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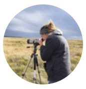

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Sampling Freshwater Turtle Populations Using Hoop Nets: Testing Potential Biases

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ABSTRACT The baited hoop-net is one of the most heavily used sampling tools for monitoring freshwater turtle populations. In the past several years, we have published a series of studies that tested potential biases associated with this sampling method. For this paper, we used a new experiment to directly test the influence of trap-mouth opening size on both captures and escapes. We also summarized the results from previous studies to direct future research on this topic and provide a useful guide for managers and researchers using this sampling device. In our experiment during May 2013 in Texas, USA, we found that traps with larger mouth-openings were more efficient at capturing turtles, while escapes were minimal for both mouth sizes. Thus, at least within the boundaries we tested here, increasing mouth-opening size is an effective way to increase captures without introducing biases caused by differential escape probabilities.

KEY WORDS freshwater turtles, hoop nets, methods, sampling, Texas.

Researchers and managers use sampling techniques to obtain estimates of size and structure of wildlife populations (Beauvais and Buskirk 1999, Buckland et al. 2000, Lancia et al. 2005). Working within time, money, and personnel constraints, the objective is to select a sampling approach that provides the least biased estimates while maximizing capture or detection success (Beauvais and Buskirk 1999, Gu and Swihart 2004, Lancia et al. 2005). For freshwater turtle populations, baited hoop-net traps are one of the most commonly used sampling tools (Lagler 1943, Conant and Collins 1998, Thomas et al. 2008). Hoop nets are convenient because they are collapsible, relatively easy to deploy, and usually require only one person (e.g., Brown et al. 2011*b*). However, similar to all sampling tools, there are a number of potential biases that could influence results, including differential escape probabilities, specific bait preferences, influences from trapping intensity and duration, and individual responses to traps (e.g., individuals becoming trap-shy or trap-happy; e.g., Frazer et al. 1990, Thomas et al. 2008, Mali et al. 2012).

Standard hoop nets are a type of aquatic funnel trap with ellipsoid or round entrance holes that stretch open when turtles enter the trap. Although the focus of this paper is on the use of standard hoop nets, we note that several researchers have investigated improving hoop-net sampling through trap modifications. For example, Kennet (1992) designed a trap that was nearly escape-proof by adding a compartment with a no-return swing door to standard hoop nets. Other investigators modified hoop nets with the goal of decreasing freshwater turtle by-catch and mortality during fishery operations (Fratto et al. 2008, Bury 2011).

During the past several years, we have tested a series of potential biases associated with standard hoop-net sampling (see Methods for trap description). We conducted these studies in south, central, and west Texas (USA), using red-eared sliders (*Trachemys scripta elegans*) and Texas spiny softshells (*Apalone spinifera emoryi*) as focal species. In these studies, we concluded that 1) trapping intensity and duration did not affect captures per unit effort (CPUE; Brown et al. 2011*b*), 2) escapes from hoop nets differed by size, sex, and species (Brown et al. 2011*a*, Mali et al. 2013), 3) turtles in traps did not attract additional turtles (Mali et al. 2013), and 4) turtles did not become trap-shy due to negative olfactory responses to bait (Mali et al. 2012).

In this study, we investigated whether height of the trap opening affected both capture success and escape probability, a potentially important factor that we and others had not previously investigated. The height of the opening (when not manually stretched) can be manipulated by modifying the string tautness, and these openings naturally loosen over time as large turtles stretch them while entering the trap. We hypothesized that capture success would be higher for traps with larger openings because of the entryway being more apparent, but that escapes would also be higher. In addition to this new study, we summarized the knowledge to date concerning potential biases associated with hoop-net sampling to assist researchers and managers with under-

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standing 1) optimal strategies to maximize trapping efficiency and results, and 2) circumstances where estimates obtained through hoop-net sampling are likely to be biased.

STUDY AREA

We used 15 sites (i.e., ponds) to test the effect of un-stretched height of the mouth opening on capture success and escape probabilities. Seven ponds were located in the Bastrop Lost Pines ecoregion (Bastrop County) in central Texas, and 8 were located in the Lower Rio Grande Valley ecoregion in South Texas (Cameron, Hidalgo, and Willacy counties). Freshwater turtle species known to occur in the Lost Pines ecoregion included common snapping turtles (*Chelydra serpentina*), red-eared sliders, Texas river cooters (*Pseudemys texana*), eastern mud turtles (*Kinosternon subrubrum*), and yellow mud turtles (*K. flavescens;* Dixon 2013, Brown et al. 2011*c*). Freshwater turtle species known to occur in the Lower Rio Grande Valley ecoregion included common snapping turtles, red-eared sliders, Rio Grande river cooters (*P. gorzugi*), Texas spiny softshells, and yellow mud turtles (Dixon 2013).

METHODS

We conducted this study during May 2013. We used 76.2-cm-diameter, single-opening, single-throated, elliptical-mouth hoop nets with a 2.54-cm mesh size and 4 hoops/net (Fig. 1; Memphis Net and Twine Co., Memphis, TN). We used 2 wooden posts connected to the first and last hoop to stretch the nets open. To test the effects of mouth-height, we created 2 trap categories: tight traps had un-stretched mouth-openings that were 1.5–2 cm high, which is the typical mouth opening height for new traps; and loose traps had un-stretched mouth-openings that were 6.5–12 cm high ($\bar{x} = 8.4$ cm, SD $= 1.7$ cm). Although entry and removal of turtles from traps causes the un-stretched openings to expand over time, based on previous experience we assumed that would not be an issue here given the short-duration of the study, and thus we did not modify trap openings after the study began. At each site we set a line of 10 traps, alternating wide- and narrow-mouth traps spaced at 5–10 m intervals. We checked traps once per day for 6 consecutive days (=30 trap days/trap category/site). We baited traps with canned sardines and replaced bait every 2 days.

Figure 1. Photograph of a hoop-net trap for freshwater turtles. The photograph shows a horizontally placed, ellipsoid mouth opening that is designed to stretch open to allow entry of turtles into the trap.

For each capture, we recorded trap type and took standard measurements of individuals caught. We used a portable rotary tool (Dremel, Racine, WI) to individually mark turtles, drilling marginal scutes using Cagle's (1939) numbering system for hardshells, and engraving a number on the posterior end of the carapace for softshells (Weber et al. 2011). With the exception of the last trap day, we placed captures back into traps (i.e., seeded turtles), alternating evenly between tight and loose-mouth traps. We placed one turtle in each trap for approximately 24 hours to estimate escape probabilities. If an individual did not escape on the first day, we tested it a second time with the alternate trap category, with the goal of accounting for inherent differences among individuals in their ability to escape traps.

To determine whether capture success differed between trap categories, we treated each site as a sampling unit, and summed captures in each trap category at each site. We used a paired randomization test with 10,000 iterations to determine whether number of captures differed between trap categories. The *P*-values in these tests represent the proportion of trials resulting in capture differences as great as or greater than those obtained (Sokal and Rohlf 1995). Thus, a small *P*-value means that it is unlikely our results were obtained by random chance given the inherent distribution of the data. We inferred statistical significance at $\alpha = 0.05$. For this analysis we used Program R 2.7.2 (The R Foundation for Statistical Computing, Vienna, Austria). Because escapes were minimal for both trap categories (see Results section), we did not statistically test the effect of trap category on escape probabilities. This research was conducted under Texas Parks and Wildlife Department permit (no. SPR-0102-191) and approved by the Texas State University-San Marcos Institutional Animal Care and Use Committee (protocol 1010_0501_09).

For the literature review portion of this paper, we compiled all peer-reviewed articles on the topic of testing potential biases using standard hoop nets for sampling turtle populations. Studies that compared hoop nets with other sampling methods (e.g., basking traps) were included as a separate category, but were not a major focus of this paper, unless a study also provided useful results with respect to hoop-net biases. Articles that introduced novel underwater traps or heavily modified hoop nets were not included in this review. We discussed the major findings of these studies, and created a flow diagram to assist researchers and managers with obtaining papers on each research topic evaluated to date.

RESULTS

In this experiment, we captured 129 turtles—110 in loose-mouth traps and 19 in tight-mouth traps. Number of captures per trap per day ranged from 0 to 8 for loose-mouth traps and from 0 to 4 for tight-mouth traps (Table 1). Red-

Table 1. Total number of freshwater turtle captures per trap (range of captures per day in parentheses) in hoop nets with loose (6.5–12 cm) and tight (1.5–2 cm) un-stretched vertical mouth-height openings at 8 ponds in the Lower Rio Grande Valley (LRGV) of Texas, USA, and 7 ponds in the Bastrop Lost Pines ecoregion of Texas (LP), in May 2013. At each site we used 5 traps for each trap category (L1–L5 and T1–T5), and trapped for 6 consecutive days.

	Loose-mouth opening traps					Tight-mouth opening traps				
Site and trap	**L1**	**L2**	**L3**	**L4**	**L5**	**T1**	**T2**	**T3**	**T4**	**T5**
LP1	0	0	3 (0–2)	2 (0–1)	0	0	0	0	0	0
LP2	0	1 (0–1)	0	0	4 (0–4)	0	0	0	0	0
LP3	0	0	0	0	0	0	0	0	0	0
LP4	2 (0–1)	1 (0–1)	3 (0–2)	1 (0–1)	1 (0–1)	0	0	0	0	0
LP5	0	1 (0–1)	2 (0–2)	1 (0–1)	0	0	0	0	0	0
LP6	0	0	0	0	0	0	0	0	0	0
LP7	0	1 (0–1)	1 (0–1)	0	0	0	0	0	0	0
LRGV1	2 (0–1)	1 (0–1)	0	0	1 (0–1)	0	0	0	0	0
LRGV2	0	2 (0–1)	3 (0–2)	0	0	0	0	0	0	0
LRGV3	0	1 (0–1)	0	0	1 (0–1)	0	0	0	0	0
LRGV4	13 (0–4)	10 (0–3)	1 (0–1)	2 (0–1)	7 (0–2)	6 (0–4)	5 (0–2)	0	4 (0–2)	3 (0–2)
LRGV5	2 (0–2)	0	3 (0–2)	0	1 (0–1)	0	0	0	0	0
LRGV6	0	1 (0–1)	2 (0–1)	0	4 (0–2)	0	0	0	0	0
LRGV7	0	0	1 (0–1)	0	3 (0–2)	0	0	0	0	1 (0–1)
LRGV8	18 (0–8)	2 (0–1)	1 (0–1)	3 (0–1)	1 (0–1)	0	0	0	0	0

eared sliders represented the majority of captures (83%) and were captured at 13 sites. We captured common snapping turtles at 2 sites in the Lost Pines and 1 site in the Lower Rio Grande Valley ecoregions, and Texas spiny softshells at 3 sites in the Lower Rio Grande Valley ecoregion, yellow mud turtles at 1 site in the Lower Rio Grande Valley ecoregion, and an eastern mud turtle at 1 site in the Lost Pines ecoregion (Table 2). At 11 sites, we captured turtles strictly in loose-mouth traps (Table 1). At 2 sites we captured turtles in both trap categories; however, even at these 2 sites captures were higher for loose-mouth traps (Table 2). At 2 sites we did not capture any turtles. Total captures per site for loose-mouth traps ranged from 0 to 33 ($\bar{x} = 7.33$; SD $= 9.21$), while captures in tight-mouth traps ranged from 0 to 18 ($\bar{x} = 1.27$; SD $= 4.64$; Table 1). The randomization test indicated total capture success was higher for loose-mouth traps ($P < 0.001$). When we used only red-eared sliders, capture success was still higher for loose-mouth traps ($P < 0.001$).

We used 85 unique individuals to estimate escape probabilities and determine whether escapes differed by trap category. Of the 85 turtles, 62 were used in both trap categories (i.e., 124 seeding occasions), 14 were placed only in loose traps, and 9 were placed only in tight traps. Out of the 147 total occasions, only 3 turtles escaped—2 from loose-mouth traps, and 1 from a tight-mouth trap. Thus, in this study the percentage of escapes was 2.6% and 1.4% for loose and tight-mouth traps, respectively.

We summarized the existing literature on potential biases for hoop-net sampling using a flow diagram (Fig. 2). We briefly discuss the major findings below, including example references; however, the full list of articles is listed in Figure 2. The most studied topic to date was bait preference (e.g., Ernst 1965, Voorhees et al. 1991, Thomas et al. 2008). Among those studies, there was evidence that different species prefer different baits, but also that different individuals within the same species prefer different baits.

Table 2. Freshwater turtle captures in hoop-net traps with loose (6.5–12 cm) and tight (1.5–2 cm) vertical mouth-height openings at 8 ponds in the Lower Rio Grande Valley (LRGV) of Texas, USA, and 7 ponds in the Bastrop Lost Pines (LP) ecoregion of Texas in May 2013. At each site we used 5 traps of each trap category, and trapped for 6 consecutive days. The captures are broken down by species: TSE, *Trachemys scripta elegans*; CS, *Chelydra serpentina*; AS, *Apalone spinifera*; KF, *Kinosternon flavescens*; and KS, *K. subrubrum*.

	Loose-mouth opening traps						Tight-mouth opening traps					
Site and species	**TSE**	**CS**	**AS**	**KF**	**KS**	**Total**	**TSE**	**CS**	**AS**	**KF**	**KS**	**Total**
LP1	4	1				5						0
LP2	5					5						0
LP3						0						0
LP4	4	3			1	8						0
LP5	4					4						0
LP6						0						0
LP7	2					2						0
LRGV1	4					4						0
LRGV2	5					5						0
LRGV3	1		1			2						0
LRGV4	30			3		33	11			7		18
LRGV5	3	2	1			6						0
LRGV6	7					7						0
LRGV7	4					4	1					1
LRGV8	22		3			25						0

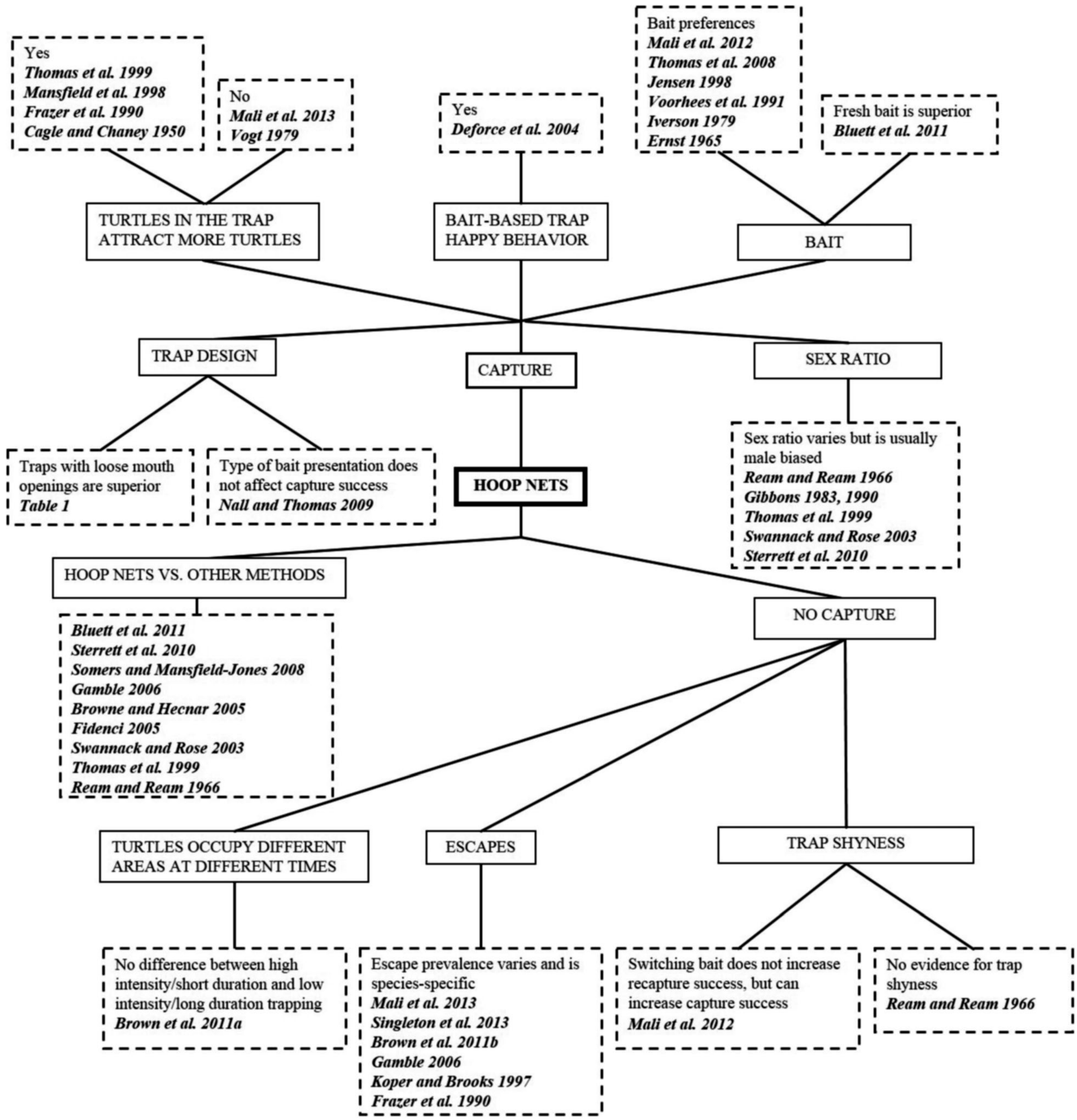

Figure 2. Flowchart representing the existing literature on potential biases for hoop-net sampling of freshwater turtles. This flowchart summarizes the knowledge to date concerning potential biases associated with hoop-net sampling to assist researchers and managers with understanding optimal strategies to maximize trapping efficiency and circumstances in which estimates are likely to be biased.

It was also found that fresh bait was preferred over 2-day-old bait (Bluett et al. 2011). We found only one study that indicated turtles became trap-happy after initial capture (Deforce et al. 2004). Several researchers speculated that turtles present in traps attracted more turtles; however, studies that directly tested this hypothesis, by either placing live turtles or decoys in traps, found conflicting results. For example, Mansfield et al. (1998) found that decoy turtles attracted additional turtles to traps, while Mali et al. (2013) found no evidence that live turtles in traps increased CPUE. It has been reported that hoop-net captures are male-biased (Ream and Ream 1966, Thomas et al. 1999, Sterrett et al. 2010); however, one study indicated that this bias was due to the sex ratio of the population rather than the sampling method (Swannack and Rose 2003). The one study that assessed the influence of trapping intensity and duration found that when total trap days were equivalent, CPUE was equivalent between low-intensity–long-duration sampling and high-intensity–short-duration sampling (Brown et al. 2011*b*). Minor modifications such as the method of bait presentation in the trap had no effects on capture success (Nall and Thomas 2009). As stated in the experimental results of this paper, large mouth-openings were more efficient at capturing turtles, without drastically increasing trap escapes. All studies investigating escapes found turtles can escape from hoop nets; however, the magnitude of escapes ranged from 80% to <2% (e.g., Frazer et al. 1990, Gamble 2006, Singleton et al. 2013). For some species, escapes differed by size (Mali et al. 2013), while for others escapes differed by sex (Brown et al. 2011*b*). Lastly, there was no evidence that turtles became trap-shy due to negative olfactory responses associated with the type of bait used (Mali et al. 2012).

DISCUSSION

The results of this study indicate that larger mouth-opening heights increase hoop-net capture success for freshwater turtles. A possible explanation for this is turtles are simply more likely to find the trap entrance hole when the mouth opening is less tight (i.e., less vertically narrow). However, contrary to our expectations, loosening mouth-openings to create a wider vertical entrance hole did not result in substantially more escapes, with the final escape percentages similar to what we found with our traps in previous studies (Brown et al. 2011*a*, Mali et al. 2013). Thus, within the bounds we tested, loose-mouth traps were superior to tight-mouth traps. Because new traps usually have tight-mouth openings, we recommend intentionally loosening them to increase capture success.

There are many questions remaining to be addressed with respect to biases associated with using hoop nets to sample freshwater turtle populations. Briefly, we discuss future research topics that we believe will be the most beneficial to advancing our knowledge. First, in this study we found that loosening trap-mouths dramatically increased capture success. However, mouths can be loosened much more than they were in this study, and we are interested in knowing the point at which increased escapes counterbalances increased captures success. Thus, we recommend replicating this study using even larger mouth-openings (e.g., 6–10 cm vs. 16–20 cm). Second, it is currently unknown how representative hoop-net captures are for population demographic parameters. Several studies have attempted to investigate this (Koper and Brooks 1997, Gamble 2006, Bluett et al. 2011), but used multiple sampling techniques on populations with unknown demographics, rather than a known population. Thus, we recommend performing manipulative experiments to address this question. For instance, ponds can be drained and closed off with fencing, intentionally stocked with turtles, then trapped to assess representativeness. Lastly, we are interested in individual responses to hoop nets following initial capture; therefore, we recommend using manipulative experiments to address these questions. In conclusion, this and other studies have improved our understanding of how to increase freshwater turtle sampling efficiency using baited hoop nets, and biases associated with their use.

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LITERATURE CITED

Beauvais, G. P., and S. W. Buskirk. 1999. Modifying estimates of sampling effort to account for sprung traps. Wildlife Society Bulletin 27:39–43.

Bluett, R. D., E. M. Schauber, C. K. Bloomquist, and D. A. Brown. 2011. Sampling assemblages of turtles in central Illinois: a case study of capture efficiency and species coverage. Transactions of the Illinois State Academy of Science 104:127–136.

Brown, D. J., B. DeVolld, and M. R. J. Forstner. 2011*a*. Escapes from hoop nets by red-eared sliders (*Trachemys scripta*). Southwestern Naturalist 56:124–127.

Brown, D. J., I. Mali, and M. R. J. Forstner. 2011*b*. No difference in short-term temporal distribution of trapping effort on hoop-net capture efficiency for freshwater turtles. Southeastern Naturalist 10:245–250.

Brown, D. J., T. M. Swannack, J. R. Dixon, M. R. J. Forstner. 2011*c*. Herpetofaunal survey of the Griffith League Ranch in the Lost Pines ecoregion of Texas. Texas Journal of Science 63(2):101–112.

Browne, C. L., and S. J. Hecnar. 2005. Capture success of northern map turtles (*Graptemys geographica*) and other turtle species in basking vs. baited hoop traps. Herpetological Review 36:145–147.

Buckland, S. T., I. B. J. Goudie, and D. L. Borchers. 2000. Wildlife population assessment: past developments and future directions. Biometrics 56:1–12.

Bury, B. R. 2011. Modifications of traps to reduce bycatch of freshwater turtles. Journal of Wildlife Management 75:3–5.

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

Cagle, F. R., and A. H. Chaney. 1950. Turtle populations in Louisiana. American Midland Naturalist 43:383–388.

Conant, R., and J. T. Collins. 1998. A field guide to reptiles and amphibians: eastern and central North America. Third edition. Houghton Mifflin, Boston, Massachusetts, USA.

Deforce, E. A., C. D. Deforce, and P. V. Lindeman. 2004. *Phrynops gibbus* (Gibba Turtle). Trap-happy behavior. Herpetological Review 35:55–56.

Dixon, J. R. 2013. Amphibians and reptiles of Texas: with keys, taxonomic synopses, bibliography, and distribution maps. Third edition. Texas A&M University Press, College Station, USA.

Ernst, C. H. 1965. Bait preferences of some freshwater turtles. Ohio Herpetological Society Newsletter 5:53.

Fidenci, P. 2005. A new technique for capturing Pacific pond turtles (*Actinemys marmorata*) and a comparison with traditional trapping methods. Herpetological Review 36:226–267.

Fratto, Z. V., V. A. Barko, P. R. Pitts, S. L. Sheriff, J. T. Briggler, K. P. Sullivan, B. L. McKeage, and T. R. Johnson. 2008. Evaluation of turtle exclusion and escapement devices for hoop-nets. Journal of Wildlife Management 72:1628–1633.

Frazer, N. B., K. P. Gibbons, and T. J. Owens. 1990. Turtle trapping: preliminary tests of conventional wisdom. Copeia 1990:1150–1152.

Gamble, T. 2006. The relative efficiency of basking and hoop traps for painted turtles (*Chrysemys picta*). Herpetological Review 37:308–312.

Gibbons, J. W. 1983. Reproductive characteristics and ecology of the mud turtle, *Kinosternon subrubrum* (Lacepede). Herpetologica 39:254–271.

Gibbons, J. W. 1990. Sex ratios and their significance among turtle populations. Pages 171–182 *in* J. W. Gibbons, editor. Life history and ecology of the slider turtle. Smithsonian Institution Press, Washington, D.C., USA.

Gu, W., and R. K. Swihart. 2004. Absent or undetected? Effect of non-detection of species occurrence on wildlife-habitat models. Biological Conservation 116:195–203.

Iverson, J. B. 1979. Another inexpensive turtle trap. Herpetological Review 10:55.

Jensen, J. B. 1998. Bait preferences of southeastern United States coastal plain riverine turtles: fish or fowl? Chelonian Conservation and Biology 3:109–111.

Kennet, R. 1992. A new trap design for catching freshwater turtles. Wildlife Research 19:443–445.

Koper, N., and R. J. Brooks. 1997. Population-size estimators and unequal catchability in painted turtles. Canadian Journal of Zoology 76:458–465.

Lagler, K. F. 1943. Methods of collecting freshwater turtles. Copeia 1943:21–25.

Lancia, R. A., W. L. Kendall, K. H. Pollock, and J. D. Nichols. 2005. Estimating the number of animals in wildlife populations. Pages 106–153 *in* C. E. Braun, editor. Techniques for wildlife investigations and management. Wildlife Society, Bethesda, Maryland, USA.

Mali, I., D. J. Brown, M. C. Jones, and M. R. J. Forstner. 2012. Switching bait as a method to improve freshwater turtle capture and recapture success with hoop net traps. Southeastern Naturalist 11:311–318.

Mali, I., D. J. Brown, M. C. Jones, and M. R. J. Forstner. 2013. Hoop net escapes and influence of traps containing turtles on Texas spiny softshell (*Apalone spinifera emoryi*) captures. Herpetological Review 44: 44–46.

Mansfield, P., E. G. Strauss, and P. J. Auger. 1998. Using decoys to capture spotted turtles (*Clemmys guttata*) in water funnel traps. Herpetological Review 29:157–158.

Nall, I. M., and R. B. Thomas. 2009. Does method of bait presentation within funnel traps influence capture rates of semi-aquatic turtles. Herpetological Conservation and Biology 4:161–163.

Ream, C., and R. Ream. 1966. The influence of sampling methods on the estimation of population structure of painted turtles. American Midland Naturalist 75:325–338.

Singleton, J. M., J. Hearlson, and R. B. Thomas. 2013. Escape rates of semi-aquatic turtles from basking and funnel traps. Herpetological Review 44:442–444.

Sokal, R. R., and F. J. Rohlf. 1995. Biometry: the principle and practice of statistics in biological research. Third edition. Freeman, New York, New York, USA.

Somers, A. B., and J. Mansfield-Jones. 2008. Role of trapping in detection of a small bog turtle (*Glyptemys muhlenbergii*) population. Chelonian Conservation and Biology 7:149–155.

Sterrett, S. C., L. L. Smith, S. H. Schweitzer, and J. C. Maerz. 2010. An assessment of two methods for sampling river turtles assemblages. Herpetological Conservation and Biology 5:490–497.

Swannack, T. M., and F. L. Rose. 2003. Seasonal and ontogenetic changes in the sex ratio of a population of stinkpots (Kinosternidae: *Sternotherus odoratus*). Southwestern Naturalist 48:543–549.

Thomas, R. B., I. M. Nall, and W. J. House. 2008. Relative efficacy of three different baits for trapping pond-dwelling turtles in east-central Kansas. Herpetological Review 39:186–188.

Thomas, R. B., N. Vogrin, and R. Altig. 1999. Sexual and seasonal differences in behavior of *Trachemys scripta* (Testudines: Emydidae). Journal of Herpetology 33:511–515.

Vogt, R. C. 1979. Spring aggregating behavior of painted turtles, *Chrysemys picta* (Reptilia, Testudines, Testudinidae). Journal of Herpetology 13:363–365.

Voorhees, W., J. Schnell, and D. Edds. 1991. Bait preferences of semiaquatic turtles in southeast Kansas. Kansas Herpetological Society Newsletter 85:13–15.

Weber, A. S., E. C. Munscher, J. R. Brown, C. A. Cox, and J. B. Hauge. 2011. Using tattoos to mark *Apalone ferox* for individual recognition. Herpetological Review 42:530–532.

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