FINAL PERFORMANCE REPORT

FEDERAL AID GRANT NO. F12AF00589 (T-51-2)

A SURVEY OF THE FRESHWATER TURTLES OF EASTERN OKLAHOMA

OKLAHOMA DEPARTMENT OF WILDLIFE CONSERVATION

MAY 15, 2012 THRU DECEMBER 31, 2012

FINAL PERFORMANCE REPORT

STATE: Oklahoma **GRANT NUMBER:** F12AF00589 (T-51-2)

GRANT PROGRAM: State Wildlife Grant

GRANT TITLE: A Survey of the Freshwater Turtles of Eastern Oklahoma

GRANT PERIOD: May 15, 2012 thru December 31, 2012

OBJECTIVE:

Evaluate the movement of freshwater turtles in and out of hoop nets to better assess their population characteristics under wild conditions.

PURPOSE:

The purpose of this grant is to gather additional information supportive of research results under the original T-51-1 and F09AF00072 State Wildlife Grants (final report submitted June 2012) and to make final management recommendations to the ODWC to foster freshwater turtle conservation in Oklahoma.

INTRODUCTION:

Hoop traps are a common live-trap method to capture many species of freshwater turtles, including Red-eared Sliders, *Trachemys scripta* (Cagle 1950, Gibbons 1990, Riedle et al. 2009, Johansen 2011). There are various modifications to the basic design, but most of these traps function similarly (Plummer 1979, Gibbons 1990). The trap is held open by 3-4 fiberglass, wood, or metal hoops covered with mesh netting. One end, the back, is closed, while the front end is open with a funnel shape of the net leading to the interior of the trap. In place, the trap is stretched from front to back to keep it from collapsing. The idea is that turtles find the wide entrance, but after they have passed through the narrow funnel throat leading to the large interior of the trap, they have difficulty escaping from the trap backward through the funnel. While hoop traps have been used in numerous studies to capture turtles, the effectiveness of hoop traps to capture and then retain caught turtles has not been adequately quantified (but see Frazer et al. 1990, Brown et al. 2011). It is suspected that after turtles are captured, they can sometimes escape the trap (and even sometimes re-enter it).

Other, improved ways to more effectively capture aquatic turtles have been proposed and tested (Vogt 1980, Kennet 1992), but the turtle hoop, or funnel, trap is still the most common method (Davis 1982, Thomas et al., 2008, Riedle et al. 2008, 2009, Nall and Thomas 2009, Johansen 2011). Nevertheless, hoop traps have their drawbacks (Ream and Ream 1966, Frazer et al. 1990; Gamble, 2006). Turtles might tend to enter (or leave) hoop traps at specific times of the day or night, for some baits more than others, and depending on age, size or sex. Any such bias could alter the use of the hoop net by individual turtles and therefore bias any estimate of population density or age, size, or sex structure (Ream and Ream 1966, Koper and Brooks 1998, Reel et al. 2006, Riedle et al. 2008). We used a marked, confined population of *T. scripta* to evaluate the capture dynamics of hoop traps as verified from remote interrogation of PIT tagged subjects via a circular antenna mounted inside the trap.

METHODS:

Using hoop traps, we captured 50 adult *Trachemys scripta* in the early summer of 2012 from the vicinity of Lake Carl Blackwell, Payne County, Oklahoma. These were released into two adjacent 0.1-ha ponds together surrounded by a turtle-proof fence located below the dam of Lake Carl Blackwell at wildlife facilities of the Oklahoma Cooperative Fish and Wildlife Research Unit, Oklahoma State University, Stillwater. Each turtle was sexed, measured (maximum carapace length and body mass), and given a unique, permanent carapace mark to ensure individual recognition by filing a small notch into the dead outer edge of two marginal scutes (equivalent to trimming one's fingernails) with a Dremel™

(7.2V Cordless MultiPro) tool. Each turtle also was implanted with an 8.5 x 2.1-mm PIT tag (Passive Integrated Transponder; Biomark, Inc., Boise, Idaho) into the thigh of the right leg. The PIT tags were injected into the animal with a large-bore syringe and are widely used in wildlife studies with no ill effects (Gibbons and Andrews 2004). The shell notches were made in case a PIT tag failed or was expelled, but this did not happen in our study.

A circular racket antenna (18-cm inner diameter, Biomark, Inc., Boise, Idaho) was mounted inside each of two commercial hoop nets, 2.1 m in length and constructed of three 1.05-m diameter hoops covered with 2.5-cm square mesh (Memphis Net and Twine Company, Memphis Tennessee) so that the circle was perpendicular to the long axis of the trap and located exactly in the center of the hoop trap. The antenna was connected to a Biomark FS2001 reader, which was enclosed in a waterproof floating box, and powered by a 12-volt deep-cycle marine battery on the nearby shore. The reader was set to continuously scan for PIT tags, but with a 10-second delay for the same PIT tag so that the memory of the reader did not fill up too quickly if the same turtle were to set motionless inside the antenna. Tags were read inside the circular antenna and to a maximum of 2.08 ± 0.81 cm outside the antenna in the plane of the antenna (toward the sides of the hoop trap) and to a maximum of 12.24 ± 2.77 cm outside the antenna perpendicular to the plane of the antenna (toward the ends of the hoop trap; Cavalieri et al. 2011). Tags outside the antenna, or those inside the trap but outside the range of the antenna as described above, i.e., in the inside corners of the trap, were not read. When a tag was read, the individual turtle identity, date, and time were recorded. Hoop traps were set into shallow water at the edge of each pond, with part of the trap above water so that turtles could surface to breathe. With this setup, we were able to monitor individual turtles entering and exiting each hoop trap, the time of each entrance and exit, and how long each individual remained in the trap, subject to the limitations of the reading range of the antennas.

We monitored entrances, exits and residence times of turtles for 18 days in two sessions (6–21 July and 13–15 August). Traps were set always in the same place and were either unbaited or baited with sections of frozen fish from other Coop Unit projects. For bait, we used shad (*Alosa* sp), carp (*Cyprinus carpio*), or catfish (*Ictalurus furcatus*). Bait was suspended by a piece of twine on the hoop furthest from the opening of the net. Each day, usually at about 11:00 am, traps were pulled out of the water and any trapped turtles were identified, tallied, and released. Traps were rebaited with fresh food of the same or different type. Traps were then lowered back into the water. Data were periodically downloaded from the PIT tag reader to a computer. Field work was conducted under approved IACUC permit AS-12-5.

RESULTS:

Early on, one PIT tag reader failed and so the majority of the data (99.6% of tag reads) derive from only one hoop trap in one pond. We registered 1,965 tag reads and recorded 169 separate entrances into the trap of 30 turtles. Twenty turtles were neither registered by the PIT tag reader nor captured in a trap. On only 3 of the 18 days of monitoring did we fail to register at least one turtle inside a trap with the PIT tag reader; however, on 13 of the same 18 days, we failed to capture at least one turtle when the traps were pulled from the water. Actual capture success of turtles by the hoop nets was low: of 76 turtle-days (each turtle-day equals one subject per day known to be inside the trap from PIT tag readings), only 17 turtles (22.4%) were actually captured when the net was pulled out of the water.

We tested to see if entrances into the trap were random with respect to day and night. Daylight hours for each field day were defined from civil dawn to civil dusk (approximately ½ hour before sunrise and ½ hour after sunset) from custom calendars for Stillwater, Oklahoma. Expected number of trap entrances for day and night were adjusted for the average number of daytime and nighttime hours in a

24-h period. Turtles entered the trap significantly more than expected during daylight hours compared to nighttime hours (Chi-squared test of goodness-of-fit: $X_1^2 = 6.43$, $p = 0.011$). In fact, turtle activity (not just trap entrances) was greatest during the period 4:00 pm to 1:59 am, with a brief burst of activity also at 06:00—06:59 am (Fig. 1).

Surprisingly, turtles did not remain inside the trap for that long; mean residency time was 40.5 minutes (range 3.5–143.4 minutes, n = 169) for 30 turtles. For this calculation, we first removed tag read sequences of 1 minute or less. Even though our dry land trials with the antenna showed that tags were not read outside the perimeter of the trap, in actual use, it appeared as though tags were sometimes read outside the trap. It makes little sense to conclude that a single tag read or a sequence less than a minute represents an entrance and quick exit from the trap. These were probably tag reads outside the trap when turtles were pushing the net toward the bait and toward the inside antenna. Consequently, apparent residences less than one minute were assumed not to be true residences inside the trap and were not included in calculations of residence times. In a similar fashion, if a turtle inside the trap was not registered after 30 minutes, it was assumed to have exited the trap. Most, but not all, PIT tag reading sequences show the same turtle being registered every few seconds or minutes until there is a long interval until it is read again (hours or days). We suppose that turtles inside the trap move around substantially, trying to get at the bait or to escape from the trap, thus frequently moving within range of the antenna while they are inside the trap. Inter-read intervals for the same turtle were extremely biased toward short intervals (Fig. 2). In fact, 88.1% of all inter-read intervals were < 30 minutes. Most, but not all, inter-read intervals > 30 minutes were time elapsed outside the trap. For the 30 turtles that entered the trap and stayed inside for at least a minute, the average number of entrances over the 18 days was 5.6 (range 1–20) and the total duration averaged 238.9 minutes (range 4.6–1,158.0 minutes; Appendix A). Over the whole duration of the study, only one-half of the PIT-tagged turtles that ever entered a trap were actually captured when the trap was pulled from the water (15 of 30 turtles).

Of these 15 trapped turtles, 10 were last registered in the trap > 1 h before it was pulled from the water, so these turtles apparently remained undetected in the trap much longer than our arbitrary 30 minutes, at least on the day they were captured. Although females ($\bar{x}$ = 45.8 min, n = 8) remained in the trap slightly longer than males ($\bar{x}$ = 38.6 min, n = 22), this was not significantly different (t-test for unequal variances: $t_{8.36} = 0.39$, $p = 0.71$). Because trap durations were not different for the sexes, data for sexes were pooled. Larger turtles remained in the trap significantly longer than smaller ones (linear regression: $F_{1,28} = 9.38$, $p = 0.005$; Fig. 3).

Baited traps (140.5 h) attracted significantly more turtles for longer time than unbaited traps (260.5 h). Number of PIT tag reads was significantly greater than expected (number of expected reads calculated from proportion of baited and unbaited trap hours) for baited vs. unbaited hoop traps (X_1^2 = 851.9, $p < 0.001$; Table 1). Shad attracted significantly fewer turtles for less time than the other two baits and of those two, carp was the better ($X_2^2 = 238.8$, $p < 0.001$; Table 2).

DISCUSSION:

We conclude that turtles are not really "trapped" by hoop traps; individuals can rather freely enter and exit the trap at will. Baiting increases activity and increases entrances into the trap (but also exits from the trap). Even when our data indicate that a specific turtle is present inside the trap since the last time the trap was pulled from the water, the chance that turtle will remain there and be captured when the trap is pulled up the next day is only 22.4%. As such, using hoop traps to estimate population size or age/size/sex structure is potentially flawed because such a small portion of the population (or age, size or sex class) is actually sampled. Additionally, because larger turtles remained in the trap for longer time than smaller ones, larger turtles will be more likely to be captured when the trap is raised, thus biasing size class data toward larger turtles. Riedle et al. (2008) also found a bias toward larger turtles in their study of the alligator snapping turtle (*Macrochelys temminckii*).

There have been only a couple of previous studies of escape of turtles from hoop nets. Frazer et al. (1990) reported that 80% of painted turtles (*Chrysemys picta*) and 25% of snapping turtles (*Chelydra serpentina*) escaped hoop nets into which each had been placed individually for 24 hours. One female *C. picta* even escaped from one trap and entered another within the 24-h period. Brown et al. (2011) placed single marked *T. scripta* in various hoop nets and then checked the nets every 12 hours for ≥ 34 hours. Only 5 of 139 turtles (3.6%) escaped. Four were females and one was a juvenile; none were males. Probability of escape was significantly related to sex, but not body size.

Our data using remote interrogation of PIT tags indicate a much higher rate of escape in *T. scripta*. Using more hoop traps at a site and pulling them from the water more frequently to inspect their catch can help alleviate the problem of escaping turtles. For this species, traps should be pulled and inspected in the evening (about 7:00—9:00 pm) and again in the early morning (about 6:00—7:00 am). These same guidelines should be followed for trapping turtles to remove them from a site or to obtain research samples. Likewise, sampling turtles via hoop nets is not as reliable as once thought to estimate turtle activity on different days or seasons, or in different habitats; turtles were active and entered and left the trap through all but three of the 18 days, whereas turtles were not actually captured in the trap on 13 of those days. One can still use hoop traps for estimating population size; sex, age, or size structure; habitat use; and seasonal activity because actual trap captures should relate to turtle activity, but the error in the data will be large because the traps sample so ineffectively.

Turtle activity was significantly higher in the day than the night; peak activity was around 8:00 pm and 6:00 am. In his landmark study of *T. scripta*, Cagle (1950) observed the greatest activity of turtles in the early morning, based on trap captures. Smith and Iverson (2004) found the same. Baited traps attracted more turtles than unbaited ones, and of the baits we used, shad was inferior bait compared with carp and catfish, and carp was better than catfish. Most previous studies have used baited traps (Plummer 1979; Gibbons 1990). The effectiveness of different bait types has been investigated for various species of turtles (Ernst 1965; Voorhees et al. 1991; Jensen 1998; Thomas et al. 2008). Mali et al. (2012) suggested that trap success can be enhanced by switching baits and not relying on just one type of bait. Nall and Thomas (2009) did not find a difference in success with regard to how the bait was placed inside the hoop trap.

Twenty of the 50 turtles tagged and released into the experimental ponds were never registered nor captured in the hoop traps. It is possible some of these individuals died, but it is more likely that they spent their time in the other adjacent pond. Even though we continued to place and check the second trap daily for the entire duration of the experiment despite that its PIT tag reader failed, none of these turtles were captured. However, given that the traps capture such a small proportion of turtles, some of these turtles could have well entered and exited the second trap (without the PIT tag reader) without getting captured in the hoop trap.

Our method of registering residence in the hoop trap (and exact times of entrance and exit) was deficient because apparently the antenna occasionally read tags outside the trap (when turtles pushed the wall of the trap inward to try to get at the bait), and the antenna's range did not incorporate the entirety of the interior of the trap. Consequently, we discarded any tag read sequences < 1 minute and assumed that a turtle had left the trap after absence of a tag read > 30 minutes. Whereas these assumptions are logical and supported by the distribution of inter-read intervals of the entire dataset, they are still somewhat arbitrary and we suspect that in some cases a turtle was in the trap longer or shorter than we inferred from the data. A valuable next step would be to incorporate an underwater video camera time-synchronized with the PIT tag reader to directly document the trap residence times of turtles whose identity is known from its PIT tag. Such data would evaluate the assumptions we made to obtain residence durations and give us a much better picture of the capture dynamics of *T. scripta* in hoop traps.

MANAGEMENT RECOMMENDATIONS:

- Use multiple hoop traps at a site
- Check catch frequently, best times are ca. 8:00 pm and 6:00 am
- If possible, use underwater video camera time-synchronized with PIT tag reader
- Use baited hoop traps; carp is a good bait

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Table 1. Observed and expected number of tag reads for baited and unbaited hoop traps over 6 July–18 August 2012 in Payne County, Oklahoma.

	Unbaited	Baited	Sum
Number of hours	140.5	260.5	401.0
Observed number of tag reads	71.0	1893.0	1964.0
Expected number of tag reads	688.1	1275.9	1964.0

Goodness-of-fit $X_1^2 = 851.9$, $p < 0.001$

Table 2. Observed and expected number of tag reads for hoop traps baited with three species of fish over 6 July–18 August 2012 in Payne County, Oklahoma.

	Shad	Carp	Catfish	Sum
Number of hours	95.25	94.75	70.5	260.5
Observed number of tag reads	373.0	916.0	604.0	1893.0
Expected number of tag reads	692.2	688.5	512.3	1893.0

Goodness-of-fit $X_2^2 = 238.8$, $p < 0.001$

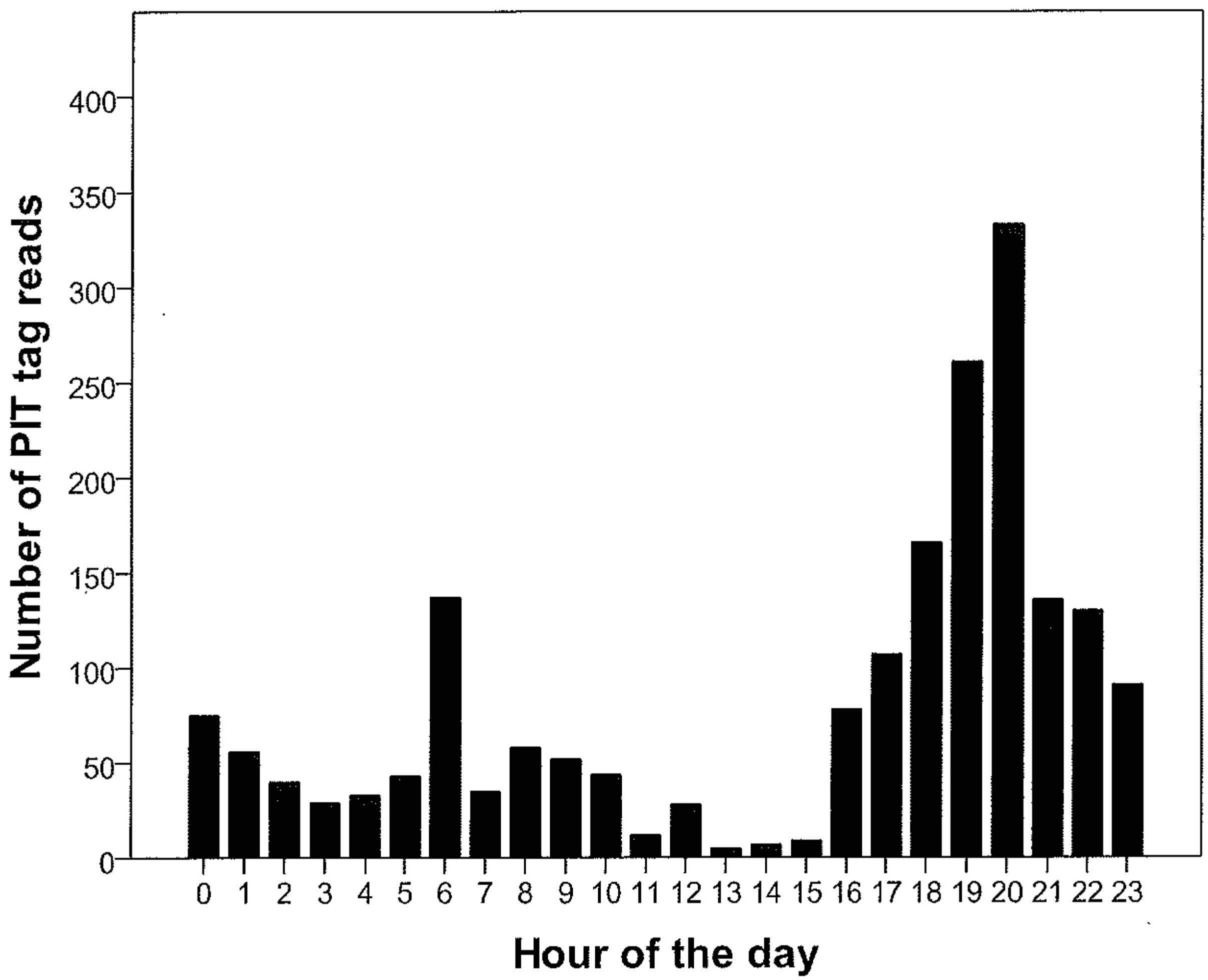

Figure 1. Frequency of all PIT tag reads over the average day.

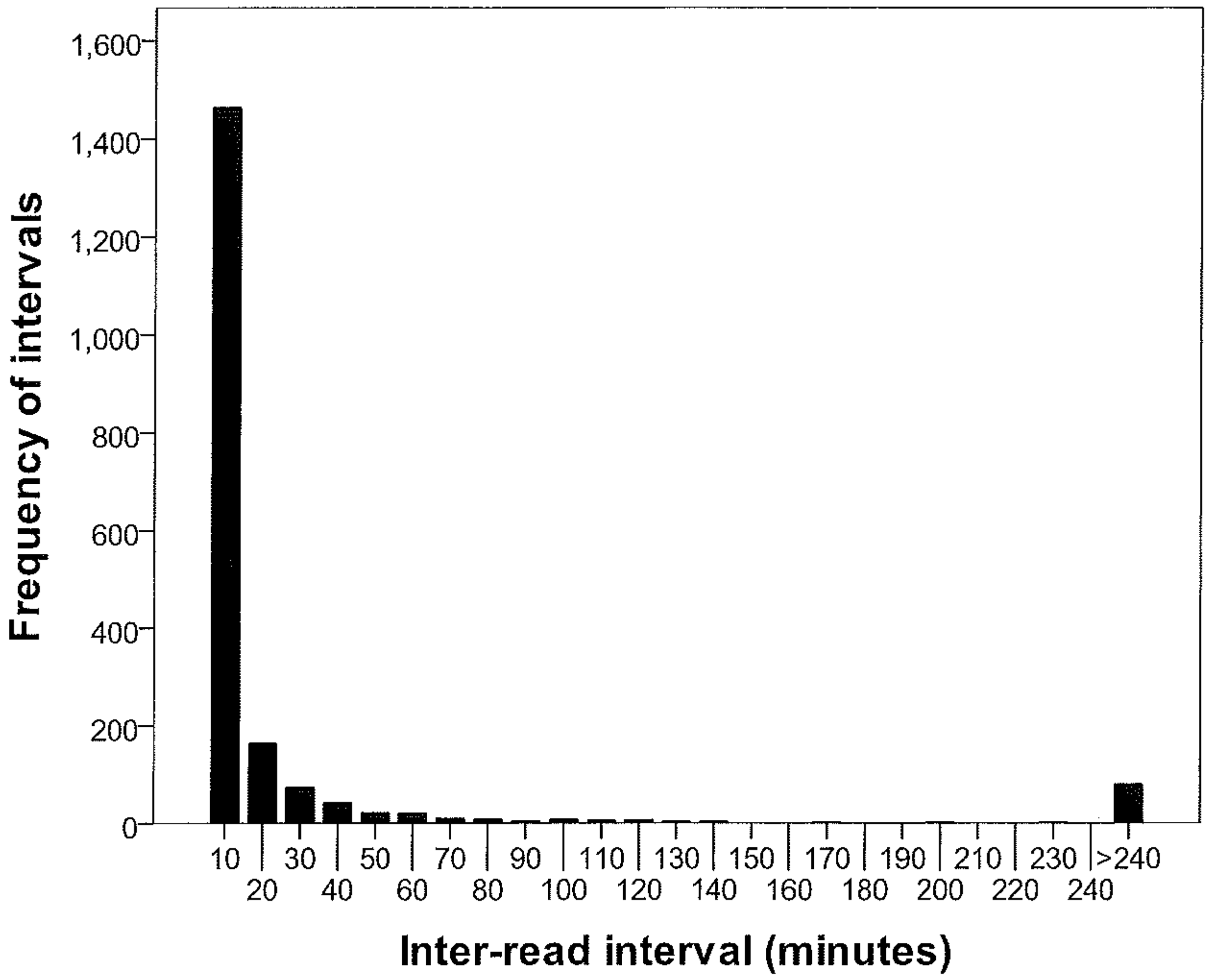

Figure 2. Frequency histogram of number of inter-read intervals for same turtle. Two-hundred forty minutes are four hours.

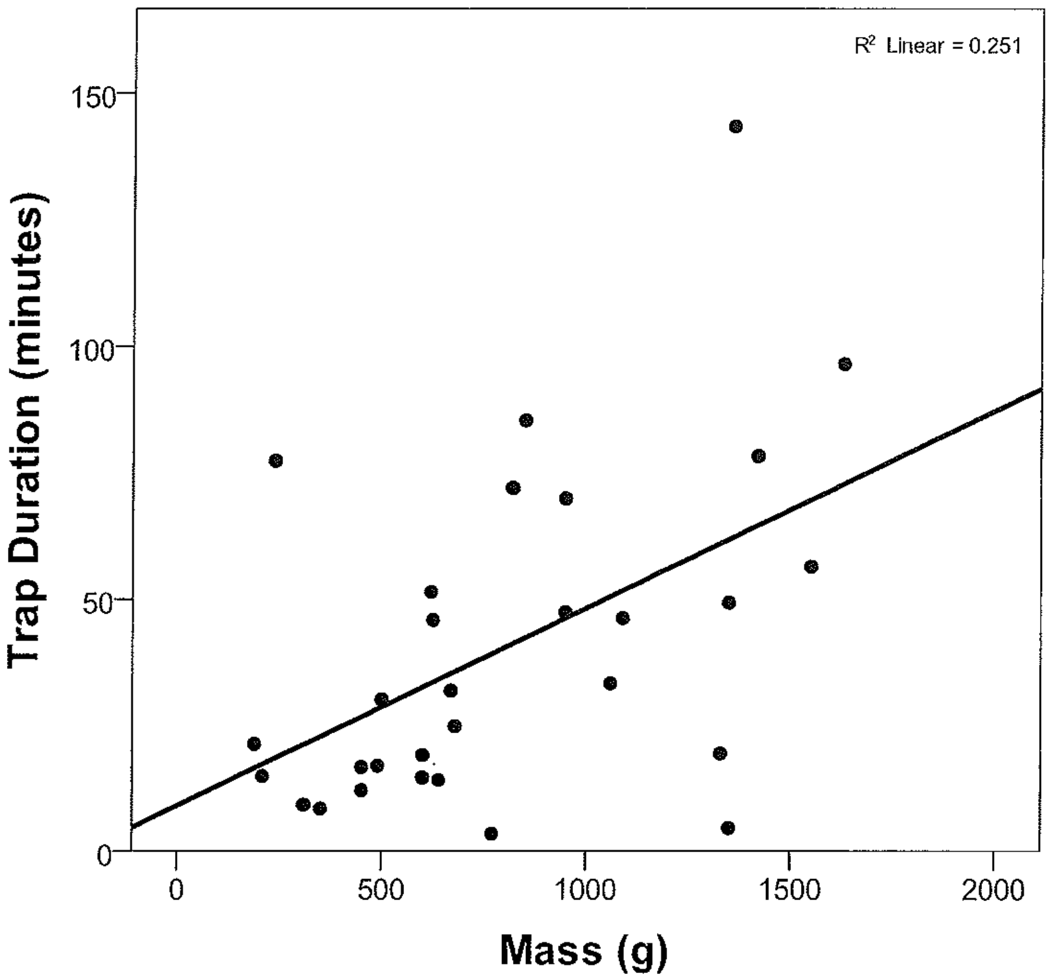

Figure 3. Time in trap as a function of turtle mass.

Appendix A. List by turtle (*Trachemys scripta*) of number of trap entrances, mean residence times, and total time in trap over 6 July–18 August 2012 in Payne County, Oklahoma, based on remote PIT tag interrogation using an internally mounted circular antenna.

PIT tag ID	Number of entrances	Mean minutes in trap	Total minutes in trap	Sex	Body Mass (g)
985.120006491422	5	19.4	97.0	F	1330
985.120006535078	1	69.9	69.9	M	950
985.120006596817	8	14.9	119.2	M	210
985.120008717880	1	8.5	8.5	M	350
985.120009206448	2	12.1	24.1	F	450
985.120010006272	4	77.4	309.5	M	240
985.120011183203	10	49.3	492.8	M	1350
985.120013029015	3	24.8	74.3	M	680
985.120013441420	16	19.1	305.1	M	600
985.120013585992	12	96.5	1158.0	F	1630
985.120013830785	7	9.2	64.6	M	310
985.120014168348	3	85.3	256.0	M	850
985.120015070582	9	47.4	426.3	M	950
985.120015126413	16	30.1	481.3	M	500
985.120016182891	2	16.7	33.4	F	450
985.120019404923	6	78.3	469.6	M	1420
985.120019556283	2	56.4	112.8	F	1550
985.120019561686	1	4.6	4.6	F	1350
985.120019788626	8	45.9	366.9	M	625

985.120020230344	1	17.0	17.0	F	490
985.120020232530	4	21.3	85.1	M	190
985.120020287486	7	72.0	503.8	M	820
985.120020292349	2	3.5	7.0	M	770
985.120020374434	3	31.8	95.5	M	670
985.120020387720	2	33.3	66.6	M	1060
985.120020733702	2	143.4	286.8	F	1360
985.120020737247	20	51.4	1028.3	M	620
985.120021024840	1	46.2	46.2	M	1090
985.120021135837	4	14.6	58.4	M	600
985.120024785861	7	14.1	98.9	M	640