Herpetological Review, 2017, 48(2), 323–327.

A New Trap Design for Catching Small Emydid and Kinosternid Turtles

Freshwater turtles are one of the most imperiled groups of vertebrates on the planet and many species have experienced severe population declines in recent years because of a variety of factors, including habitat loss, climate change, pollution, and exploitation by humans (Klemens 2000; Gerlach 2008; Buhlmann et al. 2009; Ernst and Lovich 2009). Recent population declines, even in protected areas, highlight the importance of effective monitoring techniques for freshwater turtle species throughout their range, especially in locations or habitats where turtles are rarely studied (Browne and Hecnar 2007). Trapping is the most common method used to monitor freshwater turtle populations because many species are attracted to baited traps and trapping can be conducted with minimal effort and low risk of unintended mortalities. Many studies have also shown trapping to be more effective than other survey methods when attempting to capture freshwater turtles (e.g., Somers and Mansfield-Jones 2008; Howell et al. 2016).

There is a multitude of trap types designed to capture freshwater turtles of all sizes in a variety of aquatic environments (Legler 1960; Kuchling 2003; Bury et al. 2012; Dodd 2016). Over time, trap designs have been altered and improved upon to target specific taxa or to sample more effectively in certain habitat types (e.g., Kuchling 2003). Some trap designs capture turtles at a higher rate than other trap designs (McKnight et al. 2015) and trap success can vary across different habitat types and species. Therefore, it is important for researchers to select a trap appropriate for both the type of aquatic habitat and species of turtle being targeted.

Despite the abundance of trap designs, many traps (including the most common hoop nets) are poorly suited for catching turtles in shallow freshwater environments because of their large size and deep-water design (Kuchling 2003; Howell et al. 2016). Furthermore, large traps often have wide entrance funnels that are capable of catching larger turtle species. Researchers targeting smaller turtles may wish to exclude larger turtles because they sometimes prey on other turtles (Elsey 2006). Alternatives to large traps include small (approximately 60 x 30 cm) minnow traps (both wire and mesh constructions are readily available) that can be deployed in shallow environments (McKnight et al. 2015; Howell et al. 2016). However, these small minnow traps can degrade over time and are easily disturbed (e.g., moved, bait stolen, or damaged) or even destroyed by large vertebrates (see below).

HOUSTON C. CHANDLER*
DIRK J. STEVENSON[1]
The Orianne Society, 11 Old Fruitstand Lane, Tiger, Georgia 30576, USA
JONATHAN D. MAYS
Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission, Gainesville, Florida 32601, USA
BENJAMIN S. STEGENGA
WILLAH H. VAIGNEUR
MATT D. MOORE
The Orianne Society, 11 Old Fruitstand Lane, Tiger, Georgia 30576, USA

**Corresponding author; e-mail: hchandler@oriannesociety.org*

Here, we describe a new trap design—the "Jones Trap"—to catch Spotted Turtles (*Clemmys guttata*) and other small turtles, primarily in the families Emydidae and Kinosternidae. Kinosternid turtles (22 species in four genera) can be found in habitat types ranging from large rivers to swamps. Similarly, Spotted Turtles are small, generally secretive, freshwater turtles that inhabit a variety of shallow, often ephemeral wetlands over a large geographic range, extending from Canada to the southern United States (Ernst and Lovich 2009). Despite this large range, Spotted Turtle populations are considered to be declining in many locations and are listed as endangered in Canada and are a candidate for listing in the United States (Ernst and Lovich 2009; Stevenson et al. 2015). Historically, many Spotted Turtle surveys have relied at least partially on visual encounters to capture turtles (e.g., Parker and Whiteman 1993; Litzgus and Mousseau 2004a; Rasmussen and Litzgus 2010). However, at large sites or sites with murky water, it may be more effective to trap Spotted Turtles during the times of year when turtles are most active, usually spring and fall (Litzgus and Mousseau 2004b).

Our original trap design was based on a modified crab trap used by commercial collectors targeting Spotted Turtles (David Jones, pers. comm. and trap namesake). Other types of modified crab traps have been used with some success to survey for Diamond-backed Terrapins (*Malaclemys terrapin*) in wetlands where it can be difficult to use other survey methods (Butler 2000). We designed the Jones Trap to be durable over many years, suitable for use in a wide variety of wetland habitats, including those too shallow to trap using most other trap types, and to exclude large turtles (primarily Common Snapping Turtles, *Chelydra serpentina*, and Pond Sliders, *Trachemys scripta*). A rigid design using reinforced wire also makes these traps resistant to disturbance from large vertebrates (e.g., alligators, large turtles, mammals, herons, etc.).

Materials and Methods

We constructed traps from 16-gauge galvanized-steel-mesh (ca. 2.5 x 2.5 cm) wire coated with black polyvinyl chloride (PVC; Riverdale Mills Corporation), purchased at a local hardware store. We purchased rolls of wire mesh that were 61.0 cm wide x 30.5 m long (enough to construct nine traps). To construct our modified crabwire traps, we started by cutting the wire mesh roles into 155.0 x 61.0 cm sections (two sections will make one trap). Each long piece of wire mesh was then folded at 90° angles, approximately 47.0 cm from both ends, using the edge of a table and a small rubber mallet.

After making the walls of the trap, we constructed and attached entrance funnels and bait boxes before connecting the two large pieces of wire mesh. We constructed rectangular bait boxes using a 20.9 x 35.6 cm, a 12.7 x 17.8 cm, and a 7.6 x 11.4 cm piece of wire mesh (the smaller pieces were cut from scrap wire mesh to maximize the number of traps produced from each roll of wire mesh). First, we bent the 20.9 x 35.6 cm piece into a

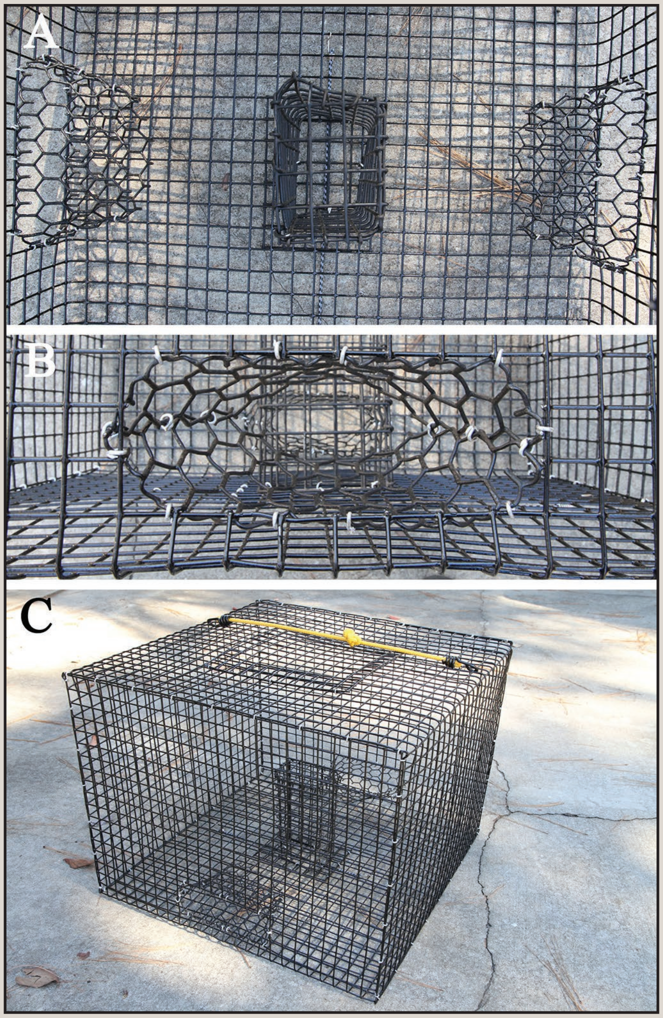

Fig. 1. Modified crabwire trap (Jones Trap) designed to catch small freshwater turtles. Jones Traps had two entrance funnels near the bottom of the trap, a single bait box attached to the bottom of the trap (designed to accommodate a variety of bait types), and a hinged lid on the top of the trap.

rectangular cuboid with two open ends, connecting the two 20.9 cm ends by wrapping the cut ends of wire mesh around the opposite side. Then we connected the 7.6 x 11.4 cm piece of wire mesh to one end of the cuboid bait box by wrapping the ends of wire mesh from the bait box around the smaller piece (this end is closed off and forms the top of the bait box; Fig. 1A). Sometimes it was necessary to use a slightly larger piece of wire mesh to close the top of the bait box. Next we cut a 7.6 x 10.2 cm hole in the bottom of the trap, 25.4 cm from two sides and 27.9 cm from the other two sides. The open side of the cuboid bait box was then connected to the opening using metal fencing rings so that the bait box was positioned inside the trap with the closed end facing up. Finally, we connected the 15.2 x 15.2 cm piece of wire mesh along a single side on the bottom (outside) of the trap to form a door that could swing open and closed (Fig. 1A). We used a small bungie cord to hold the lid of the bait box closed, allowing for easy access when baiting traps. We designed our bait boxes to accommodate a variety of different bait types (most often a can of sardines) and to prevent turtles from being able to swim directly through the trap. Bait boxes could be modified to suit other researchers' needs, including being purchased commercially.

After connecting the bait boxes, we then constructed two entrance funnels, placed low on opposite sides of the trap (Fig. 1A). First, we cut 7.6 x 20.3 cm holes 2.5 cm from the bottom of the trap and 20.3 cm from opposite sides of the trap (i.e., in the middle). Entrance funnels were then fitted over these holes on the inside of the trap. We constructed entrance funnels with 16-gauge PVC coated hexagonal wire mesh (commonly referred to as crab trap wire mesh, available at hardware stores). We cut two pieces of wire mesh that tapered from approximately 24.1 cm wide at the long end (the side connected to the trap) to 12.7 cm at the short end (the end of the funnel). Both pieces were approximately 12.7 cm in length. We connected these two pieces to each other along the tapering edges using metal rings and then attached the wider end to the inside of the trap along the previously cut hole. Finally, we bent the oval entrance funnels outward with pliers to ensure they completely covered the rectangular opening (Fig. 1B). Completed entrance funnels sloped gradually upwards, away from the bottom of the trap, which helps prevent turtles from escaping. The position of the entrance funnels and rigid walls allowed traps to stand upright and be set in water approximately 15–45 cm deep.

After attaching the bait box and two entrance funnels, the two large three-sided pieces of wire mesh were connected to form the trap. We attached the middle of each section first, using two metal rings, then worked towards the corners, connecting sections every 5.0 cm with a metal ring. Depending on the accuracy of measurements, we sometimes had to use a rubber mallet to bend the corners together to entirely close the trap. Once the trap was completely assembled, we cut a door in the top of the trap to provide access to captured animals. We cut an approximately 20.3 x 22.9 cm hole directly in the center of the top of the trap and then covered this hole with a slightly bigger piece of wire mesh (27.4 x 30.5 cm). We connected the door to the trap using metal rings along a single long side and held it in place using either a small carabiner or bungee cord. Completed crabwire traps resembled rectangular cuboids with dimensions of approximately 61.0 x 61.0 x 47.0 cm (Fig. 1C).

We used the Jones Traps to target Spotted Turtles and multiple species of kinosternid turtles from 2014–2016. We trapped at two known Spotted Turtle sites in southern Georgia and two known sites in northern Florida. All sites were generally shallow (<1 m deep) hardwood swamps, with occasional areas of deeper water and muck. The number of trap nights (i.e., one trap left in the water for one full night) varied among sites and across years. We also captured Spotted Turtles through opportunistic visual encounters while checking traps at all four sites and deployed Promar mesh minnow traps at both Florida sites. We identified all turtles captured, and all Spotted Turtles were sexed, marked with a unique notch, measured (e.g., standard carapace length, SCL), and weighed before being released near their points of capture. In addition to the four Spotted Turtle sites, we also tested our traps at eight sites located along the margins of lotic habitats (streams and rivers). These trapping events targeted Loggerhead (*Sternotherus minor*) and Common Musk Turtles (*S. odoratus*), which were rarely encountered at our Spotted Turtle sites.

Results

From 2014–2016, we deployed Jones Traps for a total of 1630 trap nights, capturing seven species of freshwater turtles (Table 1). Jones Traps successfully captured freshwater turtles in every habitat type in which they were deployed. Adult Spotted Turtles (max shell width = 86.6 mm and max shell height = 41.5 mm)

Table 1. Total number of turtles captured in Jones Traps at four Spotted Turtle (*Clemmys guttata*) sites and eight riverine sites (pooled into a single total) from 2014–2016. Captures per unit effort are displayed in parentheses (number of captures divided by the number of trap nights). Sites 1, 2, and all riverine sites were located in the Coastal Plain of southern Georgia, and sites 3 and 4 were located in northern Florida. The total numbers of *Kinosternon subrubrum* captures at Sites 1 and 2 in 2015 were not recorded (*).

	Site 1			Site 2		Site 3		Site 4		River
Species	2014	2015	2016	2015	2016	2015	2016	2015	2016	2016
Clemmys guttata	37 (0.66)	34 (0.40)	32 (0.19)	26 (0.12)	17 (0.05)	7 (0.04)	10 (0.04)	7 (0.05)	8 (0.06)	-
Chelydra serpentina	1 (0.02)	1	6 (0.04)	3 (0.01)	-	-	-	1 (0.01)	-	-
Kinosternon baurii	-	-	-	-	4 (0.01)	-	1 (0.00)	32 (0.20)	10 (0.07)	-
Kinosternon subrubrum	8 (0.14)	*	26 (0.15)	*	57 (0.16)	-	-	-	-	-
Sternotherus minor	-	-	-	-	-	-	-	-	1 (0.01)	47 (0.71)
Sternotherus odoratus	-	1 (0.01)	-	1 (0.01)	7 (0.02)	-	-	-	-	17 (0.26)
Trachemys scripta	-	-	-	1 (0.01)	2 (0.01)	-	-	-	-	1 (0.02)

were the largest turtles captured in traps (all *C. serpentina* and *T. scripta* captured were juveniles). Jones Traps caught both juvenile and adult Spotted Turtles (SCLs from 43.5–110.9 mm), although the vast majority of Spotted Turtles captured were adults (see below). We caught four species of kinosternid turtles (Table 1), representing all species in this family expected at our trapping sites. Over the three-year period, we observed no instances of traps being disturbed or damaged by large animals, despite the presence of Northern River Otters (*Lontra canadensis*), Northern Raccoons (*Procyon lotor*), and American Alligators (*Alligator mississippiensis*) at trapping sites.

At the four sites with Spotted Turtles, captures per unit effort (CPUE) varied between sites and across years (Table 1). Spotted Turtle captures were lower at the two sites in Florida (17 and 15 captures in 396 and 269 trap nights, respectively) compared to the two sites in Georgia (103 and 43 captures in 313 and 586 trap nights, respectively). The highest Spotted Turtle CPUE in any year was 0.66 at Site 1 in 2014, and we detected a decrease in CPUE towards the end of the sampling seasons (e.g., at Site 2 only one capture in 67 trap nights during May 2016 and no captures at Site 4 in 22 trap nights during May 2015). Eastern Mud Turtles (*Kinosternon subrubrum*) and Striped Mud Turtles (*K. baurii*) were often captured at Spotted Turtle trapping sites, but their CPUE values were relatively low (all ≤ 0.20; Table 1). Jones Traps were also effective in flowing streams and rivers, where we targeted Loggerhead Musk Turtles (47 captures in 66 trap nights; 0.71 CPUE) and Common Musk Turtles (17 captures in 66 trap nights; 0.26 CPUE).

Over the three years of trapping, we captured Spotted Turtles 178 times in Jones Traps, 96 times by hand, and 0 times in Promar traps (deployed for 67 trap nights at the two Florida sites). The vast majority of the Spotted Turtles captured in traps were adults, and only three turtles had an SCL < 70.0 mm (all from the same Georgia site). There were four turtles with an SCL < 70.0 mm caught by hand, again all from the same Georgia site. Overall, we caught more adult (SCL > 90) female (50) than male (32) Spotted Turtles in Jones Traps (1.6 females for every male captured). We also caught more females (26) than males (15) via hand captures (1.7 females for every male captured). The majority (54%) of Spotted Turtles captured in Jones Traps were recaptured in traps at least once, and 67% of Spotted Turtles captured prior to 2016 were recaptured at least once (i.e., at least one full trapping season was completed after initial capture). Recapture rates using Jones Traps were higher at Georgia sites (62%) compared to Florida sites (33%). Spotted Turtles captured by hand were recaptured by hand 31% of the time (42% for turtles captured prior to 2016).

Discussion

Over three years of sampling, we found Jones Traps to be an effective alternative to other traps designed to capture small freshwater turtles. Most importantly, Jones Traps caught a variety of turtle species in every habitat in which they were deployed, including all targeted species. Entrance funnels were appropriately sized to allow full-grown Spotted Turtles and kinosternid turtles to enter traps while excluding large *C. serpentina* and *T. scripta*. Furthermore, entrance funnels placed near the bottom of the trap ensured that we could successfully set traps in shallow water. This allowed us to extend our trapping seasons as swamps dried, which would not have been possible with other trap types that have been used to capture Spotted Turtles (Mansfield et al. 1998). The rigid construction and weight of the wire mesh made it easy to deploy traps in a variety of environments, including in flowing water. Additionally, we were able to place traps in deeper water than one can place small minnow traps. After multiple years of use, we had no issues with traps deteriorating, indicating that crabwire traps made with PVC-coated-wire mesh are durable enough to be deployed for many trapping seasons before needing to be repaired or replaced. Because of the dark-colored (black) wire, we found that these traps were not easily spotted from a distance or especially visible, which will help limit human disturbance.

We caught Spotted Turtles at four different sites in the southern portion of their range, despite substantial variation in flooded area, water depths, the amount of available cover, and substrate characteristics. Spotted Turtles can be difficult to trap (Parker and Whiteman 1993; Mansfield et al. 1998; Milam and Melvin 2001), and our captures per unit effort varied substantially among sites and through time. Differences in site size and habitat characteristics probably influenced CPUE to some extent, but the variation in CPUE between sites was likely driven by the Spotted Turtle population size at the four sites. Spotted Turtle captures were highest at site 1, which we believe has a population size at least twice as big as each of the other sites included in this study (Chandler and Stevenson, unpubl. data). Spotted Turtle populations are generally smallest at the southern and northern extremes of their range (Ernst and Lovich 2009) and this appears to be especially true of the two sites in northern Florida. At these two sites, we had only 32 captures over two years despite substantial trapping effort. Similarly, we had only 13 Spotted Turtle captures through visual encounters at these two sites over the same time period, even though this is often the primary sampling technique for Spotted Turtles (e.g., Litzgus and Mousseau 2004a).

In addition to the variation among sites, there was also variation in the Spotted Turtle CPUE over time. Some of this temporal variability can be attributed to a longer trapping season at sites 1 and 2 during 2016 (i.e., lower CPUE than in other years). More traps were set, and traps were checked until a later date, particularly at site 2, in an effort to catch additional turtles for a radiotelemetry study. The reduction in CPUE after April highlights the importance of targeting Spotted Turtles during the times of year when they are most active (Litzgus and Mousseau 2004a). Climate variability between years likely also contributed to the differences in Spotted Turtle CPUE over time. Spotted Turtle activity is directly influenced by temperature and the amount of available flooded habitat (Ernst and Lovich 2009), both of which could influence trapping success in a given year. Interestingly, we captured Spotted Turtles active at site 1 during late December 2015 (outside of the normal trapping season), likely because of an exceptionally warm winter in southern Georgia, indicating that Spotted Turtles may remain active through winter in the southern portion of their range (Ernst and Lovich 2009). We believe that our traps have a great value in future status surveys and monitoring efforts for Spotted Turtles, a poorly known (in some regions), difficult to detect, and declining species that was recently petitioned for federal listing (Stevenson et al. 2015).

We caught almost twice as many Spotted Turtles in Jones Traps than we did through visual encounter surveys over the same time period. We did not record the amount of time spent visually looking for turtles, but it was similar to the time spent checking traps (i.e., the majority of hand captures occurred while walking through sites to check traps). We had no success catching Spotted Turtles using Promar traps at the two Florida sites, and we found that these traps were often disturbed by other animals. Spotted Turtles with a SCL < 70 mm were conspicuously absent from most sites, regardless of the sampling method. Other authors have also reported that juvenile Spotted Turtles make up a small percentage of total captures (Litzgus 1996; Litzgus and Mousseau 2004a), and this size class likely exhibits behaviors that make them difficult to effectively sample. We caught more female than male Spotted Turtles in Jones Traps and via hand captures. We think it is likely that at least some of these populations are female biased, which has been documented in other Spotted Turtle populations (Haxton 1998; Ernst and Lovich 2009).

We found Jones Traps to be similarly effective when used to target kinosternid turtles of several species. Eastern Mud Turtles and Striped Mud Turtles were commonly captured alongside Spotted Turtles. Loggerhead Musk Turtle CPUE along the margins of flowing streams and rivers were the highest of any species caught in any year. Previous studies have captured various species of kinosternid turtles using a wide variety of trap types, including hoop nets (Frazer et al. 1991), wire-mesh funnel traps (Melancon et al. 2011), minnow traps (McKnight et al. 2015), and wire basket traps (Fonnesbeck and Dodd 2003). Overall, kinosternid turtles appear to be easily attracted to baited traps and can likely be successfully surveyed using a variety of traps that are appropriate for the available habitat. We cannot assess the potential biases of the Jones Traps with respect to the kinosternid species that we captured, and we recommend that these potential biases be examined in future research.

The biggest disadvantage of the Jones Trap is the size and rigidity (also one of the strengths) of each trap when compared to other trap types (Howell et al. 2016). The construction prevents traps from being folded or broken down for transport, limiting the number that can be hauled (nine traps will fit in a standard-sized pickup truck). In the field, we found it challenging to carry more than two traps at a time. This may make these traps undesirable for researchers who must drive or walk long distances to field sites. Construction time for each trap usually ranged from 2–2.5 hours for a single builder, and the total cost for each trap was approximately US $40 for material and labor. We found it most effective to use a small team of builders, using one roll of wire mesh at a time. The durability and longevity of these traps should help to offset the initial high cost per trap.

We recommend that researchers using Jones Traps take steps to minimize the chances of unintended mortality (we did not have any mortalities during our trapping). Traps should be positioned to reduce the chances of them shifting over time, including anchoring traps in place with stakes if necessary (e.g., in flowing water). Traps should be checked at least every other day, although we prefer to check traps daily. Finally, traps should be placed in shallow enough water to allow for a large air pocket at the top. Researchers should be cognizant of the hydrology of their study sites (e.g., a site's propensity to flood after precipitation events) and plan accordingly if rain is in the forecast while traps are deployed. It may be necessary to temporarily remove traps in habitats that are prone to flooding.

In conclusion, we found Jones Traps useful for catching multiple species of turtles, especially in shallow, fluctuating environments. During our surveys, we captured more Spotted Turtles and recaptured them at a higher rate than through visual encounter surveys. However, there were individuals that were captured through visual encounters that were not captured in traps and vice versa. Using a combination of capture techniques can help limit the influence of biases that may be associated with a single methodology. The Jones Trap's high-sided design reduces the chances of unintended mortalities (drowning) during precipitation events, especially if proper planning is used while setting traps (see above). We were able to catch all species we specifically targeted, while excluding larger species that could potentially lower capture rates of small turtles. Jones Traps were also durable over multiple field seasons and were not damaged or disturbed by larger animals, which happened frequently with smaller Promar traps at Florida sites. The suitability of these traps for use in multiple projects (i.e., Spotted Turtles, other small emydid turtles—including species that we did not target in our trapping events—and kinosternid turtles) also increases their usefulness over the lifespan of the trap.

Acknowledgments.—We thank our numerous turtle colleagues for assistance with fieldwork, most notably Ben and Louann Williams. We thank Chris Coppola, Don Imm, Chris Jenkins, and John Jensen for assisting with various aspects of this study. This manuscript benefited from the comments of two anonymous reviewers. The U.S. Fish and Wildlife Service provided funding for trap construction and fieldwork. Fieldwork for this study was carried out under a scientific collecting permit from the Georgia Department of Natural Resources (permit number: 29–WJH–16–21).

Literature Cited

Browne, C. L., and S. J. Hecnar. 2007. Species loss and shifting population structure of freshwater turtles despite habitat protection. Biol. Conserv. 138:421–429.

Buhlmann, K. A., T. S. Akre, J. B. Iverson, D. Karapatakis, R. A. Mittermeier,

A. Georges, A. G. Rhodin, P. P. van Dijk, and J. W. Gibbons. 2009. A global analysis of tortoise and freshwater turtle distributions with identification of priority conservation areas. Chelon. Conserv. Biol. 8:116–149.

Bury, R. B., D. T. Ashton, D. J. Germano, N. E. Karraker, D. A. Reese, and K. E. Schlick. 2012. Sampling turtles: trapping and snorkeling. *In* R. B. Bury, H. H. Welsh, D. J. Germano, and D. T. Ashton (eds.), Western Pond Turtle: Biology, Sampling Techniques, Inventory and Monitoring, Conservation, and Management, pp. 35–50. The Society for Northwestern Vertebrate Biology, Olympia, Washington.

Butler, J. A. 2000. Status and distribution of the Carolina diamondback terrapin, *Malaclemys terrapin centrata*, in Duval County. Final Report of Project NG94-103 to the Florida Fish and Wildlife Conservation Commission.

Dodd, C. K. 2016. Reptile Ecology and Conservation: A Handbook of Techniques. Oxford University Press. New York, New York. 512 pp.

Elsey, R. M. 2006. Food habits of *Macrochelys temminckii* (alligator snapping turtle) from Arkansas and Louisiana. Southeast. Nat. 5:443–452.

Ernst, C. H., and J. E. Lovich. 2009. Turtles of the United States and Canada, 2nd edition. John Hopkins University Press, Baltimore, Maryland. 819 pp.

Fonnesbeck, C. J., and C. K. Dodd Jr. 2003. Estimation of flattened musk turtle (*Sternotherus depressus*) survival, recapture, and recovery rate during and after a disease outbreak. J. Herpetol. 37:602–607.

Frazer, N. B., J. W. Gibbons, and J. L. Greene. 1991. Life history and demography of the common mud turtle *Kinosternon subrubrum* in South Carolina, USA. Ecology 72:2218–2231.

Gerlach, J. 2008. Fragmentation and demography as causes of population decline in Seychelles freshwater turtles (genus *Pelusios*). Chelon. Conserv. Biol. 7:78–87.

Haxton, T. 1998. Large spotted turtles, *Clemmys guttata*, sampled in Central Ontario. Can. Field Nat. 112:717–718.

Howell, H. J., D. T. McKnight, and R. A. Seigel. 2016. A novel method of collecting spotted turtles (*Clemmys guttata*). Herpetol. Rev. 47:202–205.

Klemens, M. W. 2000. Turtle Conservation. Smithsonian Institution Press, Washington, D.C. 344 pp.

Kuchling, G. 2003. A new underwater trap for catching turtles. Herpetol. Rev. 34:126–128.

Legler, J. M. 1960. A simple and inexpensive device for trapping aquatic turtles. Proc. Utah Acad. Sci. 37:63–66.

Litzgus, J. D. 1996. Life history and demography of a northern population of spotted turtles, *Clemmys guttata*. M.S. Thesis, University of Guelph, Guelph, Ontario. 145 pp.

———, and T. A. Mousseau. 2004a. Demography of a southern population of the Spotted Turtle (*Clemmys guttata*). Southeast. Nat. 3:391–400.

———, and T. A. Mousseau. 2004b. Home range and seasonal activity of southern Spotted Turtles (*Clemmys guttata*): Implications for management. Copeia 2004:804–817.

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

McKnight, D. T., J. R. Harmon, J. L. McKnight, and D. B. Ligon. 2015. Taxonomic biases of seven methods used to survey a diverse herpetofaunal community. Herpetol. Conserv. Biol. 10:666–678.

Melancon, S. R., R. A. Angus, and K. R. Marion. 2011. Growth of the flattened musk turtle, *Sternotherus depressus* Tinkle and Webb. Southeast. Nat. 10:399–408.

Milam, J. C., and S. M. Melvin. 2001. Density, habitat use, movements, and conservation of spotted turtles (*Clemmys guttata*) in Massachusetts. J. Herpetol. 35:418–427.

Parker, P. G., and H. H. Whiteman. 1993. Genetic diversity in fragmented populations of *Clemmys guttata* and *Chrysemys picta marginata* as shown by DNA fingerprinting. Copeia 1993:841–846.

Rasmussen, M. L., and J. D. Litzgus. 2010. Habitat selection and movement patterns of spotted turtles (*Clemmys guttata*): effects of spatial and temporal scales of analyses. Copeia 2010:86–96.

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

Stevenson, D. J., J. B. Jensen, E. A. Schlimm, and M. Moore. 2015. The distribution, habitat use, activity, and status of the spotted turtle (*Clemmys guttata*) in Georgia. Chelon. Conserv. Biol. 14:136–142.