baits sometimes resulted in differences in capture rates. But various factors limit our ability to directly compare our results with those of previous studies. For example, the three published studies (Ernst 1965; Jensen 1998; Voorhees et al. 1991) were conducted in different geographic locations and/or habitats, sometimes used different baits, and/or involved different species. Our study was conducted in manmade ponds located within a small portion of east-central Kansas and we cannot necessarily assume that our results are applicable across the relatively large geographic distributions of these species. We examined three commonly used baits but there are a large number of baits that have been used as bait in funnel traps. Currently, nothing is known with respect to the relative effectiveness of most of these baits. Likewise, the potential for seasonal, sexual, and ontogenetic variation in the effectiveness of particular baits deserves further consideration.

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A Simple Pitfall Trap for Sampling Nesting Diamondback Terrapins

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The Diamondback Terrapin *(Malaclemys terrapin)* is an estuarine turtle inhabiting coastal salt marshes from Massachusetts to Texas (Ernst et. al. 1994). Previous data on nesting Terrapins have primarily been collected via visual searches during peak nesting activity (Feinberg and Burke 2003; Roosenberg 1996; Roosenberg and Dunham 1997). Although effective, this method is time consuming, requires a reasonably large population, and sometimes requires numerous volunteers. Many of these studies occurred along the Atlantic Coast where nesting beaches are located on the mainland. This has allowed researches to easily access nesting beaches to conduct visual searches for terrapins. Nesting beaches in the Northern Gulf of Mexico, however, are located almost exclusively on islands (D. H. Nelson, pers. comm.), making nesting beaches accessible only by boat. Boat travel results in increased travel time and thus decreased searching time for nesting Terrapins. To complicate matters, nesting beaches in the northern Gulf Coast are usually small and widely distributed, making typical nesting surveys almost impossible to conduct (Nelson et. al. 2005). Unlike Atlantic coast nesting beaches, beaches in Alabama are largely composed of oyster shells, which prevents locating turtles and their nests via female crawls (a method used in Feinberg and Burke 2003). Given these atypical nesting conditions, we decided that a passive trapping method would be more appropriate for capturing Terrapins on local nesting beaches.

Initial efforts with pitfall traps constructed from Christiansen and Vandewalle (2000) fell short of our expectations. These traps did not hold up to the demands of the estuarine environment (e.g., saltwater, winds). Specifically, the wooden lid and metal rod degraded quickly, rendering the trap non-functional. Furthermore, 5-gallon buckets did not seem to provide suitable space for trapped terrapins to maneuver. We used the Christiansen and Vandewalle (2000) design as a starting point and began experimenting with various modifications of their design. Herein, we describe the modified design that best addressed the specific problems described above.

We erected four, 90-m long drift fences on shell middens (composed of oyster shell) at Barton Island (30°23'N, 88°22'W), Mon Luis Island (30°20'N,88°11'W), and Cedar Point (30°19'N, 88°08'W) in southern Mobile County, Alabama, USA. Pre-staked construction silt fencing, 90 cm in height, was used for several reasons including, low cost, ease of handling, and durability. Fences were buried to a depth of 30 cm leaving 60 cm above ground. Two pitfall traps were installed along each fence 30 m from the ends and 30 m apart. Pitfalls had a self-righting lid that was placed over the pitfall (Fig. 1). This type of lid was chosen for two reasons: 1) to increase the numbers of turtles that were captured, since turtles seemed wary of uncovered pitfalls (Christiansen and Vandewalle, 2000), and 2) to provide shelter from thermal stress. Temperature was monitored in the month of June (tropical storms prevented sampling temperature in July) using HBE International Inc. Minimum-Maximum thermometers. One thermometer was secured with cable-ties midway inside a pitfall trap, while another thermometer was staked on exposed shell adjacent (outside) to the same pitfall trap. Thermometers were reset everyday to acquire daily temperature extremes. Minimum temperature inside the pitfall ranged from 18°C to 23°C and a maximum temperature ranged from 25°C to 29°C. Temperatures outside the pitfall had a minimum range of 24°C to 30°C and a maximum range from 40°C to 47°C (N = 20 days).

Each trap consisted of a single 68.1 L (19 gal) plastic storage container. The rigid construction of the Sterilite® brand worked better than other available styles, as shifting sand and shells of nesting beaches tended to warp and distort other plastic containers. To prevent water accumulation from rain and/or over wash caused by storm events, holes were drilled through the bottom of the containers. The lid was designed to rotate when a large or heavy animal walked across one side or the other. The lid returned to its original, horizontal position after a turtle fell into the trap via a

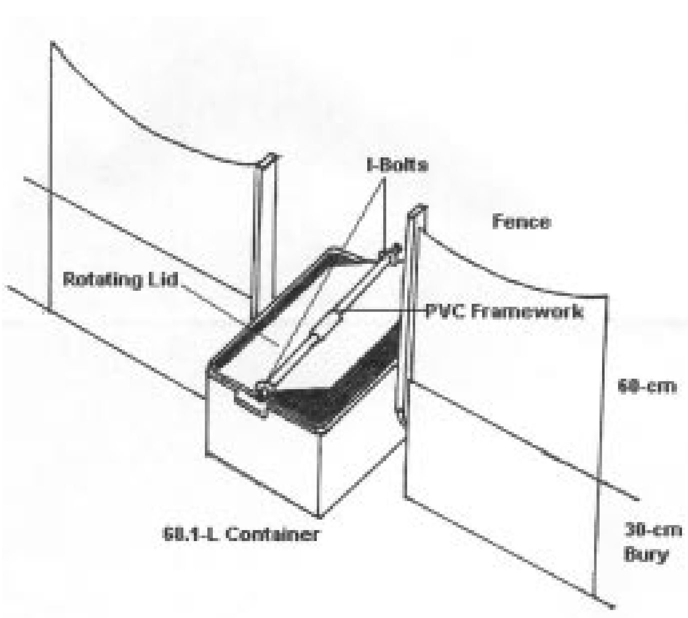

FIG. 1. Diagram for 68.1 L (19 gal) pitfall trap with self-righting lid, shown attached to a drift fence. (Illustration provided by B. Gill)

pendulum. Construction of the rotating lid assembly began by drilling holes in the handles where 15.2 cm (6 inch) steel I-bolts were mounted on each handle with 3/8 inch washers and nuts to create a mount for the rotating lid. Next, the outer edges of the lids were cut to fit inside the container, which allowed the lids to rotate freely inside the pitfall trap. The lid was very flimsy, so 1/2 inch PVC tubing was used as a framework for the rotating lid and attached to the lid with 20.4 cm (8 inch) cable ties. The PVC was cut to fit through the I-bolts and capped to prevent sliding of the lid assembly. A hole was cut at the center of the lid for a pendulum to pass through into the pitfall. The pendulum consisted of a 15.2 cm (6 inch) section of 1/2 inch PVC, filled with lead fishing weights, attached to the central rib at the T-joint. The pendulum allowed the rotating lid to remain level even during high winds and right itself after a turtle was captured.

The labor and construction cost involved in erecting the fences and burying the pitfalls was minimal compared to hourly monitoring of nesting beaches. Total cost of one 90 m fence with two pitfall assemblies was US $90, and each array required 2 person-hours for construction and instillation. No part of the traps needed to be replaced throughout the nesting season, which included two tropical storm events.

From 13 May to19 August 2005, we successfully captured 14 gravid female terrapins 16 times in 310 trap days (one trap day = one pitfall open for one night) for a catch per unit effort of 0.05 terrapins per trap day. Capture rates were greater than those of modified crab traps (similar traps used by Wood 1997) sampled near the nesting beaches, 21 captures over 2048 trap days (0.01; Borden, unpubl. data). Although catch per unit effort was low, terrapin populations in Alabama appear to be uncommon to rare and highly isolated (Nelson and Marion 2004). During the nesting season, the plastic pitfalls did not degrade. However, it was necessary from time to time to adjust the fit of the lid with a utility knife to ensure unobstructed rotation. We opened traps on Mondays and closed them on Fridays. Traps were checked daily. When not in use, we covered traps with a 60 × 80 cm piece of rubber-coated chicken wire and staked the wire at each corner, to prevent the inadvertent capture of terrapins. We observed no apparent predation on terrapins within the traps, although Raccoons *(Procyon lotor)* and River Otters *(Lontra canadensis)* were observed on the nesting beaches. Although nesting beaches are used by humans, there was no evidence of trap disturbance during this study.

We found this technique to work well for terrapins inhabiting estuaries with minimal nesting habitat. However, it may be less effective than visual searches in habitats with expansive or readily accessible nesting beaches. Longer drift fences with more pitfalls will need to be tested to determine their effectiveness at large nesting areas. Possible disadvantages of this technique are that nesting females may be forced to alter nesting behavior when they encounter the fence. In our experience, however, turtles nested along and even beneath drift fences with no adverse impacts.

In conclusion, although pitfall traps have been used to capture turtles for many years (Congdon et. al. 1987; Gibbons et. al. 1983; Tucker 2000), our trap is the first to incorporate a pendulum and the first designed for harsh, estuarine environments. This trapping system will be appreciated by terrapin researchers along the northern Gulf Coast where typical capture methods (e.g., visual transects, locating signs of nesting females) are not effective. Overall, this trapping system seems to be a relatively inexpensive and time saving technique for sampling terrapins in an undersampled portion of their range.

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Use of Traditional Turtle Marking to Obtain DNA for Population Studies

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Genetic analysis has been applied extensively to studies of wildlife populations to examine population diversity, gene flow, inbreeding depression, source-sink dynamics, and extinction-recolonization frequencies (Hedrick and Kalinowski 2000; Jehle and Arntzen 2002). Blood or tissue samples and buccal swabs are the common source of DNA for most genetic studies. In chelonians, blood samples are acquired by drawing blood from the tail, leg, or neck (Avery and Vitt 1984; Jacobson et al. 1992; Rosskopf 1982). Although effective, obtaining blood samples is invasive, sometimes difficult to accomplish, and possibly stressful to the turtle. However, alternative methods have also had serious drawbacks, including a protocol using shell samples that required such large amounts of bone that either a deceased animal was needed or the animal had to be sacrificed (Hsieh et al. 2006).

In this paper, we describe a method of obtaining tissue for genetic studies that makes use of the traditional marking techniques for turtles, i.e., drilling or notching the marginal scutes (Cagle 1939; Ernst et al. 1974; Mockford et al. 1999). The drill shavings produced during marking are used as the source of DNA for genetic analysis instead of being thrown away thereby eliminating the invasive and stressful procedure of blood extraction and increasing the speed with which the samples can be taken.

Materials and Methods.—All samples collected came from gopher tortoises at the Kennedy Space Center (Brevard and Volusia Counties, Florida, USA) where mark-recapture studies have been conducted for over 30 years (Pike et al. 2005). Tortoises collected were examined for previous marks and mass and length measurements were recorded (Pike et al. 2005). While wearing sterile gloves, 100% ethanol was used to swab the scute area to be drilled in order minimize contamination of the sample. A 1/8th inch (3.17 mm) drill bit was used to drill holes in scutes of unmarked tortoises, while a larger bit was used to drill holes in scutes of previously marked individuals. Filter paper was placed under the scute area where the hole was drilled to catch the drill shavings during the marking process. Drill shavings from one or two holes were enough to facilitate genomic DNA extraction. After drilling, the shavings were placed in a sterile 15 ml polypropylene tube, and stored at ambient temperature. After a tortoise was marked, the drill bit was cleaned by brushing with a firm toothbrush dipped in 100% ethanol. The drill bit was then dipped in 100% ethanol and flamed to sterilize. (Note: Isopropyl alcohol could be substituted for ethanol.)

The extraction process used two 5/8th inch (15.88 mm) hex bolts and a matching nut. Prior to use, the threaded end of the bolts