Effects of Bait Type, Bait Age, and Trap Hours on Capture Success of Freshwater Turtles

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Abstract - We trapped freshwater turtles using hoop nets and 3 different bait types along a short section of Oyster Creek, Fort Bend County, TX. Using a model-selection approach, we tested the effectiveness of different baits on capture success, taking into consideration the length of time the bait was in the water, time of day, and the number of hours for the set (trap hours). We had significantly more success when we used dry dog food and dry cat food than traditional canned sardine bait. Bait age and time of day when traps were checked had no influence on capture success. Contrary to our expectations, the number of captures decreased throughout the study. Our results suggest that turtle researchers should consider using alternative bait types to maximize trap effort. However, there was a significant interaction between canned sardines and bait age for *Trachemys scripta elegans* (Red-eared Slider) captures, suggesting that canned sardines should be replaced often. In addition, more research is needed to test capture success when baits are older than one day.

Introduction

Selection of appropriate sampling methods is essential for monitoring demographic components of wildlife populations (Buckland et al. 2000). For passive sampling techniques, researchers require a trap method that maximizes efficiency and minimizes potential biases. In the case of freshwater turtles, baited hoop traps are commonly used to collect a wide variety of species (Brown et al. 2011, Davis 1982, Gamble 2006, Plummer 1979). Researchers place hoop traps in shallow waters over multiple days and position bait under water in hollow containers that allow scent dispersal but prevent bait consumption (Browne and Hecnar 2005, Lagler 1943, Mali et al. 2012, Nall and Thomas 2009). Multiple factors including bait preferences, re-baiting frequency, trap placement, and trap duration can potentially influence capture success (Brown et al. 2011, Frazer et al. 1990, Thomas et al. 2008, Voorhees et al. 1991).

Bait preferences can vary among species and also between populations of freshwater turtles (Ernst 1965, Jensen 1998, Thomas et al. 2008, Voorhees et al. 1991). For example, Ernst (1965) systematically tested 6 types of bait and concluded that canned sardines were most effective for *Chrysemys picta* Schneider (Painted Turtle) and *Sternotherus odoratus* Latreille (Eastern Musk Turtle), and fresh fish and fowl entrails attracted the most *Chelydra serpentina* L. (Snapping Turtle). Jensen (1998) observed a preference for fresh fish by *Macrochelys temminckii* Troost (Alligator Snapping Turtle), while *Trachemys scripta elegans* Wied-Neuwied (Red-eared

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Slider) preferred fresh chicken entrails. Voorhees et al. (1991) succeeded in capturing 9 species of freshwater turtles using a jelly-like bait composed of fresh mussels, canned creamed corn, or canned sardines. Thomas et al. (2008) found that freshwater turtles preferred frozen fish and canned mackerel to creamed corn. In addition, Mali et al. (2012) found that switching bait during consecutive years of trapping increased per-unit-capture effort, and that turtles do not express trap-shy behavior because of a negative olfactory response associated with the hoop traps.

Hoop nets are commonly checked for captures once a day, and bait is replaced every other day due to limitations in time, money, and personnel, as well as site remoteness (Bluett et al. 2011, Mali et al. 2012, Thomas et al. 2008). Researchers have reported that fresh bait or partially decomposed bait is the most effective (Ernst 1965, Lagler 1943, Legler 1960). However, different bait types could have different decomposition and scent-dispersal rates. Traps could potentially attract more turtles when the bait is fresh (i.e., recently placed in the trap), and the traps containing old bait (i.e., bait that has been in the trap for the longer period of time) might generate fewer captures. Yet, we found only one published study that specifically tested the influence of bait age on capture success. Bluett et al. (2011) found that fresh baits were more effective at attracting turtles than one-day-old baits. However, in the Bluett et al. (2011) study, turtles were able to consume the bait; therefore, bait consumption would likely lead to lower capture rates from day-old baits because less bait was available as an attractant to promote new captures.

We designed our experiment to test the effect of 3 different baits and of bait age on turtle-capture rates by varying the length of time the bait was in the water. To our knowledge, the use of dry dog or cat food has not been previously reported in the peer-reviewed literature, but anecdotally we know commercial turtle trappers use them. We also considered 2 additional parameters that could influence capture success: the time of day the traps were checked and trap hours (the number of hours since the traps were set). Although not previously reported, different capture rates at different times of the day (e.g., morning vs. afternoon) could provide useful insights on turtle-foraging activity. In addition, Vogt (1980) hypothesized that captures may increase with an increase in trap hours because turtles become accustomed to the presence of the traps.

Field-Site Description

We undertook our study along a short section of Oyster Creek approximately 375 m downstream from the Williams Trace Bridge within the corporate limits of Sugar Land, Fort Bend County, TX. The creek is dammed, has a generally southwest–northeast course, and has suburban housing along both sides at a distance of 50–100 m from the water. The creek is lightly used for recreation, but power craft are prohibited. Low brush and a few short (<3 m) trees grow immediately along the bank; within a meter of the water, the ground is covered with lawn grasses that are regularly mowed. Emergent vegetation covers the water surface within ~1 m out from the bank, and floating algal mats extend out to a maximum of ~2 m. The creek

is ~45 m wide at the study site, and the mud bottom slopes gently to a maximum depth of ~2 m.

During the study, the weather was typical of the Texas coastal plain in mid-July: mornings were generally clear to partly cloudy, with clouds increasing during the day. There was light rain after dark on day 2 and in the late afternoon of day 6. High and low air temperatures, as reported by the US Weather Bureau at Houston Intercontinental Airport (~47 km NE of the study site), averaged 34 °C and 23.4 °C, respectively. Sunrise and sunset averaged 0630 and 2025 respectively, during the study period, and a full moon occurred the night of day 3.

Methods

We conducted the study 10–16 July 1995 using 3 homemade hoop traps constructed of 2.54-cm-mesh galvanized poultry netting. The traps were 122 cm long x 50 cm diameter with no bracing. Each end was fitted with a funnel, made of the same netting, that extended 25 cm into the trap and terminated in a 20 cm x 10 cm oval opening. We set the traps with the longer axis of the opening parallel with the orientation of the stream. Each trap had a 265-cm^{-3} bait can (a perforated can with a perforated cover) suspended by a wire in the middle of the trap.

We tested 3 types of bait: commercial dog food, store-brand dry cat food, and canned sardines packed in vegetable oil. The dog food was ~10 mm^{-2} cubes containing ground yellow corn, meat, bone meal, and a variety of other ground grains. The cat food was shaped like crosses, with 4-mm arms and the same ingredients as the dog food, except that it also contained poultry and fish by-products. For dog- and cat-food baits, we filled cans halfway with dry food to allow expansion following water absorption; we put 2 fish in each of the sardine-baited cans.

We set 3 traps, each with a different bait, approximately 25 m away from each other, and every trap was baited with a different bait type each day. We moved the traps along the 50-m site each day; however, due to the short total length, we treated the entire area as one location. We inspected all traps on each run and removed any trapped turtles. The time between runs varied by day: 1 hour on days 1 and 6, 2 hours on days 2 and 4, and 4 hours on days 3 and 5. We varied the bait-renewal interval at random, without regard to run interval, to test the effectiveness of the baits in water for various lengths of time. We left traps undisturbed between the last run in the evening (as late as 2230) and the first run in the morning (as early as 0630). We measured and weighed all captured specimens, sexed them using secondary sexual characteristics (Conant and Collins 1998, Gibbons and Lovich 1990), and released them near the original capture site.

We created a model that assessed bait type, bait age, time of day, and trap hours with respect to number of captures per trap per run. We defined bait age as the interval (in hours) between the time the bait was placed in the trap and time the trap was checked, and trap hours as the interval (in hours) between the time the trap was first placed in the water and the time the trap was checked. We also included an interaction between the bait type and bait age because different bait types could have different decomposition rates and scent-dispersion rates.

We created a generalized linear model (GLM) with Poisson error distribution using all explanatory variables. To determine which variables were important for capture success, we had the options of using either a selection criterion (e.g., Akaike information criterion) or the hypothesis-testing approach (*Z*-statistic; Zuur et al. 2009); we chose the latter. To do the hypothesis-testing, we dropped each explanatory variable and calculated the difference between the deviance of the new model and the deviance of the original model. We then compared the difference to a chi-square distribution. If the reduced model was not significantly different from the original model, we removed the term from the model. We inferred statistical significance at $\alpha = 0.05$ and conducted statistical analyses using program R 2.7.2 (The R Foundation for Statistical Computing, Vienna, Austria).

Results

The three traps were continuously active for 143 hours, and we checked each trap on 52 occasions. Number of runs per day per trap was $n = 5–15$ (excluding the last day, when we pulled the traps out of the water after the first run in the morning) and bait age ranged 1–18 hours. We removed a 2-hour period (2 trap runs) and 2 captured Red-eared Sliders from the calculations because 1 of the traps was incorrectly baited. Out of 154 trap runs, 73 (47%) traps were empty, 54 (35%) captured 1 turtle, and the remaining 27 (18%) traps captured multiple specimens. We recorded a total of 126 captures during the 6-day period: 68 Red-eared Sliders, 55 Common Musk Turtles, 2 *Pseudemys texana* Baur (Texas Cooter), and 1 *Apalone spinifera pallida* Webb (Pallid Spiny Softshell) (Table 1). We captured a total of 52 turtles in traps containing cat food, 49 in traps containing dog food, and 25 in traps containing sardines. The two pet foods were also equally attractive to the two main species: 24 Red-eared Sliders and 24 Eastern Musk Turtles responded to dog food, and 27 Red-eared Sliders and 24 Eastern Musk Turtles responded to cat food. We captured 1 Texas Cooter in a trap with each pet food. Seventeen Red-eared Sliders, 7 Eastern Musk Turtles, and the Pallid Spiny Softshell were collected with sardines.

Red-eared Slider

The models with and without the time-of-day parameter did not show significant difference ($\chi^2 = 0.03$; df = 1; $P = 0.87$); therefore, we omitted this variable. Our final model included bait type, bait age, their interaction, and trap hours as explanatory

Table 1. Freshwater turtle captures from Oyster Creek, Fort Bend County, TX, using 3 different bait types. Three hoop-net traps were set 10–16 July 1995, resulting in143 trap hours. Each trap was set with different bait and checked on 52 occasions.

	Species			
Bait type	Red-eared Slider	Eastern Musk Turtle	Texas Cooter	Pallid Spiny Softshell
Cat food	27	24	1	0
Dog food	24	24	1	0
Canned sardine	17	7	0	1
Total	68	55	2	1

variables, with cat-food bait set as the baseline (Table 2). The number of captures decreased the longer the traps were in the water ($P < 0.01$). There was no difference in capture rate between cat food and dog food bait ($P = 0.22$). There was a significant interaction between sardine bait and bait age ($P = 0.02$).

Eastern Musk Turtle

The models without the following parameters did not show significant difference when compared to the full model: interaction between bait type and bait age ($\chi^2 = 0.08$, df = 2; $P = 0.96$), bait age ($\chi^2 = 0.0004$, df = 1; $P = 0.98$), and time of day ($\chi^2 = 3.15$, df = 1; $P = 0.08$). Therefore, the final model included only bait type and trap hours (Table 3). Sardine bait captured significantly fewer turtles than pet food baits ($P < 0.01$), and the number of captures decreased the longer the traps were in the water ($P < 0.01$).

Discussion

Our results suggest that dry pet foods were more effective in capturing the taxa involved in this experiment than were sardines canned in oil. Although canned sardines are the most commonly used bait among freshwater turtle researchers (Brown et al. 2011, Ernst 1965, Mali et al. 2012, Voorhees et al. 1991), in our study, sardines were comparatively less successful in capturing turtles. This result is contrary to the findings of Ernst (1965) and Thomas et al. (2008) that showed high preference for frozen fish or canned sardines in Red-eared Sliders and Eastern Musk Turtles. However, none of these studies used dry pet food in comparison. Therefore, if maximizing the trap effort is the goal, alternative baits should be considered. Interestingly, the significant interaction between canned sardines and bait age in the Red-eared Slider model suggests that when canned sardines are used, this bait type should be replaced often. In our experiment, we obtained more captures per run from the bait that was <6 hours

Table 2. The results of the Poisson generalized linear model for Red-eared Slider captures. * = significant at $\alpha = 0.05$.

Parameter	Estimate	95% CI	*Z*	*P*
Bait.dog	-0.55	+ 0.88	-1.23	0.22
Bait.fish	-1.41	+ 0.98	-2.84	0.01*
Bait.age	-0.23	+ 0.18	-2.59	0.01*
Trap.hours	-0.01	+ 0.01	-3.53	<0.01*
Bait.dog:Bait.age	0.13	+ 0.22	1.20	0.23
Bait.fish:Bait.age	0.25	+ 0.22	2.36	0.02*

Table 3. The results of the Poisson generalized linear model for Eastern Musk Turtle captures. * = significant at $\alpha = 0.05$.

Parameter	Estimate	95% CI	*Z*	*P*
Bait.dog	-0.01	+ 0.57	-0.03	0.98
Bait.fish	-1.24	+ 0.84	-2.89	<0.01*
Trap.hours	-0.02	+ 0.0001	-4.60	<0.01*

old (mean capture rate = 0.51) than the bait that was more than 6 hours old (mean capture rate = 0.20).

The time of day that the traps were checked did not affect capture success, suggesting that turtles were equally active throughout the day foraging for food. However, only 3 Red-Eared Sliders were trapped after 1830 and during the first run of the morning, suggesting that this species is not active overnight. Contrary to Vogt's (1980) findings, captures did not increase throughout the study. Several factors may explain our generally declining results over time. Although individuals could be trapped more than once, experienced turtles may be less likely to enter the traps than naïve animals. However, there is weak evidence in the literature that turtles become trap shy (Deforce et al. 2004, Mali et al. 2012, Ream and Ream 1966). The disruption caused at the trap sites by our checking the traps multiple times per day may also have made the trapping area increasingly less attractive to turtles. However, on average, we caught fewer turtles per hour for the 2-hour and 4-hour runs (1 and 1.4, respectively) than for 1-hour runs (2.57).

Our study was conducted on a relatively short temporal scale and with only 3 replicates; however, our frequent trap runs (total = 154) provide useful fine-scale information. Most important, our findings add to the existing literature on bait preferences of freshwater turtles, and suggest that alternative bait types should continuously be tested because bait preferences may vary among different populations and species. In addition, older bait did not fail to attract Eastern Musk Turtles, but it could be a reason for lower captures of Red-eared Sliders in the traps with canned sardines. The oldest bait in our experiment was 18 hours old. Considering that in most experiments the bait is replaced every 48 hours, it would be worth conducting a similar experiment on a longer time scale. For example, a study that would retain the bait for 48 hours while decreasing run frequency could increase our understanding of the importance of bait age in trapping freshwater turtles in contrast to the effect ofdisturbance at the trap site.

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