use of cattail over other vegetation types, including submerged aquatic vegetation, by *T. scripta* over 56 wetlands in Lakes Huron, Michigan, and Superior. Cattail beds may provide some refuge to *T. decorata* at Lake Trou Caïman as such zones are less exposed to harvest pressure by fishers due to the increased difficulty of moving through the dense vegetation; however, the importance of cattail beds for *T. decorata* in Haiti and the Dominican Republic clearly deserves further investigation.

Information collected from local fishers at Lake Trou Caïman revealed that their bycatch of turtles (see Santos et al. 2020) represents only an opportunistic, complementary source of income. Indeed, on average, the sale of turtle amounted to < 10% of the total income of fishers and none of them specialized on catching turtles. Still, some demand for turtles exists locally and in other parts of Haiti, including large cities like Port-au-Prince where freshwater turtles are for sale on several markets, and, possibly, the Dominican Republic. The demand for turtles may vary between areas in both Haiti and the Dominican Republic, partly depending on the prevalence of the Vodou religion and the level of education. From our estimated weekly catch of turtles by the 31 fishers we interviewed, and assuming that the harvest pressure exerted by the other 19 fishers is of similar magnitude, we can calculate an overall weekly catch of 58 *T. decorata*. The intensity of fishing activity varies monthly at Lake Trou Caïman, peaking from March to June (when water levels are high and winds remain moderate), and at a lower level from September to December (as the weather becomes windier). The fishing activity is only sporadic in July and August (the hottest period of the year) and from the end of December to February (because of strong winds). Considering that the fishing activity lasts for at least 7 mo per year, we can estimate that a minimum number of 1,628 individuals are removed from Lake Trou Caïman each year. This estimate must be regarded as conservative, as interviews were conducted outside of the peak fishing season and because other villagers may capture turtles too for their own use as food, pets or for rituals. To what extent the observed situation at Lake Trou Caïman is representative of other sites with important populations of *T. decorata* in Haïti is unknown; however, it deserves further attention, especially as several of the fishers we interviewed reported a drastic decrease in the catch of turtles in recent years, suggesting that harvesting of *T. decorata* at Lake Trou Caïman might not be sustainable in the long term (Commission for Environmental Cooperation 2019).

Although *T. decorata* is listed as Vulnerable on the Red List of the IUCN, its conservation status clearly deserves closer scrutiny. In particular, unregulated harvest pressure and hybridization should be added as important threats, together with continuing decline in area, extent and/or quality of habitat. In that respect, research and monitoring programs of wild populations involving local people are important to evaluate the true conservation status of the species and guide management policies in the future. Given the difficulties we faced in implementing a research and monitoring program for *T. decorata* at Lake Trou Caïman, we strongly suggest developing collaborative participatory programs with local populations in the future (see Schmiedel et al. 2016). Consistent employment of local fishers to assist with capture and marking of individuals for a few days at regular intervals might a be a good solution to reduce interference and develop awareness about conservation issues. In addition, we recommend extending the monitoring of natural populations and assessment of harvest pressure to other wetlands in Haiti and the Dominican Republic.

Acknowledgments.—We thank all the fishers at Lake Trou Caïman for their help during the study. The study was implemented through a framework agreement signed between Caribaea Intitiative and the Ministère de l'Environnement de la République d'Haïti. We thank Tracey D. Tuberville and Raymond A. Saumure for insightful comments on a previous version.

Literature Cited

Acharya, A.S., A. Prakash, P. Saxena, and A. Nigam. 2013. Sampling: why and how of it? Indian Journal of Medical Specialties 4:330−333.

Agha, M., J.R. Ennen, A.J. Nowakowski, J.E. Lovich, S.C. Sweat, and B.D. Todd. 2017. Macroecological patterns of sexual size dimorphism in turtles of the world. Journal of Evolutionary Biology 31:336−345.

Aparicio, Á., M.I. Enrquez, U.A. Montiel, E. Gaona-Murillo, T. Butterfield, and R. Macip-Ríos. 2018. Ecological observations of the Mexican Mud Turtle (*Kinosternon integrum*) in the Patzcuaro Basin, Michoacan, Mexico. Chelonian Conservation and Biology 17:284−290.

Ayres Fernández, C., and A. Cordero Rivera. 2004. Asymmetries and accessory scutes in *Emys orbicularis* from Northwest Spain. Biologia Bratislava 59 (Suppl. 14):85–88.

Bock, B.C., V.P. Páez, and J.M. Daza. 2010. *Trachemys callirostris* (Gray 1856) - Colombian Slider, Jicotea, Hicotea, Galapago, Morrocoy de Agua. Chelonian Research Monographs 5:042.1−042.9.

Brito, E.S., R.C. Vogt, R.M. Valadão, L.F. França, J. Penha, and C. Strüssmann. 2018. Population ecology of the freshwater turtle *Mesoclemmys vanderhaegei* (Testudines: Chelidae). Herpetological Conservation and Biology 13:355−365.

Bujes, C.S., and L. Verrastro. 2007. Supernumerary epidermal shields and carapace variation in Orbigny's Slider Turtles, *Trachemys dorbigni* (Testudines, Emydidae). Revista Brasileira de Zoologia 24:666−672.

Cagle, F. 1939**.** A system of marking turtles for future identification. Copeia 1939:170−173.

Cedeño-Vásquez, J.R., D. Rodriguez, S. Calmé, J.P. Ross, L.D. Densmore III, and J.B. Thorbjarnarson. 2008. Hybridization between *Crocodylus acutus* and *Crocodylus moreletii* in the Yucatan Peninsula: I. Evidence from mitochondrial DNA and morphology. Journal of Experimental Zoology 309A:661−673.

Close, L.M., and R.A. Seigel. 1997. Differences in body size among populations of Red-Eared Sliders (*Trachemys scripta elegans*) subjected to different levels of harvest. Chelonian Conservation and Biology 2:563–566.

Commission for Environmental Cooperation. 2019. Trinational trade and enforcement training workshop to support the legal and sustainable trade in turtles and tortoises. Commission for Environmental Cooperation, Montreal, Canada. 84 p.

Ernst, C., J. Lovich, and R. Barbour. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, D.C., USA.

Fagundes, C.K., A. Bager, and S.T. Zanini Cechin. 2010. *Trachemys dorbigni* in an anthropic environment in southern Brazil: I) Sexual size dimorphism and population estimates. Herpetological Journal 20:185−193.

Fong, J.J., and T-H. Chen. 2010. DNA evidence for the hybridization of wild turtles in Taiwan: possible genetic pollution from trade animals. Conservation Genetics 11:2061−2066.

Fritz, U. 1991. Zur Variabilität der Carapaxzeichnung von *Trachemys decorata* (Barbour and Carr, 1940) und *Trachemys stejnegeri vicina* (Barbour and Carr, 1940) der Hispaniola by Beitrag zur Kenntris-Schmuckschildkrote. Sauria 13:11−14.

Georges, A., R.J. Spencer, A. Kilian, M. Welsh M, and X. Zhang. 2018. Assault from all sides: hybridization and introgression threaten the already critically endangered *Myuchelys georgesi* (Chelonia: Chelidae). Endangered Species Research 37:239−247.

Gibbons, J.W., and J.E. Lovich. 1990. Sexual dimorphism in turtles with emphasis on the Slider Turtle (*Trachemys scripta*). Herpetological Monographs 4:1−29.

Gibbons, J.W., R.D. Semlitsch, J.L. Green, and J.P. Schubauer. 1981. Variation in age and size at maturity of the Slider Turtle (*Pseudemys scripta*). American Naturalist 117:841−845.

Gradela, A., T.O.C. Santiago, I.C. Pires, A.C.S. Silva, L.C. de Souza, M.D. de Faria, J.P. Neto, and L. Milanelo. 2017. Sexual dimorphism in Red-Eared Sliders (*Trachemys scripta elegans*) from the Wild Animal Triage Center of the Tiete Ecological Park, São Paulo, Brazil. Acta Scientiae Veterinariae 45:1468, 10. https://doi.org/10.22456/1679-9216.80442.

Hays, K.A., and K. McBee. 2010. Population demographics of Red-Eared Slider Turtles (*Trachemys scripta*) from Tar Creek Superfund site. Journal of Herpetology 44:441−446.

Jeannot, B. 2015. Inventaire des différents points d'eau (commune de Thomazeau) et caractérisation physicochimique et ichtyologique du plan d'eau principal (étang Trou Caïman). Bachelor Dissertation, Faculté d'Agronomie et de Médecine Vétérinaire, Université d'Etat d'Haïti, Port-au-Prince, Haiti. 45 p.

Jury, M.R., and A. Winter. 2010. Warming of an elevated layer over the Caribbean. Climatic Change 99:247−259.

Loehr, V.J.T. 2016. Wide variation in carapacial scute patterns in a natural population of Speckled Tortoises, *Homopus signatus*. African Journal of Herpetology 65:47−54.

Lyons, J.A., D.J.D. Natusch, and C.R. Shepherd. 2013. The harvest of freshwater turtles (Chelidae) from Papua, Indonesia, for the international pet trade. Oryx 47:298−302.

McKnight, D.T., and D.B. Ligon. 2014. Shell and pattern abnormalities in a population of Western Chicken Turtles (*Deirochelys reticularia miaria*). Herpetology Notes 7:89−91.

McRobert, S.P. 1999. Housing density and growth in juvenile Red-eared Turtles. Journal of Applied Animal Welfare Science 2:133−140.

Meyer, E., C.A. Eagles-Smith, D. Sparling, and S. Blumenshine. 2014. Mercury exposure associated with altered plasma thyroid hormones in the declining Western Pond Turtle (*Emys marmorata*) from California mountain streams. Environmental Science and Technology 48:2989−2996.

Páez, V.P., B.C. Bock, P.A. Espinal-García, B.H. Rendón-Valencia, D. Alzate-Estrada, V.M. Cartagena-Otálvaro, and S.S. Heppell. 2015. Life history and demographic characteristics of the Magdalena River Turtle (*Podocnemis lewyana*): implications for management. Copeia 103:1058−1074.

Parham, J.F., T.J. Papenfuss, P.P. van Dijk, B.S. Wilson, C. Marte, L. Rodriguez Schettino, and W.B. Simison. 2013. Genetic introgression and hybridization in Antillean freshwater turtles (*Trachemys*) revealed by coalescent analyses of mitochondrial and cloned nuclear markers. Molecular Phylogenetics and Evolution 67:176–187.

Pinello, D., J. Gee, and M. Dimech. 2017. Handbook for Fisheries Socio-Economic Sample Survey - Principles and Practice. Technical Paper No. 613, Food and Agricultural Organization, Fisheries and Aquaculture, Rome, Italy.

Powell, R., and S.J. Incháustegui. 2009. Conservation of the herpetofauna of the Dominican Republic. Applied Herpetology 6:103–122.

Powell, R., J.A. Ottenwalder, S.J. Incháustegui, R.W. Henderson, and R.E. Glor. 2000. Amphibians and reptiles from the Dominican Republic: species of special concern. Oryx 34:118−128.

R Core Team. 2014. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/.

Readel, A.M., J.K. Warner, R.L. Holberton, and C.A. Phillips. 2008. Maturational changes in male Slider Turtles (*Trachemys scripta*) in Illinois. Herpetological Conservation and Biology 3:170−175.

Rhodin, A.G.J., C.B. Stanford, P.P. van Dijk PP, C. Eisemberg, L. Luiselli, R.A. Mittermeier, R. Hudson, B.D. Horne, E.V. Goode, G. Kuchling, et al. 2018. Global conservation status of turtles and tortoises (Order Testudines). Chelonian Conservation and Biology 17:135–161.

Roe, J.H., A.C. Brinton, and A. Georges. 2009. Temporal and spatial variation in landscape connectivity for a freshwater turtle in a temporally dynamic wetland system. Ecological Applications 19:1288–1299.

Rose, F.L., and R.W. Manning. 1996. Notes on the biology of the slider, *Trachemys scripta elegans* (Reptilia: Emydidae), inhabiting man-made cattle ponds in West Texas. Texas Journal of Science 48:191−206.

Saint-Louis, L.J., J.M. Paul, W. Célestin, D. Beaune, and F. Cézilly, F. 2021. A baseline survey of waterbirds in five major wetlands of Haiti. Waterbirds 4:370–375.

Santos, R.L., T.L. Bezerra, J.M. Sousa Correia, and E.M. dos Santos. 2020. Artisanal fisheries interactions and bycatch of freshwater turtles at the Tapacurá Reservoir, northeast Brazil. Herpetology Notes 13:249−252.

Schmiedel, U., Y. Araya, M.I. Bortolotto, L. Boeckenhoff, W. Hallwachs W, D. Janzen, S.S. Kolipaka, V. Novotny, M. Palm, M. Parfondry, et al. 2016. Contributions of paraecologists and parataxonomists to research, conservation, and social development. Conservation Biology 30:506−519.

Seidel, M.E. 2002. Taxonomic observations on extant species and subspecies of slider turtles, genus *Trachemys*. Journal of Herpetology 36:285−291.

Seidel, M.E., and S.J. Incháustegui 1984. Status of trachemyd turtles (Testudines: Emydidae) on Hispaniola. Journal of Herpetology 18:468−479.

Sergile, F. 2008. Haiti. Pp. 249–254 *In* Important Bird Areas in the Caribbean: Key Sites for Conservation. BirdLife Conservation Series No. 15, BirdLife International, Cambridge, UK.

Siegel, S., and N.J. Castellan, Jr. 1988. Nonparametric Statistics for the Behavioral Sciences. 2nd Edition. McGraw-Hill, New York, New York, USA.

Smith, G.R., G.E. Rettig, and J.B. Iverson. 2020. Frequency of and temporal trends in shell anomalies in a turtle community in a northern Indiana lake. Chelonian Conservation and Biology 19:277–282.

Sos, T., S. Daróczi, R. Zeitz, and L. Pârâu. 2008. Notes on morphological anomalies observed in specimens of *Testudo hermanni boettgeri* Gmelin, 1789 (Reptilia: Chelonia: Testudinidae) from Southern Dobrudja, Romania. North-Western Journal of Zoology 4:154−160.

Starking, M., T. Yoder-Nowak, G. Rybarczyk, and H. Dawson. 2018. Movement and habitat use of headstarted Blanding's Turtles in Michigan. Journal of Wildlife Management 82:1516−1527.

Stuart, J.N., and J.P. Ward. 2009. *Trachemys gaigeae* (Hartweg 1939) - Big Bend Slider, Mexican Plateau Slider, Jicotea de la Meseta Mexicana. Pp. 32.1−32.12 *In* Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Rhodin, A.G.J., P.C.H. Pritchard, P.P. van Dijk, R.A. Saumure, K.A. Buhlmann, J.B. Iverson, and R.A. Mittermeier (Eds.). Chelonian Research Monographs No. 5, doi:10.3854/crm.5.032.gaigeae.v1.2009.

Thomas, R.B. 2006. *Trachemys scripta*- Slider or Yellow-Bellied Slider. Pp. 297–312 *In* Biology and Conservation of Florida Turtles. Meylan, P.A. (Ed.). Monographs No. 3, Chelonian Research Foundation, Lunenberg, Massachusetts, USA.

Tuberville, T.D., K.A. Buhlmann, R.K. Bjorkland, and D. Booher. 2005. Ecology of the Jamaican Slider Turtle (*Trachemys terrapen*) with implications for conservation and management. Chelonian Conservation and Biology 4:908–915.

Turner, D.W. 2010. Qualitative interview design: a practical guide for novice investigators. The Qualitative Report 15:754−760.

Turtle Taxonomy Working Group (Anders G.J. Rhodin, John B. Iverson, Roger Bour, Uwe Fritz, Arthur Georges, H. Bradley Shaffer, and Peter Paul van Dijk). 2017. Turtles of the World: Annotated Checklist and Atlas of Taxonomy, Synonymy, Distribution, and Conservation Status. 8th Edition. In: Rhodin, A.G.J., Iverson, J.B., van Dijk, P.P., Saumure, R.A., Buhlmann, K.A., Pritchard, P.C.H., and Mittermeier, R.A. (Eds.). Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelonian Research Monographs 7:1–292. doi: 10.3854/crm.7.checklist.atlas.v8.2017.

Velo-Antón, G., C.G. Becker, and A. Cordero-Rivera. 2011. Turtle carapace anomalies: the roles of genetic diversity and environment. PLoS ONE 6: 1-11. https://doi.org/10.1371/journal.pone.0018714.

Vuillaume, B., V. Valette, O. Lepais, F. Grandjean, and M. Breuil. 2015. Genetic evidence of hybridization between the endangered native species *Iguana delicatissima* and the invasive *Iguana iguana* (Reptilia, Iguanidae) in the Lesser Antilles: management implications. PLoS ONE 10:1-20. https://doi.org/10.1371/journal.pone.0127575.

Wieten, A.C., M.J. Cooper, A.D. Parker, and D.G. Uzarski. 2012. Great Lakes coastal wetland habitat use by seven turtle species: influences of wetland type, vegetation, and abiotic conditions. Wetlands Ecology and Management 20:47–58.

Wilson, K., and I.C.W. Hardy. 2002. Statistical analysis of sex ratios: an introduction. Pp. 48–92 *In* Sex Ratios. Concepts and Research Methods. Hardy, I.C.W. (Ed.). Cambridge University Press, Cambridge, UK.

Xia, X., L. Wang, L. Nie, Z. Huang, Y. Jiang, W. Jing and L. Liu. 2011. Interspecific hybridization between *Mauremys reevesii* and *Mauremys sinensis*: evidence from morphology and DNA sequence data. African Journal of Biotechnology 10:6716−6724.

Zimm, R., B.P. Bentley, J. Wyneken, and J.E. Moustakas-Verho. 2017. Environmental causation of turtle scute anomalies *in ovo* and *in silico*. Integrative and Comparative Biology 73:1303−1311.

Jeffey Mackenzy Paul received his Diploma in Agronomic Engineering with specialization in Natural Resources and Environment from the Université d'Etat d'Haïti, Port-au-Prince. His Master in Ecology (2020) was bestowed by the Université des Antilles (UA) in Guadeloupe, for his work on the factors affecting the Red List status of the International Union for Conservation of Nature for Caribbean-endemic vertebrates. He received in 2020 a doctoral fellowship from Caribaea Initiative (www.caribaea.org) to develop a research project on the population biology of native and invasive *Trachemys* species in the insular Caribbean. Jeffey is currently registered as a Ph.D. student at the Université des Antilles and conducts fieldwork in Haiti and Guadeloupe. His main ambition is to contribute significantly to the scientific study and conservation of reptiles in Haiti, his native country. (Photograph courtesy of the Caribaea Initiative).

Lens Jerry Saint-Louis obtained his Master's degree in Biodiversity, Ecology and Evolution from the Université des Antilles, Guadeloupe. His research activity focuses on the monitoring of waterbirds and wetland conservation in Haiti. Lens is a founding member of the Network of Students and Professionals Operating for a New South East (REPONSE) in which he voluntarily supports activities favoring sustainable development. (Photograph courtesy of the Caribaea Initiative).

Anthony Olivier is a French Biologist working as a Research Engineer at the Tour du Valat Research Institute, Arles, France, for the conservation of Mediterranean wetlands. His research focuses on the ecology and conservation of amphibians and reptiles in the Mediterranean basin. In particular, he is leading a long-term demographic study (for 25 y) on the European Pond Tturtle (*Emys orbicularis*) in the Camargue (South France). (Photographed by Tour du Valat).

Wilson Célestin is a Haitian Fisheries Biologist. He obtained his Master's degree in Fisheries and Aquaculture from Auburn University (Alabama, USA) and has been working as a Professor and Researcher in the Faculty of Agronomy and Veterinary Medicine of the State University of Haiti. His research activities have been carried out notably in marine and inland water ecology and conservation. (Photograph courtesy of the Caribaea Initiative).

Frank Cézilly is a Professor at the University of Burgundy, Dijon, France. He obtained his Ph.D. (Animal Behaviour) from the Université de Provence, France. His current research interests involve behavioral ecology and conservation of biodiversity in both natural and urban ecosystems. (Photograph courtesy of the Caribaea Initiative).