Herpetological Review, 2013, 44(2), 233–235.

Using a Handheld PIT Scanner and Antenna System to Successfully Locate Terrestrially Overwintering Hatchling Turtles

The benefits of Passive Integrated Transponders (PIT) for identification of individual wildlife have been well documented. Originally used to determine movement of salmonids (Prentice and Park 1983), PIT technology has been used with a variety of reptiles and amphibians for spatial ecology studies. For example, mark-recapture techniques were used in conjunction with PITs to measure habitat use and movement of Brown Water Snakes (*Nerodia taxispilota*; Mills et al. 1995) and the activity patterns of arboreal geckos (*Gehyra variegata*; Gruber 2004). PITs do not transmit a signal and cannot be located unless an antenna is within close proximity.

While earliest studies with PITs in turtles involved sea turtles, PIT injection into the body cavity of smaller freshwater adult turtles was not considered until Buhlmann and Tuberville (1998) injected young *Trachemys scripta elegans* with 12 × 2 mm PITs in

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the inguinal region. Of six turtles recovered over two years, none showed adverse effects due to PITs. The authors recommend against the use of PIT with hatchling turtles, presumably due to the size of hatchlings relative to the tags used in their study. Subsequently, PITs (12 × 1 mm) were injected into the intraperitoneal region of hatchling *Chrysemys picta* with no adverse effects or mortality observed in the lab after one year (Rowe and Kelly 2005). A more recent study embedded PIT tags into *Podocnemis sextuberculata* and *P. unifilis* adults and hatchlings in the Amazon Basin (Guilhon et al. 2011). The authors reported results for mark-recapture, movement, abundance, survival, and recruitment.

I suggest a new application for using PIT tags with a scanner and a portable antenna to track and precisely locate terrestrial overwintering hatchling turtles. I field-tested this technique with hatchling Diamondback Terrapins (*Malaclemys terrapin*) overwintering beneath ground cover and soil. Diamondback Terrapin hatchlings overwinter on land near their nests but specific locations have not previously been determined (Muldoon and Burke 2012).

Methods.—In September and October 2009 I inserted 9 × 2.12 mm (0.067 g) PIT tags (Biomark, TX148511B) into 60 individual hatchling diamondback terrapins newly emerged from protected nests in Jamaica Bay Wildlife Refuge, New York. Thirty-six hatchlings were tagged in August, September, and October of 2010. An additional 251 hatchlings were tagged in August and September of 2011, all from protected nests at the same locale. Tag insertion generally followed the procedures of Rowe and Kelly (2005) with the exception that tags were not inserted via needle injection. Prior to tag insertion the skin in the left inguinal region was cleaned with 99% ethyl alcohol. A 2-3 mm incision was made into the body wall with a recurved scalpel blade to avoid excessive cutting of musculature and internal organs. A single sterilized PIT was inserted via the incision into the intraperitoneal region with sterilized tweezers. Once the PIT was no longer visible, the wound was again sterilized and covered with a quick-drying liquid bandage (CVS, liquid bandage). Hatchlings were observed a minimum of 20 min and up to 24 h post-insertion. Release sites were within 1 m of capture sites.

After release, area searches were conducted with a Biomark FS2001 Reader and portable antenna to determine each animal's location throughout the year. The reader was worn in a chest harness and the attached antenna was mounted on a handle and waved a few centimeters over or in direct contact with the ground much like a metal detector. Searches were generally concentrated on potential cover such as wrack lines, under dense vegetation and areas of leafy and woody debris. Failure to locate an individual was followed by a more methodical radius search from the release point.

According to the manufacturer, the antenna can scan through wood, soil, and water, although the signal is influenced by metals and other electronics and the read range of the antenna at highest power is optimal when a tag has a perpendicular orientation. The effective read range of the portable antenna with an 8-ft. (2.4 m) cable is 3.7 in. (9.4 cm) with the tag at a parallel orientation and 10.5 in. (26.7 cm) when the tag is oriented perpendicularly (Anonymous 2011).

Hibernacula were excavated to recover tags or possible hatchling remains after 1 June when presumably all active hatchlings had emerged. Excavation was done by hand. One millimeter of soil was removed from the site and scanned away from the nest to detect the presence or absence of tags. Each soil sample was carefully searched for any remains apart from the PIT tag.

Results.—One hundred forty-three (41%) of the tagged hatchlings were relocated at least once, 57 (16%) within 24 h. Of the individual hatchlings located, 127 (89%) stayed within 10 m of the nest while 13 (9%) moved 10–20 m, 1 (0.7%) moved 20-30 m, and 2 (1.3%) moved 40+ m, before settling in winter hibernacula. Thirteen individuals changed location at least one time before choosing hibernacula while one individual moved twice and three changed location three times.

I was able to monitor 81 (23%) hatchlings throughout the winter. By early summer they had either left their hibernacula or were killed by predators. Thirteen PIT tags were found when hibernacula were excavated, three with dead hatchlings and the other ten at varying depths in the soil without any visible hatchling remains.

Discussion.—I demonstrated the ability of the Biomark TX148511B scanner and handheld antenna to locate PIT-tagged hatchlings within their shallow hibernacula in a terrestrial environment under a variety of soil types and moisture conditions and the ability of hatchlings to retain the PITs for up to 295 days. Previous studies imbedded larger 12 × 2 mm PIT tags (Buhlmann and Tuberville 1998) or 10 × 2.1 mm tags (Camper and Dixon 1988) into turtles. The smaller 9 × 2.2 mm tag allowed me to embed tags into hatchling turtles, apparently without negative effects, although I cannot identify the cause of deaths for some tracked turtles.

The finding that 59% of tagged individuals were never relocated and 77% were lost before spring emergence may be attributed to five possibilities. Hatchlings may have moved beyond my search area, either on land or into the ocean. Thick vegetation hampered effective searching, either by making some areas impassable to me or by deflecting the antenna from effectively scanning some areas. Hatchlings may have dug deeper than the effective read range of the antenna. Also, marked hatchlings may have been killed by predators and carried away. Tags found with no visible hatchling remains were possibly shed from live individuals.

Compared to a radio-telemetry system, the PIT tag system is less expensive per animal (ca. US $6.25/ tag vs. ca. US $200/ transmitter) but more expensive for receivers and antennas (ca. US $4500 vs. ca. US $1200). Marking a large number of hatchlings, especially given normally high predation rates, is prohibitively expensive with radio transmitters, but may be possible with PIT tags. PIT tags are smaller and lighter than radio transmitters (0.067 g vs. 0.23 g) which may be important if attachment weight may alter the behavior of tagged animals. Adhesives for transmitters may affect normal shell growth in young turtles and the recommended transmitter weight is not more than 10% of the host animal (Beaupre et al. 2004). The average weight of terrapin hatchlings in Jamaica Bay is 6.7 g (N = 74). Small radio transmitters typically having lifespans of days to weeks are a viable option for short-term tracking studies. However, PIT tags weighing 1% of the host hatchling have indefinite lifespans, perhaps making it possible to track hatchlings into maturity. Unlike radio transmitters, PIT tags can only be detected from a small range. A distinct disadvantage of the handheld antenna is the potential need for a researcher to search large areas that may be covered by thick vegetation. It is also possible to confirm predation on PIT-tagged animals via the presence of tags in predator scats because PIT tags should survive predation events. Known latrine sites as well as individual scats can be scanned for tags, which would indicate predation events.

There is little information regarding behavior for the young of many reptiles. This is especially true with *Malaclemys* and *Terrapene* hatchlings, both of which have been reported to overwinter on land (Capitano 2005; Draud et al. 2004). Therefore, identification of critical habitat for both terrestrial and aquatic turtles that may overwinter on land is necessary for direct effective management.

Acknowledgments.—I thank Biomark for generously loaning equipment for the field trial and The National Park Service Jamaica Bay Institute, American Museum of Natural History Lerner Gray Fund for Marine Research, and the South Shore Audubon Society for financial support. Russell Burke, Alex Kanoniak, Ceasar Rahman, and the diamondback terrapin research team collected hatchlings and aided in tagging.

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