No Difference in Short-term Temporal Distribution of Trapping Effort on Hoop-net Capture Efficiency for Freshwater Turtles

Donald J. Brown[1,*], Ivana Mali[1], and Michael R.J. Forstner[1]

Abstract We investigated the influence of trapping duration on freshwater turtle captures using baited hoop-nets. We trapped 9 ponds in the Lower Rio Grande Valley and 6 ponds in the Lost Pines ecoregion areas of Texas in the summer of 2010 using high-intensity, short-duration trapping (40 traps/1 day) and low-intensity, longer-duration trapping (10 traps/4 days). We found that the number of captures was not different between sampling schemes. However, the mean capture rate was twice as high after the first day of low-intensity trapping. This study showed that researchers seeking to maximize captures per-unit-effort (CPUE) should focus on the least time-intensive, labor-intensive, and expensive way to complete the trapping effort, rather than short-term temporal distribution of trapping effort.

Introduction

Estimation of demographic components (e.g., population size and survivorship) is fundamental to many population-monitoring programs (Buckland et al. 2000, Campbell et al. 2002). Capture-recapture methods are widely used and are often the most accurate means for estimating demographic components (Amstrup et al. 2005). These methods rely on capturing and marking individuals, and then recapturing the individuals during later sampling periods. Because of time, money, and personnel constraints, researchers often seek to maximize capture efficiency (Gamble 2006) through determining when, where, and how to best sample a population to optimize captures per-unit-effort (CPUE), while minimizing biases that skew estimates (Thompson 2004).

Many techniques have been developed for sampling aquatic turtle populations (Lagler 1943, Vogt 1980). Hoop-nets remain one of the most common turtle-trapping devices used today (Davis 1982, Thomas et al. 2008). They are logistically superior to most other passive trapping devices (i.e., basking traps, fyke nets, and trammels) because they are lightweight, easily portable in large numbers, require only one worker, and provide easily quantifiable results. Several factors can influence hoop-net capture rates and affect sex- and size-specific capture probabilities, including trap size, trap placement, and type of bait (Cagle and Chaney 1950, Thomas et al. 2008). In addition, capture rates may change with trapping effort and duration.

The purpose of this study was to investigate the influence of trapping duration on turtle capture rates using baited hoop-nets. It is usually less expensive

[1]Department of Biology, Texas State University-San Marcos, 601 University Drive, San Marcos, TX 78666. [*]Corresponding author - db1300@txstate.edu.

and time-consuming to conduct high-intensity trapping for short periods of time, as opposed to low-intensity trapping for longer time periods. However, this may result in fewer captures from a given population if highly variable abiotic conditions (e.g., temperature or precipitation) affect activity patterns and thus captures (Cagle 1950, Crawford et al. 1983), if the water body is large and turtles utilize different areas on different days (Bodie and Semlitsch 2000, Brown and Brooks 1993), or if captures increase as turtles become accustomed to presence of the traps (Vogt 1980). Alternately, high-intensity trapping may increase captures by increasing the concentration of bait scent in the water, or both trapping schemes may produce comparable CPUE results.

Field-Site Description

We conducted this study in two ecoregions of Texas, the Lower Rio Grande Valley (LRGV), and the Lost Pines. We trapped freshwater ponds in Cameron, Hidalgo, and Willacy counties in the LRGV, and Bastrop County in the Lost Pines. Ponds in the LRGV were typically bordered by reeds, primarily *Typha* spp. (cattails) and *Arundo donax* L. (Giant Cane). Ponds in the Lost Pines were typically surrounded by *Pinus taeda* L. (Loblolly Pine), *Juniperus virginiana* L. (Eastern Red Cedar), and *Quercus stellata* Wangenh (Post Oak) trees. Pond area ranged from 0.08 ha to 8.2 ha (mean = 2.01 ha) across all sites.

Two freshwater turtle species are found in the LRGV that were not captured in this study, *Kinosternon flavescens* (Agassiz) (Yellow Mud Turtle) and *Chelydra serpentina* (L.) (Eastern Snapping Turtle). Based on our extensive freshwater turtle work in the LRGV since 2008, densities seem to be low for both species (Dickerson et al. 2009). In addition to turtles, we routinely captured *Nerodia rhombifer* (Hallowell) (Diamond-backed Watersnake) and *Siren intermedia texana* Goin (Rio Grande Lesser Siren) in LRGV ponds. Two of the LRGV ponds also contained *Alligator mississippiensis* (Daudin) (American Alligator) during this study.

Two freshwater turtle species are found in the Lost Pines that were not captured in this study, the Yellow Mud Turtle and *Pseudemys texana* Baur (Texas Cooter). We did not capture other aquatic reptile fauna in the Lost Pines during this study, but have observed large numbers of *Nerodia erythrogaster transversa* (Hallowell) (Blotched Watersnake) and several *Agkistrodon piscivorus leucostoma* (Troost) (Western Cottonmouth) at the same ponds during other investigations.

All ponds sampled contained fish populations. We captured *Lepomis megalotis* (Rafinesque) (Longear Sunfish) and *Ictalurus punctatus* (Rafinesque) (Channel Catfish) in hoop-nets in the Lost Pines. We did not specifically identify fish species in the LRGV captured during this project. We know that one pond had been previously stocked with *Micropterus salmoides* (Lacepède) (Largemouth Bass), and these were occasionally seen in traps. At several of the sites in the LRGV, we observed *Cichlasoma cyanoguttatum* (Baird and Girard) (Rio Grande Cichlid) alongside abundant introduced *Oreochromis aureus* (Steindachner) (Blue Tilapia), *Hypostomus* spp. (suckermouth catfish), and *Cyprinus carpio* L. (Common Carp) in past years. Among notable native fishes, we captured several *Awaous banana* (Valenciennes) (River Goby) at one of the LRGV sites in 2008 and 2009.

The majority of ponds were located on preserves or state parks. One pond in the LRGV was located on a private ranch stocked with cattle.

Methods

We trapped 9 and 6 ponds in the LRGV and Lost Pines, respectively. Trapping sites were chosen based on access and security from trap-theft. We conducted short-term, high-intensity trapping by placing 40 hoop-nets in each pond for 1 day (23–25 hours). We conducted longer-term, low-intensity trapping by placing 10 hoop-nets in each pond for 4 days (94–97 hours). Ponds were randomized for initial trap intensity, and were re-trapped with opposite intensity after a 33- to 55-day cool-down period. The goal of performing both sampling schemes at each pond was to mitigate the influence of inherent population-size differences on study results.

We spaced traps evenly along the edges of ponds, tying them to reeds or other vegetation at 5- to 15-m (40 traps/1day) or 20- to 60-m (10 traps/4 days) intervals. We marked individual trap locations with a portable GPS unit (Map60, Garmin Ltd., Olathe, KS) to ensure that the same area was trapped during the second trapping event at each site. We performed this study between 10 May and 13 July 2010.

We used 76.2-cm-diameter single-opening, single-throated, widemouth hoop-nets with a 2.54-cm mesh size and four hoops per net (Memphis Net and Twine County, Memphis, TN). Traps were kept taut using wooden posts connected to the first and last hoop. Two stretcher posts were used for each trap, located lateral to the mouth opening. We baited all traps with sardines in non-consumable containers containing holes for scent escape. Fresh bait was used for high-intensity trapping, and bait was refreshed every 2 days for low-intensity trapping. We placed flotation devices between the two middle hoops to prevent drowning and to keep traps parallel with the water's surface. We inspected traps for holes and damage daily.

We measured carapace length and width, plastron length and width, and body depth of captured individuals to the nearest 1.0 mm using tree calipers (Haglof, Madison, MS). Turtles were weighed to the nearest 10 g using spring scales (Pesola, Baar, Switzerland), and individually marked by notching the carapace using a rotary tool (Dremel, Racine, WI). We determined sex using secondary sexual characteristics (Conant and Collins 1998, Gibbons and Lovich 1990).

We used a paired randomization test with 10,000 iterations to determine if total number of captures differed by sampling-duration scheme (i.e., 40 traps/1 day or 10 traps/4 days), using pond as the sampling unit. The P-value obtained was the proportion of trials resulting in a capture difference between duration schemes as great or greater than the one obtained (Sokal and Rohlf 1995). We then re-performed the test using only *Trachemys scripta elegans* (Wied-Neuwied) (Red-eared Slider) captures, which represented 79.5% of total captures. We removed captures for individuals captured more than once within a sampling period ($n = 1$). We treated recaptures between sampling periods as new individuals ($n = 2$). We conducted the statistical analyses using R 2.7.2 (The R Foundation for Statistical Computing, Vienna, Austria).

Results

We captured 65 turtles while conducting high-intensity trapping and 62 turtles conducting low-intensity trapping (Table 1). In the LRGV, we captured 78 Red-eared Sliders and 19 *Apalone spinifera emoryi* (Agassiz) (Texas Spiny Softshell). In the Lost Pines, we captured 23 Red-eared Sliders and 7 Eastern Snapping Turtles. Number of captures between the two trapping schemes was not different for the complete data set ($P = 0.437$), or when only Red-eared Sliders were included ($P = 0.429$). For low-intensity trapping, we obtained 50% of total captures on the first day of trapping, 14.5% on day 2, 22.6% on day 3, and 12.9% on the fourth day of trapping.

Discussion

We found that short-term high-intensity trapping yielded similar total captures to longer-term low-intensity trapping (Table 1). Therefore, at least for Red-eared Sliders, when the goal is to maximize CPUE, the least time-intensive, labor-intensive, and expensive way to complete the trapping effort should be primary considerations, rather than temporal distribution of trapping effort. This study also showed that total effort matters. We captured 52.3% more turtles in the 40 traps/1 day sampling scheme than in the first day of the 10 traps/4 days sampling scheme. However, from the perspective of capture-rates, 10 traps/1 day was more effective than 40 traps/1 day, with mean capture-rates of 0.21 and 0.11 turtles per trap day, respectively.

Table 1. Number and captures per-unit-effort (CPUE) of freshwater turtles captured in baited hoop nets using short-term, high-intensity trapping and longer-term, low-intensity trapping at 9 ponds in the Lower Rio Grande Valley (LRGV) and 6 ponds in the Lost Pines areas of Texas. Ponds were trapped with both sampling schemes to mitigate the influence of inherent population size differences on results.

Study area	40 traps/1day total	10 traps/4 days total	Day 1	Day 2	Day 3	Day 4
LRGV	0	6	0	1	4	1
LRGV	1	3	2	0	0	1
LRGV	6	6	0	1	3	2
LRGV	8	18	16	1	0	1
LRGV	2	3	1	1	1	0
LRGV	2	5	0	3	1	1
LRGV	1	3	2	0	1	0
LRGV	13	7	4	0	3	0
LRGV	13	0	0	0	0	0
Lost Pines	2	4	3	0	0	1
Lost Pines	6	1	1	0	0	0
Lost Pines	1	1	1	0	0	0
Lost Pines	3	4	1	2	0	1
Lost Pines	3	1	0	0	1	0
Lost Pines	4	0	0	0	0	0
Sum	65	62	31	9	14	8
CPUE	0.108	0.103	0.207	0.06	0.093	0.053

Besides maximizing CPUE, these results have important implications for study repetitions and long-term monitoring of freshwater turtle populations. First, it is probably more important to focus on repeating observations within the same general time-frame (e.g., season, month, or week) than to focus on equal temporal distribution of sampling effort. Activity patterns and captures have been shown to vary substantially by season (Brown and Brooks 1993, Ream and Ream 1966, Thomas et al. 1999). Secondly, capture rate might not be an appropriate metric for assessing change if total effort is not repeated. This topic warrants further study, as it is not always tenable to exactly repeat trapping effort every year in long-term monitoring programs. Based on this study, the mean capture rate was similar between sampling schemes when 50% of the effort was completed in the low-intensity trapping (mean capture rate = 0.13 turtles per trap day). Therefore, when using capture rate as a proxy for abundance differences, we recommend that trapping effort does not vary by more than 50% due to the risk of concluding artificial abundance differences among sites or years.

Finally, we found that capturing no turtles in one sampling period did not mean that the habitat wasn't suitable. For 3 of the ponds, we captured turtles in only 1 sampling period. In one of these ponds, a 5.3-ha oxbow lake in the LRGV, we captured no turtles during the 4-day low-intensity trapping event, but captured 13 during the high-intensity event. Given that this water body is located in a highly urbanized area, we speculate that most of the turtles were present in the pond during the low-intensity trapping, but were simply not near enough to the traps to be attracted by the scent. This result is contrary to our expectation that longer-term trapping would be a more efficient trapping scheme in larger water bodies, and may indicate a bait-scent-concentration effect. However, because we captured 42 turtles during both sampling schemes in the 6 largest ponds (1.5–8.2 ha), it is not apparent that increasing bait scent in larger water bodies attracts more turtles.

Acknowledgments

We thank J.R. Dixon, J. Tokarz, J. Barnett, M. Lindsay, and M. Vandewege for assistance in checking traps. We are indebted to M. Pons, Jr. and the Nature Conservancy of Texas for allowing us to reside at Southmost Preserve and use the preserve for this study. Thanks to the Boy Scouts of America, Texas Parks and Wildlife Department, and private agencies and landowners for allowing us to trap turtles on their properties. Individuals and funding were through the Texas Parks and Wildlife Department (Permit No. SPR-0102-191). This research was approved by the Texas State University-San Marcos Institutional Animal Care and Use Committee (Protocol No. 0715-0428-07).

Literature Cited

Amstrup, S.C., T.L. McDonald, and B.F.J. Manly. 2005. Handbook of Capture-recapture Analysis. Princeton University Press, Princeton, NJ. 313 pp.

Bodie, J.R., and R.D. Semlitsch. 2000. Spatial and temporal use of floodplain habitats by lentic and lotic species of aquatic turtles. Oecologia 122:138–146.

Brown, G.P., and R.J. Brooks. 1993. Sexual and seasonal differences in activity in a northern population of Snapping Turtles, *Chelydra serpentina*. Herpetologica 49:311–318.

Buckland, S.T., I.B.J. Goudie, and D.L. Borchers. 2000. Wildlife population assessment: Past developments and future directions. Biometrics 56:1–12.
Cagle, F.R. 1950. The life history of the Slider Turtle, *Pseudemys scripta troostii* (Holbrook). Ecological Monographs 20:31–54.
Cagle, F.R., and A.H. Chaney. 1950. Turtle populations in Louisiana. American Midland Naturalist 43:383–388.
Campbell, S.P., J.A. Clark, L.H. Crampton, A.D. Guerry, L.T. Hatch, P.R. Hosseini, J.J. Lawler, and R.J. O'Connor. 2002. An assessment of monitoring efforts in endangered species recovery plans. Ecological Applications 12:674–681.
Conant, R., and J.T. Collins. 1998. A Field Guide to Reptiles and Amphibians: Eastern-central North America. Houghton Mifflin Company, New York, NY. 616 pp.
Crawford, K.M., J.R. Spotila, and E.A. Standora. 1983. Operative environmental temperatures and basking behavior of the turtle *Pseudemys Scripta*. Ecology 64:989–999.
Davis, D.E. 1982. CRC Handbook of Census Methods for Terrestrial Vertebrates. CRC Press, Boca Raton, FL. 424 pp.
Dickerson, B.D., A.D. Schultz, D.J. Brown, B. DeVolld, M.R.J. Forstner, and J.R. Dixon. 2009. Geographic distribution: *Chelydra serpentina serpentina*. Herpetological Review 40:448.
Gamble, T. 2006. The relative efficiency of basking and hoop traps for Painted Turtles (*Chrysemys picta*). Herpetological Review 37:308–312.
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.
Lagler, K.F. 1943. Methods of collecting freshwater turtles. Copeia 1943:21–25.
Ream, C., and R. Ream. 1966. The influence of sampling methods on the estimation of population structure in Painted Turtles. American Midland Naturalist 75:325–338.
Sokal, R.R., and F.J. Rohlf. 1995. Biometry: The Principles and Practice of Statistics in Biological Research. 3rd Edition. Freeman, New York, NY. 887 pp.
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.
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.
Thompson, W.L. 2004. Sampling Rare or Elusive Species: Concepts, Designs, and Techniques for Estimating Population Parameters. Island Press, Washington, DC. 429 pp.
Vogt, R.C. 1980. New methods for trapping aquatic turtles. Copeia 1980:368–371.