SPACE USE PATTERNS OF THE COMMON SNAPPING TURTLE,

CHELYDRA SERPENTINA SERPENTINA,

AT THE HEADWATERS OF THE SAN MARCOS RIVER,

HAYS COUNTY, TEXAS

THESIS

Presented to the Graduate Council of
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For the Degree of

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By

Paul B. Aguirre, B.S.

San Marcos, Texas
May, 1999

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I thank the North Texas Herpetological Society for the scholarship I received from them in 1997. I thank Steve Reagan for his work in producing the GIS photos used in this paper. I thank Todd Swannack for helping me measure the depths of the lake. I thank my family and close friends who supported me in so many ways while here in San Marcos.

I also thank my soul mate, Rachel, for her love and support while overseas for 12 months – I love you.

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ABSTRACT

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Supervising Professor: Francis L. Rose

I investigated space use and activity patterns of the common snapping turtle, Chelydra serpentina serpentina, from March 1997 to May 1998 using radio-telemetry techniques. Home range areas were estimated and extensive overlap of home range areas were found among males, but not among females. Snapping turtles were found to be active both day and night, and throughout all seasons with periodic episodes of inactivity. Snapping turtles were not seen on land, nor were any seen basking. Aggressive behaviors were observed among snapping turtles, but it was not known if they were territorial or courtship encounters. Radio-telemetered turtles were tracked mostly in areas of slow-moving water, submerged below muddy substrates and beneath heavy vegetative cover.

INTRODUCTION

The common snapping turtle (Chelydra serpentina serpentina) is one of the largest of freshwater turtles of North America. Its geographic range extends from southern Canada to the Gulf of Mexico and the Atlantic Ocean to the Rocky Mountains with subspecies occurring from southern Mexico to Ecuador (Conant and Collins, 1991). As a habitat generalist, it occupies almost any freshwater habitat within its range (Ernst *et al.*, 1994).

Snapping turtles have been described as slow-moving in water (Stebbins, 1954), sedentary (Cagle, 1944; Ernst *et al.*, 1994), and as ambush predators (Carr, 1952; Stebbins, 1954; Feuer, 1971; Punzo, 1975). They have been found in areas of shallow water over a soft, muddy bottom associated with abundant aquatic vegetative cover (Feuer, 1971; Hammer, 1971; Ernst *et al.*, 1994). In laboratory experiments, Froese (1978) stated this species might utilize habitats opportunistically, provided that some cover is available.

Behavioral studies (Brown and Brooks, 1991; Cagle, 1944; Galbraith *et al.*, 1987; Hammer, 1969, 1971; Meeks and Ultsch, 1990; Obbard and Brooks, 1979, 1980, 1981; Pettit *et al.*, 1995; Ultsch and Lee, 1983) have been conducted on populations of snapping turtles in lakes, rivers, ponds and laboratories across the northern areas of the range. Alternatively, there have been few studies (Froese, 1974, 1978; Froese and Burghardt, 1975; Punzo, 1975) of populations throughout the remainder of its distribution, particularly towards the southern limits in the United States.

Since 1972, numerous studies have been conducted on populations of snapping turtles at Algonquin Provincial Park in southern Ontario, which lies within 150 kilometers of the northernmost known distributional limit. Obbard and Brooks (1981) found these turtles to be primarily diurnal and inactive with extensive home range overlap. They reported no evidence of territoriality or aggression, although there were reports of aggression in this species (Raney and Josephson, 1954; Hammer, 1969, 1971; Galbraith *et al.*, 1987). Galbraith *et al.* (1987) reported that snapping turtles were not territorial, and suggested that their spacing was, in part, due to aggressive interactions. Atmospheric basking in northern populations was found to be far more common than previously reported for this species (Obbard and Brooks, 1979). Obbard and Brooks (1979) offered that this might be due to observers overlooking basking turtles since they usually basked alone, and further suggested that this was a behavioral difference based on basking behavior observed among their study population and reports on southern populations. Hammer (1969) studied parameters of a population in a marsh area that ranged in size from 50 to 540 acres (124 to 1339 ha) in southern South Dakota. He reported that average movements were low, having a mean distance between recaptures of 0.57 miles (0.92 km). Studying a dense population of turtles (~59/hectare) in a small pond (0.81 ha) in Tennessee, Froese and Burghardt (1975) concluded that inter-population parameters were variable, and might be due to habitat characteristics.

I present initial behavioral information on a population of common snapping turtles at a southernmost limit of its range in the United States. Using radio-telemetry techniques, I studied space use patterns of turtles in a small, stable lake. Due to the characteristics of this lake, and previous observations of snapping turtle movements at this locality by local residents, I hypothesized that individual turtles would utilize most of this lake in their daily and seasonal activity patterns. Studies (Obbard and Brooks, 1981; Ultsch and Lee, 1983; Meeks and Ultsch, 1990) of northern populations found periods of dormancy in overwintering turtles. I suspected that turtles in my study population would remain active year-round due to the relatively constant warm water temperature of the lake, and the mild winter conditions at this location.

METHODS AND MATERIALS

Study Site

This study was conducted at Spring Lake, Aquarena Center in San Marcos, Hays County, Texas, from March, 1997 to May, 1998. Spring Lake is a 7.9 hectare reservoir, fed by some 200 artesian springs issuing from the Edwards Aquifer (Seaman, 1997), forming the headwaters of the San Marcos River. Due to this spring fed nature, water temperature at the spring sources is relatively constant at 21 ± 3 °C (Groeger *et al.*, 1997). For the purpose of this study, there are two discernible regions of Spring Lake - the main lake and the slough (Seaman, 1997) (Fig. 1).

The main lake is lotic, with water emptying into the San Marcos River over two spillways approximately 650 meters downstream from the main springs. Because of this flow, the surface of the main lake has little aquatic vegetative cover. The upper region of the main lake, from the main springs to about 450 meters downstream, has shorelines with steep banks that descend abruptly to water depths up to 6.5 m. The western shoreline is overgrown with dense mats of elephant ear (Colocasia esculenta) and abundant growths of floating fern (Ceratopteris thalictroides). The eastern shoreline is curbed in stone and concrete to 350 m downstream, forming the grounds and walkways of Aquarena Center. Aquarena Center is a former amusement park (Aquarena Springs), remnants of which include an underwater submarine theater, an

Fig. 1. Spring Lake Aquarena Center San Marcos, Texas

underwater fountain system and several boat docks along this shoreline. From 350 to 450 m downstream, the slough joins the main lake. Here the substrate is composed of soft mud and a bed of delta arrowhead (Sagittaria platyphylla). The substrate of the upper region of the main lake is covered with calcareous rocks along the shorelines with areas of fine, loose silt associated around the artesian springs. There are thick, tall beds of aquatic vegetation between the springs. An underwater fountain system is in a small inlet (35 m across), where water depth is less than one meter with a soft, muddy substrate and extremely dense growths of hydrilla (Hydrilla verticillata).

The lower region of the main lake, making up the remaining 200 m, is not as deep as the upper region and the shorelines are not as steep. Water depth along the shorelines is more shallow (<1 m), with a substrate of calcareous rocks and soft mud. Dense mats of elephant ear and water hyacinth (Eichhornia crassipes) grow along both shorelines, with thick mats of hydrilla throughout this region. Water empties into the river here, over two man-made spillways.

The second region of Spring Lake is the slough. The slough is a backwater area that receives water from ill-defined spring sources. There is minimal water flow through the slough except during heavy rains when it receives floodwaters from the Sink Creek drainage. The slough has a substrate of deep, soft mud littered with organic debris. There are expanses of shallow water along the western shoreline of the slough, while the eastern shoreline descends abruptly in many areas to a deep channel, 1.5 to 4.5 meters in depth, that runs through the slough. The slough is flanked on both sides by a golf course, and softball fields, but the shore is generally overgrown with thick vegetation. There are fallen and submerged trees and limbs along the shorelines and throughout the slough.

During the spring and summer months filamentous algae and aquatic macrophytes, including many introduced species, cover most of the water surface of the slough and lower portions of the main lake. These macrophytes include hydrilla, water hyacinth, floating fern, Brazilian parrot's feather (Myriophyllum brasiliensis) and water lettuce (Pistia stratiotes). Dense beds of elephant ears grow along most of the shoreline. Prominent species of vegetation along the shore of this lake include: bald cypress (Taxodium distichum), black willow (Salix nigra), pecan (Carya illinoiensis), greenbriar (Smilax bona-nox), hackberry (Celtis spp.), Chinese tallow (Sapium sebiferum), poison ivy (Toxicodendron radicans), sweet mountain grape (Vitis monticola), pepper-vine (Ampelopsis arborea), privet (Ligustrum lucidum), Japanese honeysuckle (Lonicera japonica), and cattail (Typha latifolia).

Capture and Marking Techniques

Turtles were captured in hoop traps baited with chicken necks and fish, or were dip-netted from shore or from a canoe, and occasionally some were captured by hand. Because snapping turtles have long life expectancies, and research on this population is expected to continue, three methods of marking for identification were used: 1) Holes were bored into marginal scutes; 2) A brass rivet embossed with a number was inserted through a hole in a posterior marginal scute. This number corresponded to the number of snapping turtles captured at this study site; and 3) a 12 mm x 1.2 mm Passive Integrated Transponder (AVID Microchip, Norco, California) with a unique, 9-digit code was inserted under the skin in the tail. Vernier calipers were used to measure carapace length (CL), carapace width (CW), and plastron length (PL) to the nearest 0.1 cm. Pesola spring scales were used to determine mass to the nearest 0.1 kg. Sex was determined according to the method of Mosimann and Bider (1960, Fig. 2).

Radio-Telemetry Techniques

Radio-telemeters were one-stage transmitters (non-amplified oscillators) that operated in the 151 MHz band by a 3.0 V lithium battery (model SM1 H, AVM Instrument Co., Livermore, California). These units measured 24.4 mm in diameter x 5.0 mm in thickness and weighed 6.2 g, with 30 cm whip antennas. Battery life was estimated to be between eight and ten months. Standard airline tubing with an inside diameter of 4 mm was fitted over the whip antennas for protection. The carapace was scrubbed free of algal growths and leeches and allowed to dry completely. The unit was affixed to an anterior vertebral scute using PC • 7 heavy duty, waterproof epoxy paste (Protective Coating Co., Allentown, Pennsylvania). The airline tubing containing the whip antenna was cemented along the succeeding vertebral scutes and allowed to extend past the posterior edge of the carapace on large turtles, or cemented back up along marginal scutes on smaller turtles. The epoxy was allowed to cure for at least 12 hours before releasing turtles at capture sites. Five males and four females were outfitted with radio-telemeters and released between March, 1997 and October 1997.

Radio-telemetered turtles were located ("fixed") from a canoe or on foot using a portable receiver (model TRX 1000S, PLL synthesized receiver, Wildlife

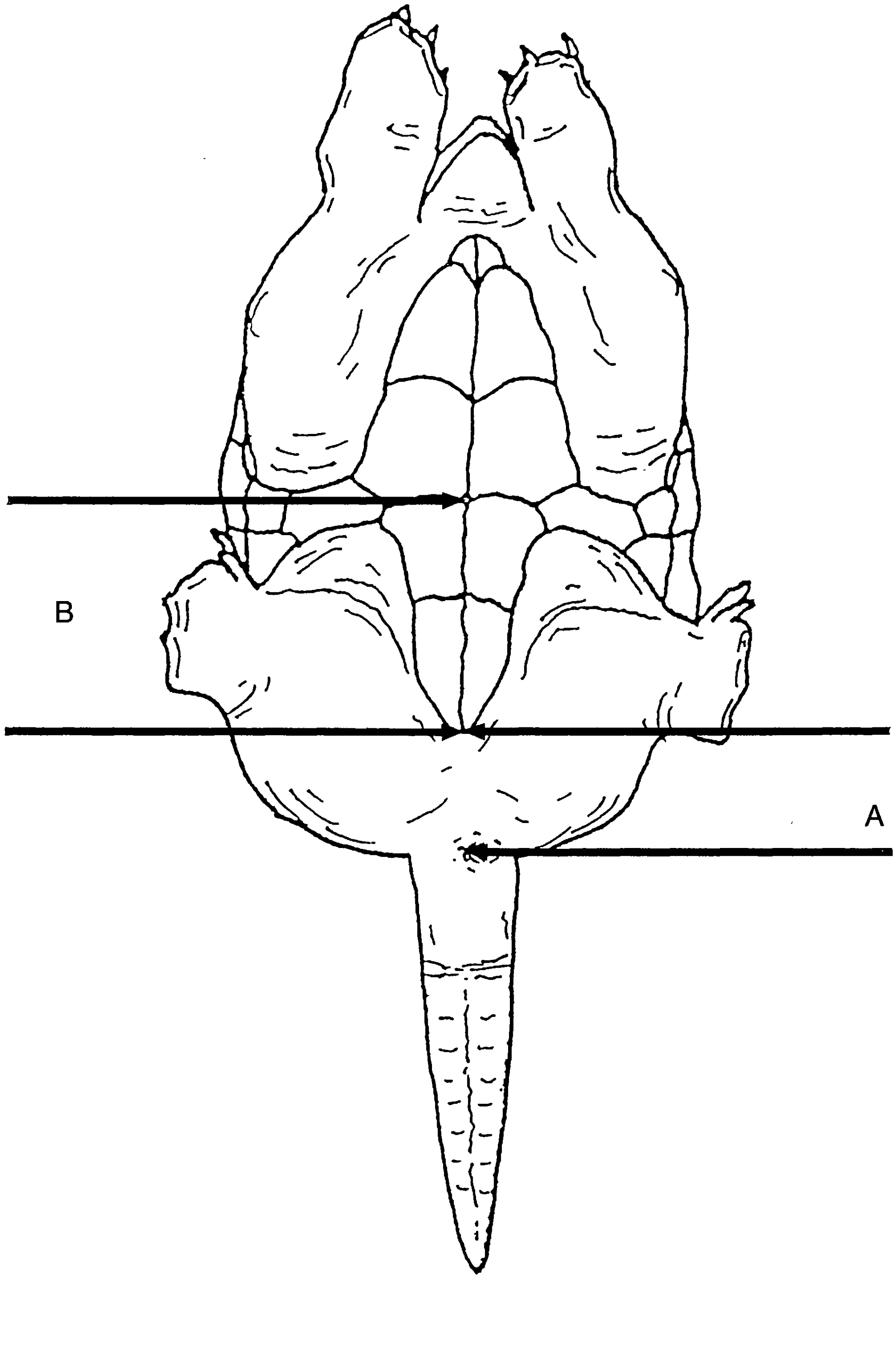


Fig. 2. Method used to determine sex of snapping turtles. Length of posterior lobe of plastron (B) divided by the pre-cloacal distance (A). If greater than 0.86, the turtle was assumed to be a male (Mosimann and Bider, 1960).

Materials, Inc., Carbondale, Illinois) and a three-element collapsible Yagi antenna. When located, time, habitat and behavior were recorded and the location was plotted, within five meters of the turtle's exact location, as a point on a base map of the lake. The base map was digitized from a Digital Orthophoto Quarter Quadrangle (DOQQ) created by Earth Information Systems Corporation (EISYS, Austin, Texas), using ArcView GIS Version 3.1 (Environmental Systems Research Institute, Inc., Redlands, California). The outermost collection of plotted points for each turtle was connected, using ArcView GIS, by the minimum convex polygon method after Mohr (1947) to delineate a home range polygon to estimate area. Home range refers to the planimetric area of recorded activity/inactivity in which a turtle was radio-tracked during this study. Inactivity was reported as repeated "fixes" of a turtle in the same location, and home sites were reported as locations to which a turtle repeatedly returned. Distance between "fixes" was determined and plotted against frequency of each distance for each turtle to display individual movements.

Data are reported as the mean ± standard deviation, followed by minimum to maximum range limits. Home range values are presented in hectares, distances traveled are presented in meters. Number of radio-telemetered turtles is presented as N and number of "fixes" is presented as n

RESULTS

Home Range

Radio-telemetered turtles (N = 9) were located between 5 to 57 times during the study period. One turtle was located only five times after release. As a result, the minimal data that was collected for this turtle is not reported. Mean home range size for females was 0.76 ha ± 1.30 (0.01 to 2.07, N = 3). Mean home range size for males was 0.51 ha ± 0.83 (0.13 to 2.25, N = 5). Only one instance of area overlap was noted among the three females (Fig. 3), while considerable overlap of home ranges was noted among the five males (Fig. 4). Turtles appeared to have a home site within their home range, which was assumed after a turtle had returned to a specific location in its area repeatedly. Three turtles were found to use more than one home site within their home ranges. Turtle #26 repeatedly returned to five different home sites during this study. Turtles #32 and #18 were found to use three different home sites, while turtles #23, #44, #59, #68 and #73 used only one home site. Three turtles (#18, #32, and #44) used nutria (Myocastor coypus) burrows as home sites.

Distance Traveled

The three radio-telemetered females had a mean distance traveled between "fixes" of 54.3 m ± 96.9 (0 to 485, n = 86), while the five males had a mean distance traveled between "fixes" of 53.8 m ± 76.2 (0 to 435, n = 138). Turtle #26 had a mean distance traveled between "fixes" of 73.4 m ± 112.4 (0 to 485, n = 57)(Fig. 5). Turtle #44 had a mean distance traveled between "fixes" of

Fig. 3. Home range estimates for female radio-telemetered snapping tutles at Spring Lake.

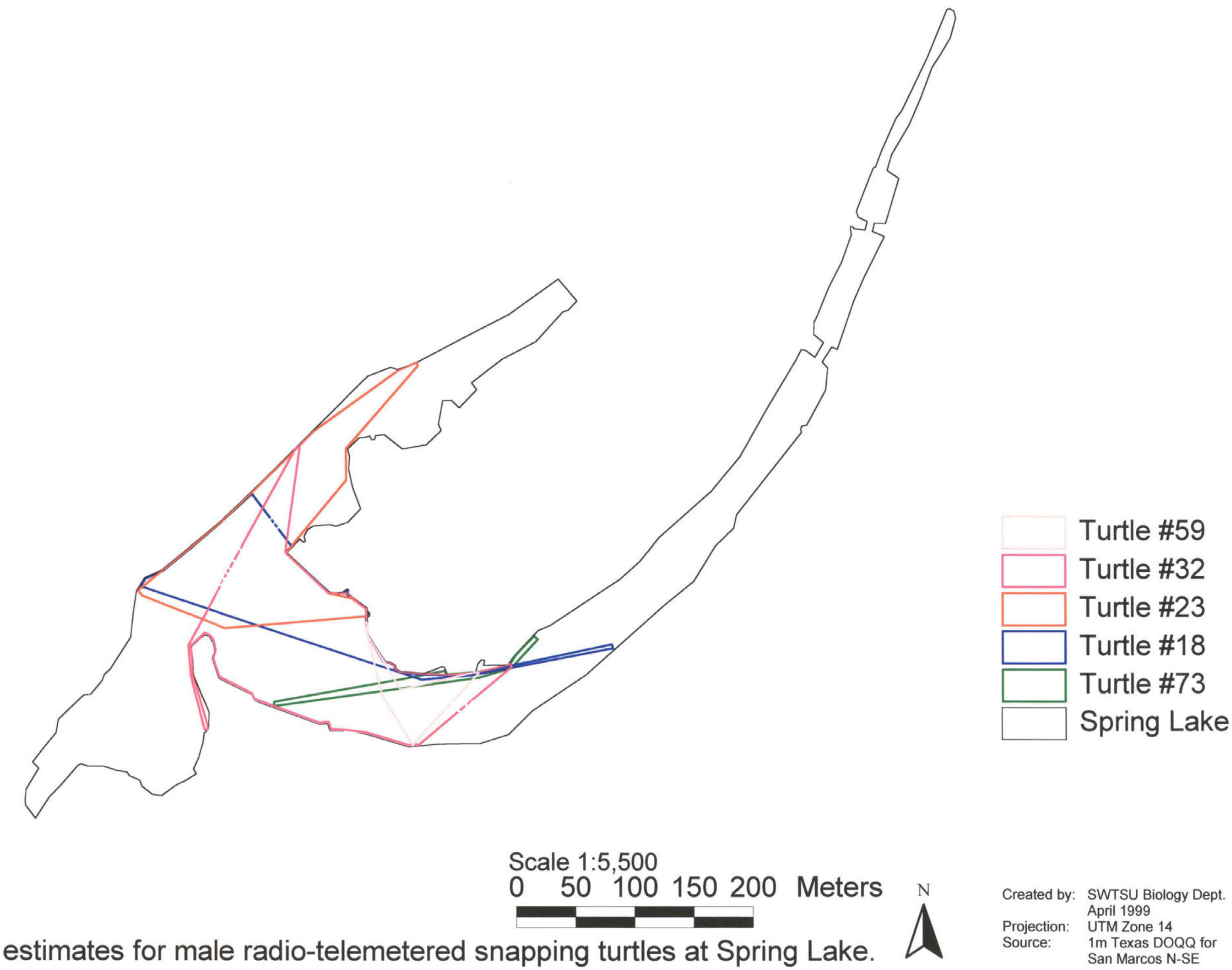


Fig. 4. Home range estimates for male radio-telemetered snapping turtles at Spring Lake.

1.8 m ± 3.37 (0 to 10, n = 11)(Fig. 5). Turtle #68 had a mean distance traveled between "fixes" of 25.8 m ± 38.6 (0 to 120, n = 18)(Fig. 5). Turtle #18 had a mean distance traveled between "fixes" of 32.9 m ± 55.6 (0 to 240, n = 48)(Fig. 6). Turtle #23 had a mean distance traveled between "fixes" of 124.7 m ± 121.2 (0 to 435, n = 17)(Fig. 6). Turtle #32 had a mean distance traveled between "fixes" of 66.1 m ± 70.7 (0 to 330, n = 47)(Fig. 6). Turtle #59 had a mean distance traveled between "fixes" of 27.5 m ± 30.7 (0 to 70, n = 12)(Fig. 6). Turtle #73 had a mean distance traveled between "fixes" of 20.7 m ± 52.9 (0 to 190, n = 14)(Fig. 6). Distances traveled between "fixes" were plotted against frequency of each distance traveled to show the extent of movements between "fixes" and the frequency of "fixes" where no movement was recorded (Figs. 7 - 14).

Activity/Inactivity

Four turtles (one female and three males) exhibited several "fixes" of recorded movement interspersed with few "fixes" of recorded inactivity. The remaining four turtles (two females and two males) exhibited several "fixes" of recorded inactivity interspersed with few "fixes" of recorded movement. Turtle #26 (female) was the first turtle radio-telemetered and was active throughout the year, but showed periods of inactivity in March, April, and May. Turtle #44 (female) was radio-telemetered in June and tracked through December, until the telemeter failed. This turtle remained in a nutria burrow at the headwaters of

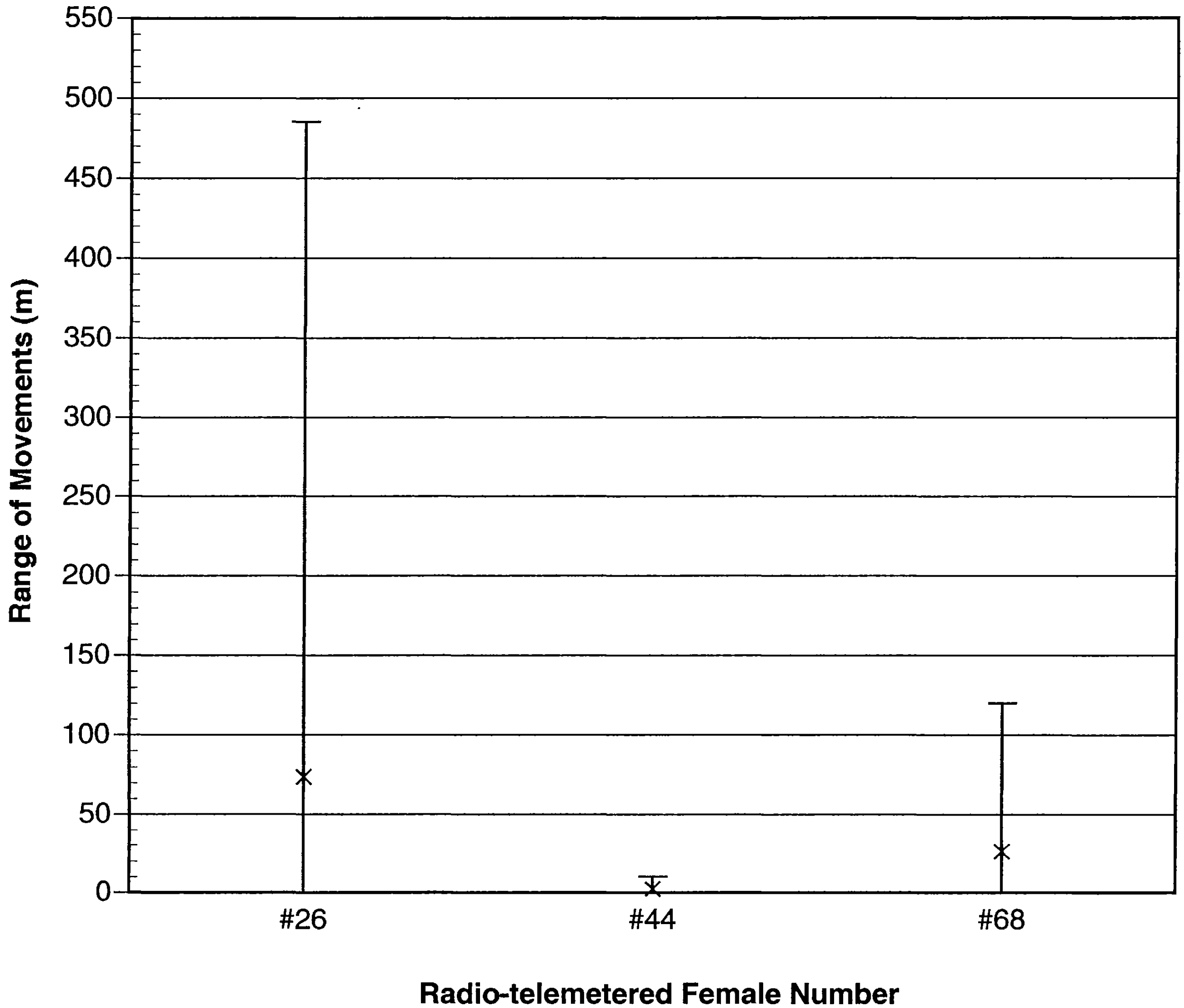


Fig. 5. Range of movements (—) and mean distance traveled (×) for female radio-telemetered snapping turtles.

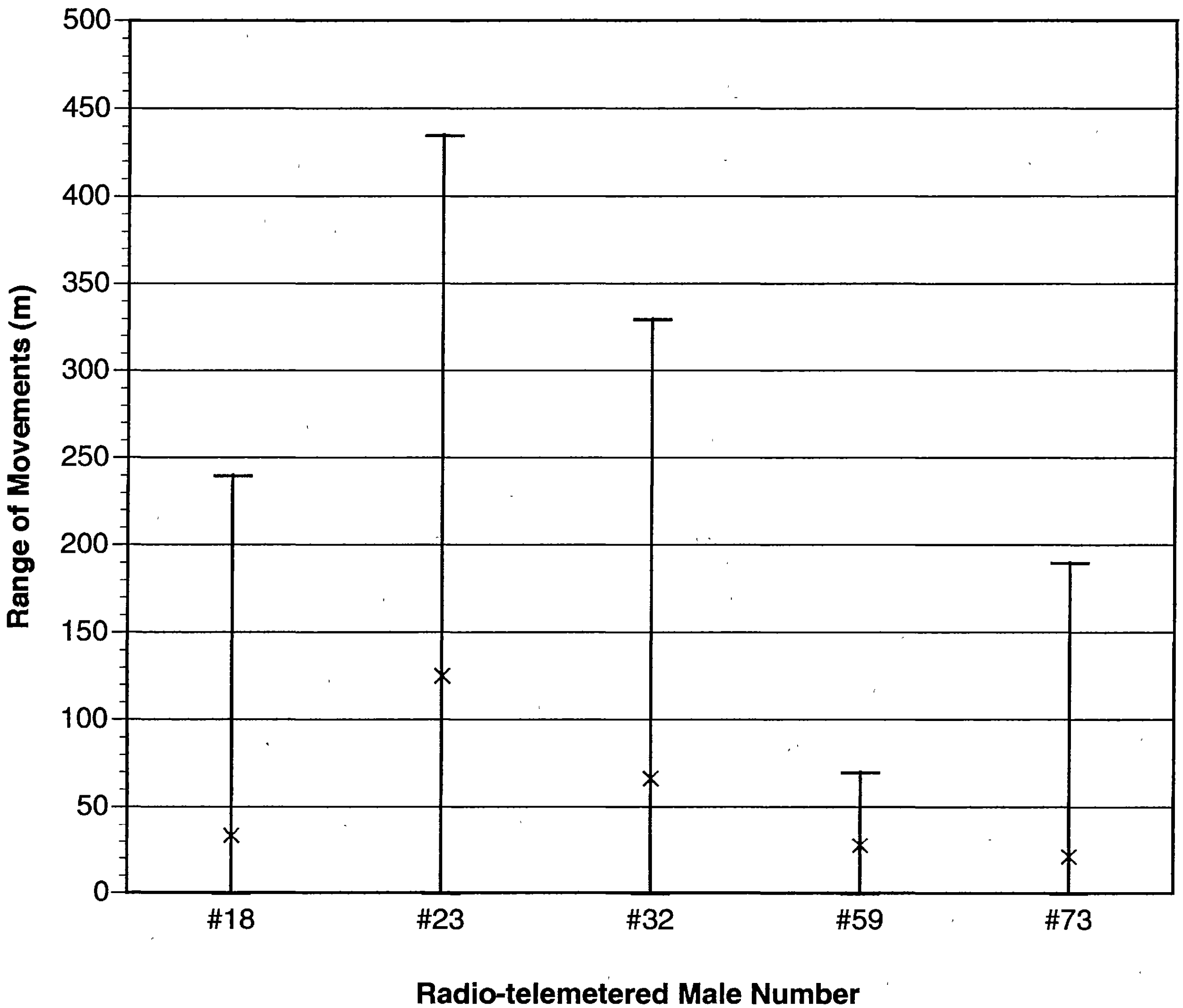


Fig. 6. Range of movements (—) and mean distance traveled (×) for male radio-telemetered snapping turtles.

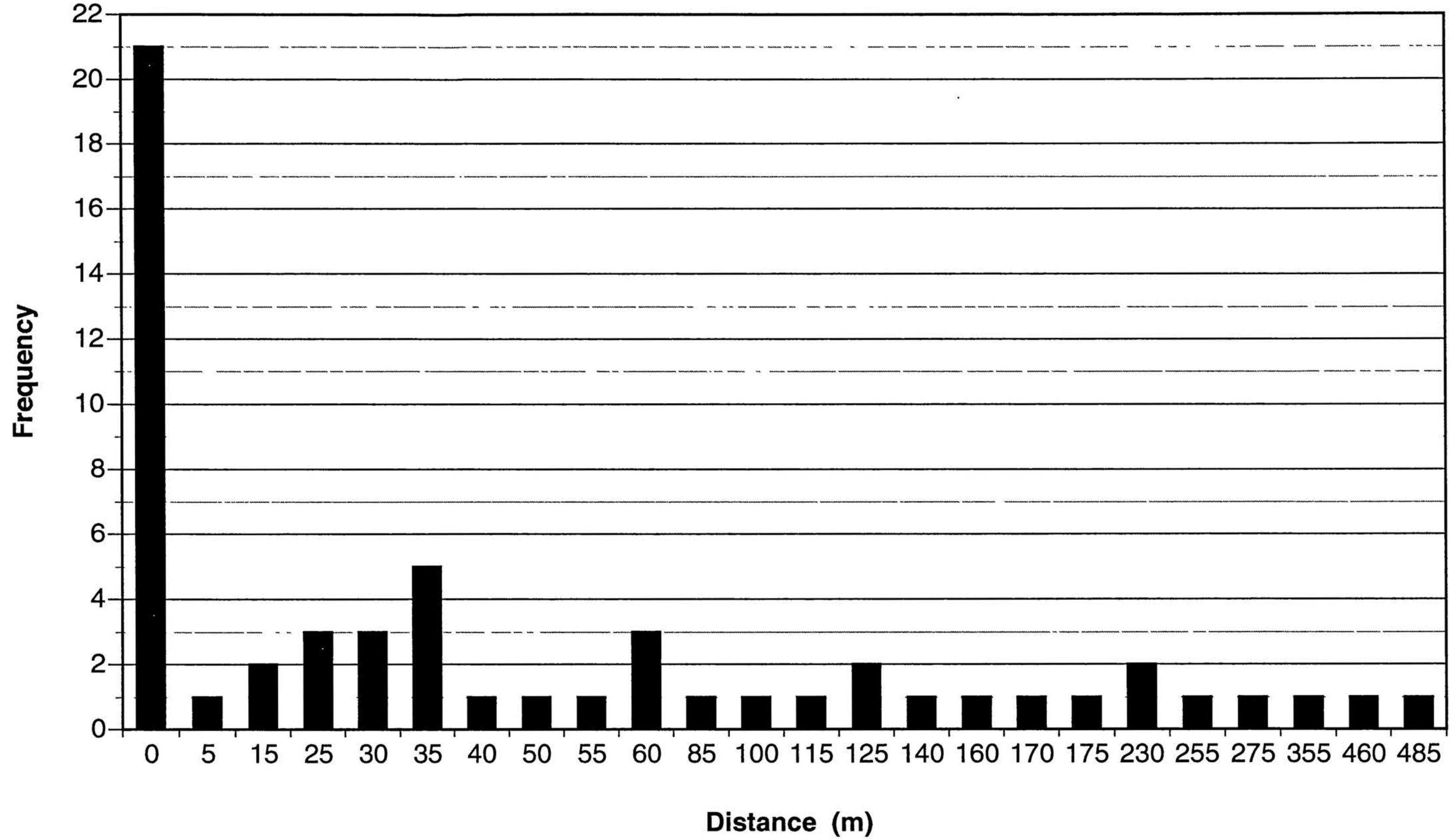


Fig. 7. Distance traveled between "fixes", Turtle #26.

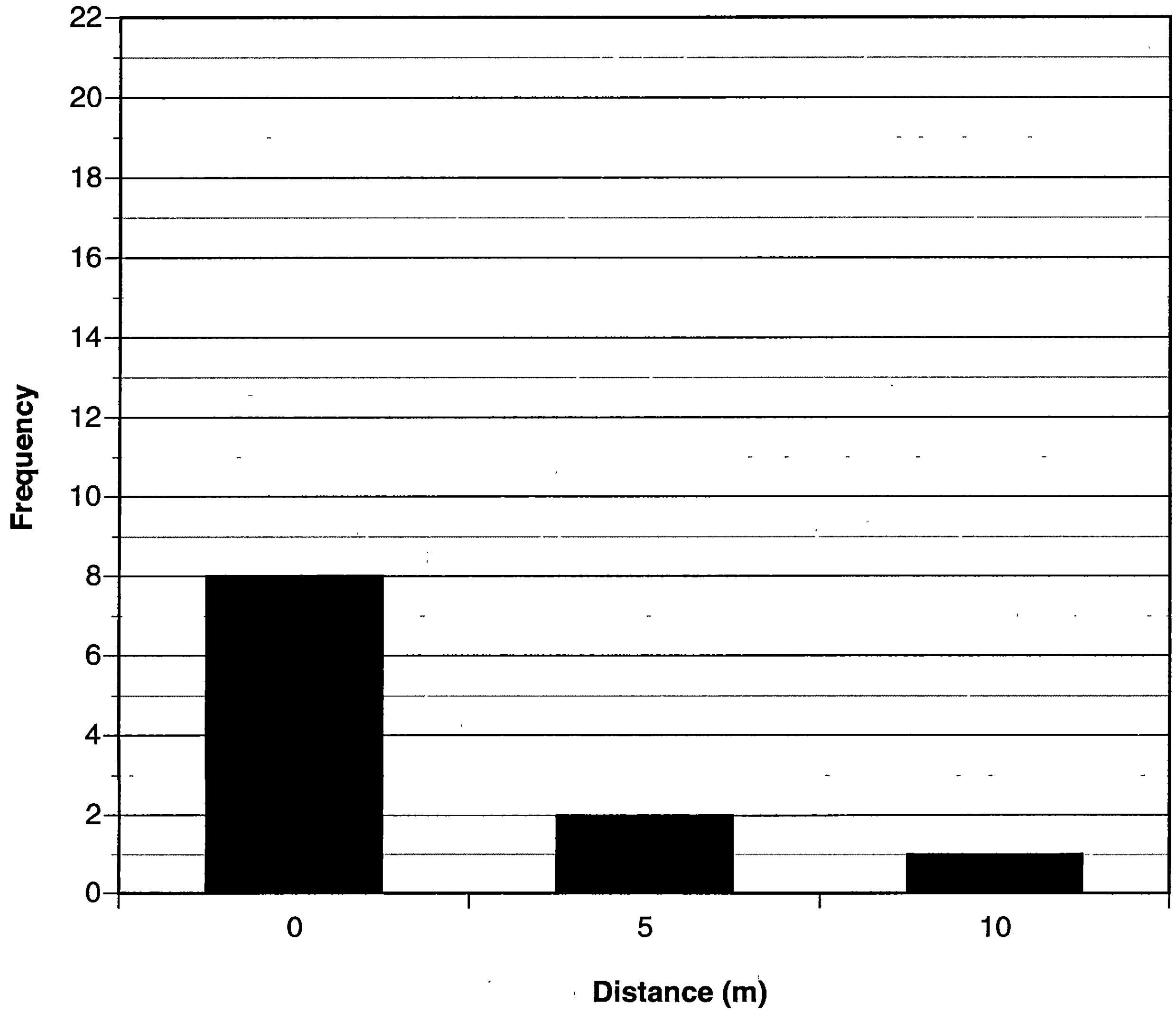


Fig. 8. Distance traveled between “fixes”, Turtle #44.

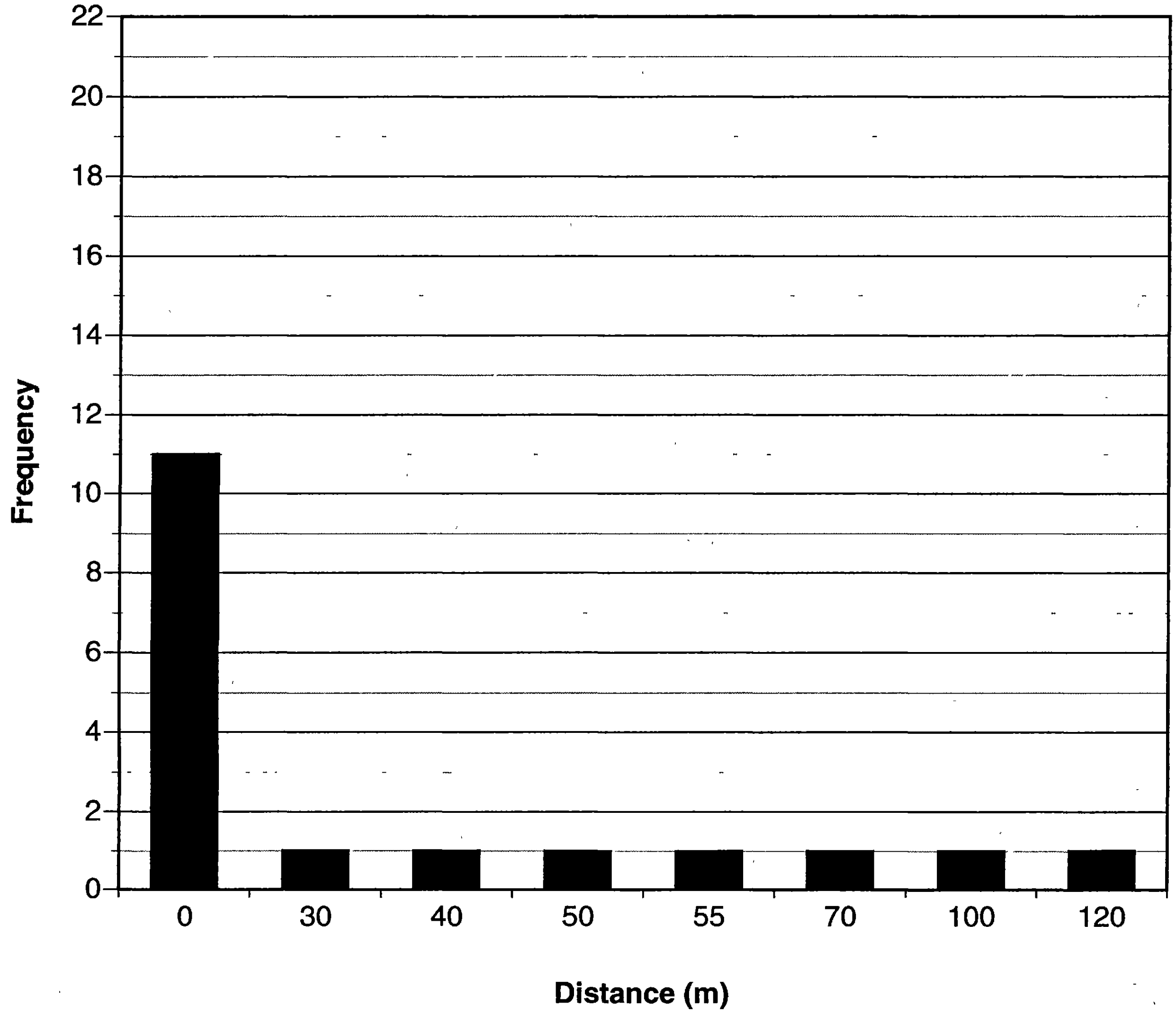


Fig. 9. Distance traveled between "fixes", Turtle #68.

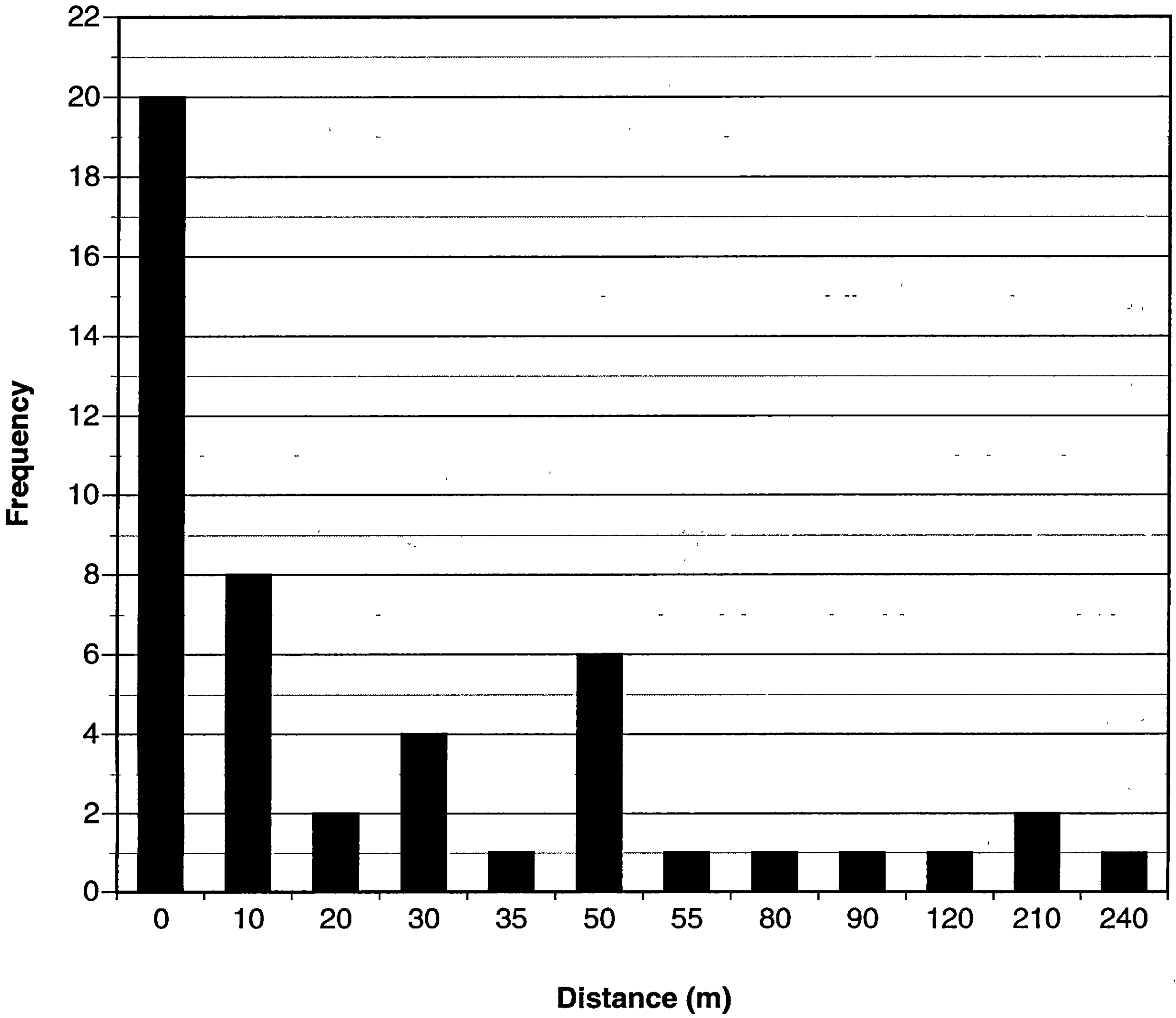


Fig. 10. Distance traveled between “fixes”, Turtle #18.

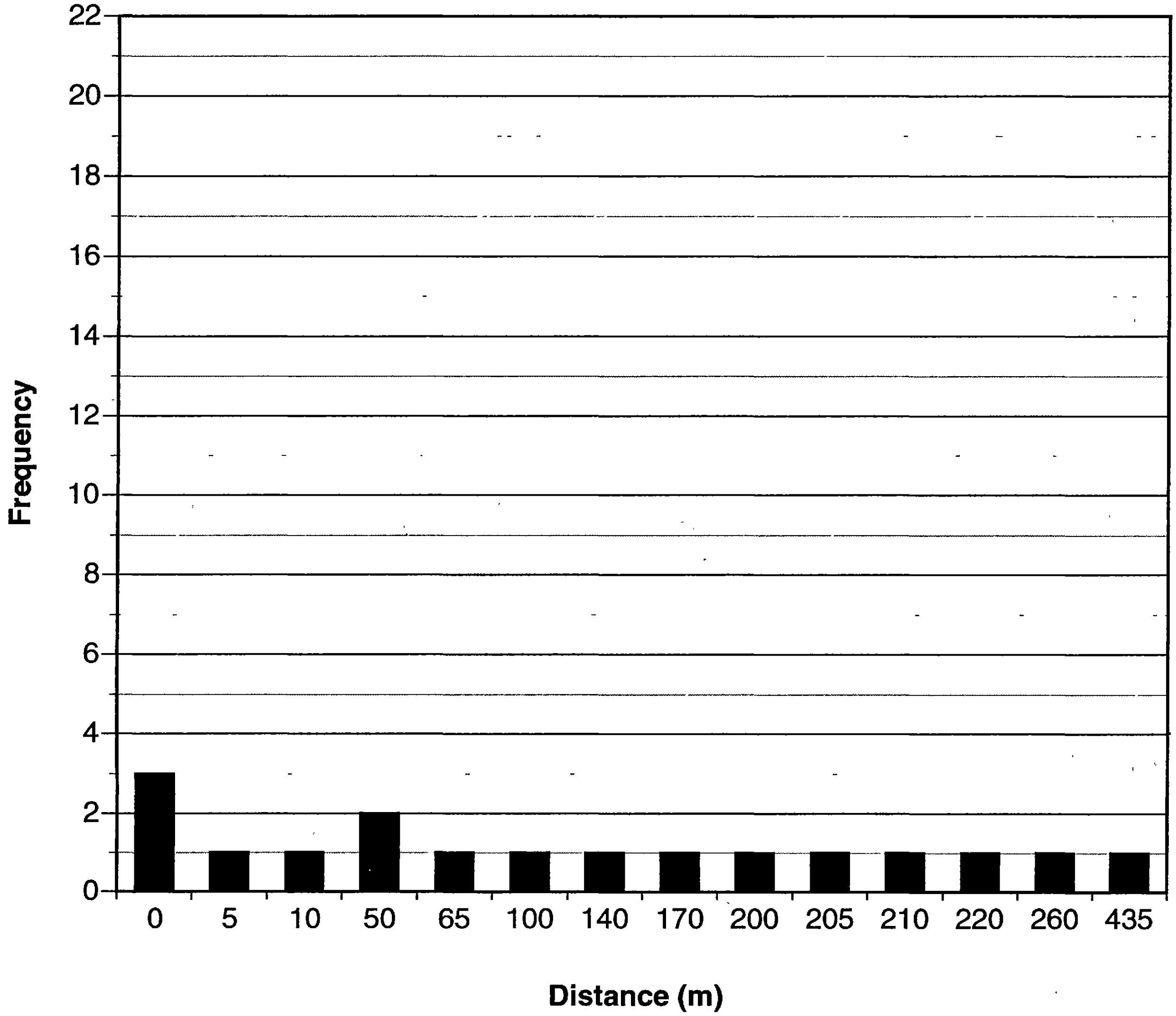


Fig. 11. Distance traveled between "fixes", Turtle #23.

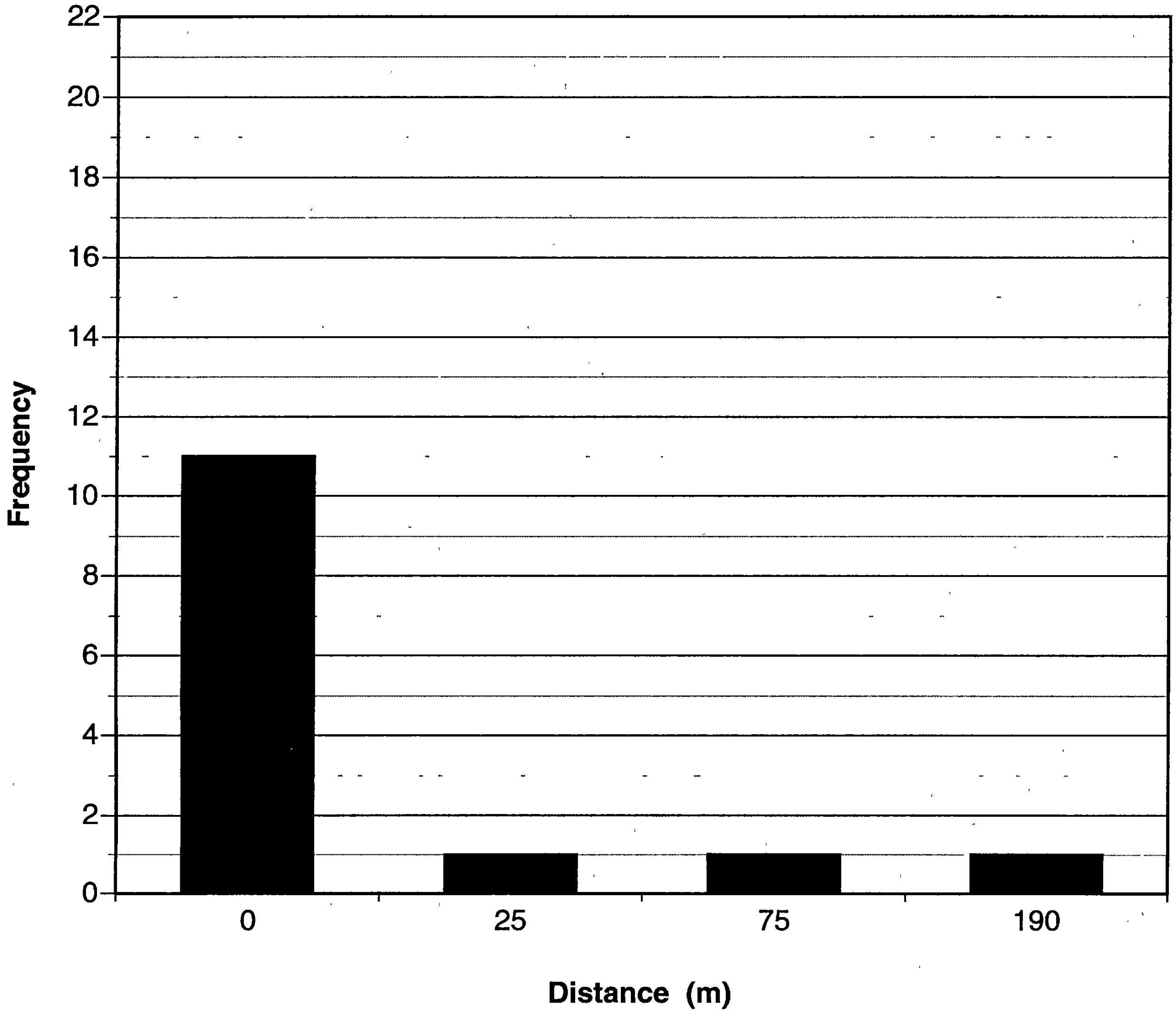


Fig. 12. Distance traveled between “fixes”, Turtle #32.

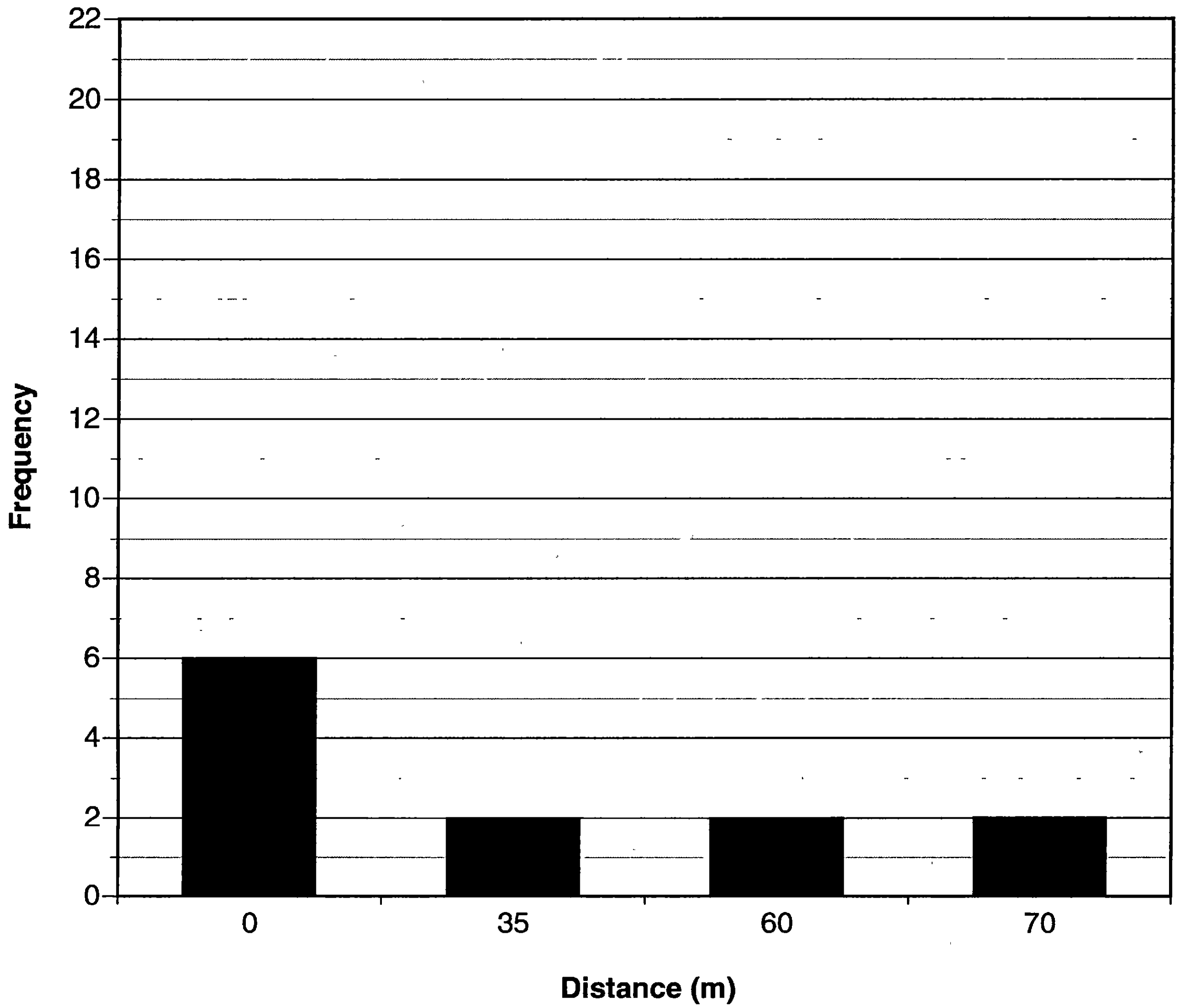


Fig. 13. Distance traveled between “fixes”, Turtle #59.

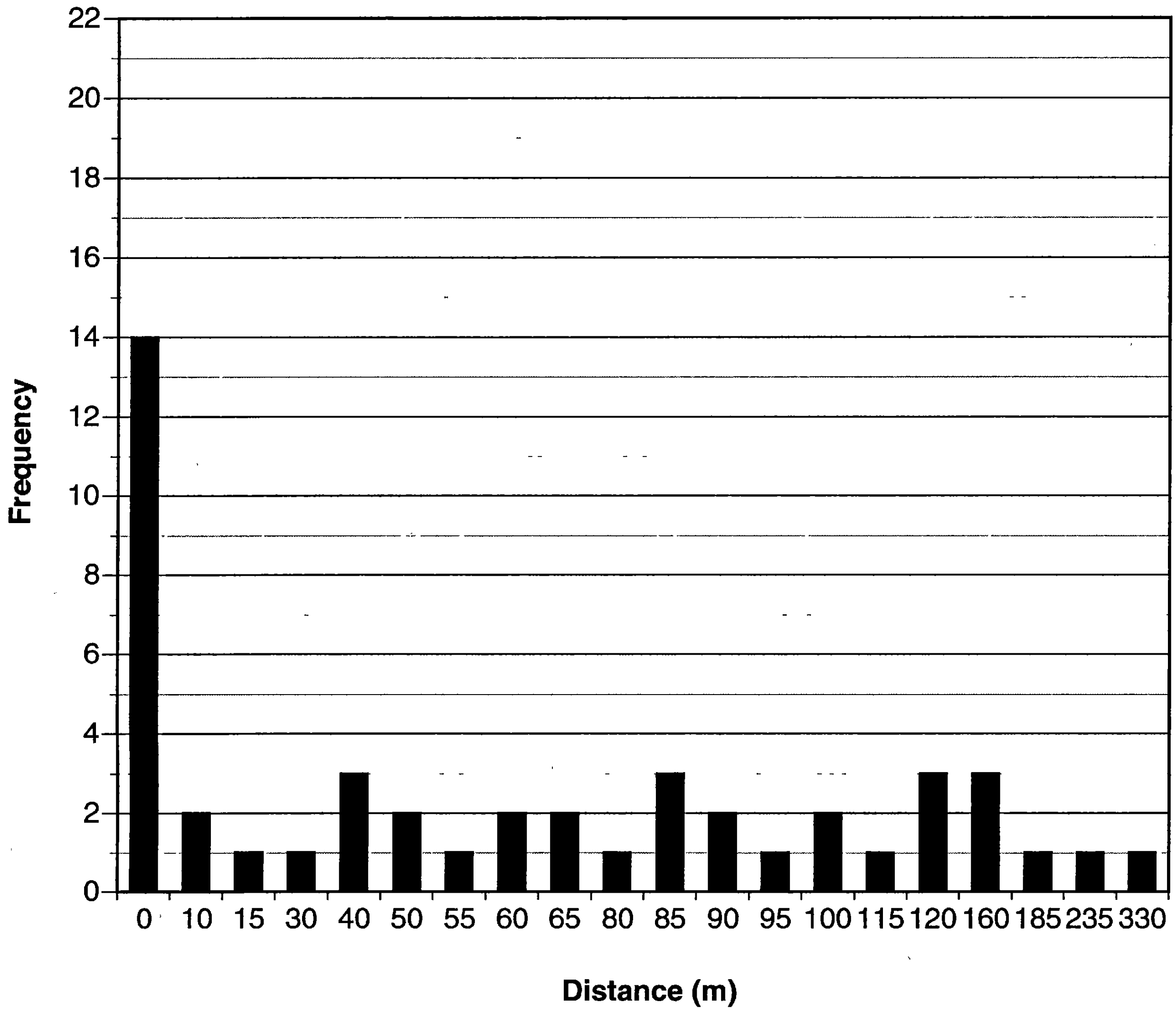
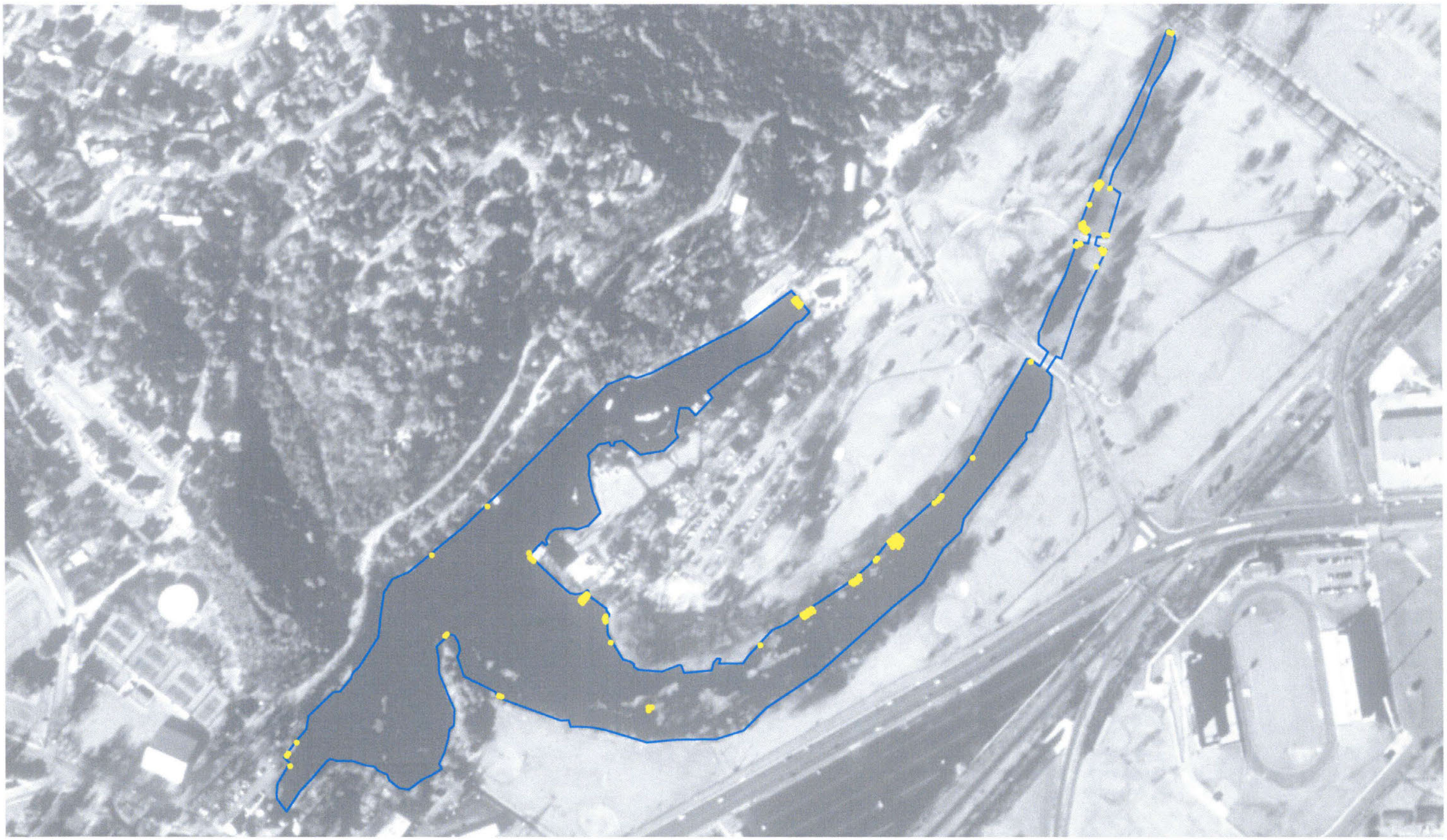


Fig. 14. Distance traveled between "fixes", Turtle #73.

the lake (where the large springs were located) and showed movement by radio-tracking on only three events. However, this turtle was observed swimming in this area between times of radio-tracking (F. L. Rose, *pers. comm.*). Turtle #68 (female) was radio-telemetered in September, and was inactive until mid-February. After months of no observable movements, I radio-tracked the exact location of the turtle in shallow water (<0.1 m) over deep mud. Probing this area, I was able to locate the turtle and verify that the radio-telemeter unit was attached to the carapace. The turtle became active immediately and left the site. Turtle #18 (male) was radio-telemetered in April and showed periods of inactivity in April, May and June, then remained active until January. It was mostly inactive throughout January and February, and activity resumed in March. Turtle #23 (male) was radio-telemetered in June and was active through April, with one period of inactivity during December and January. Turtle #32 (male) was radio-telemetered in March, had a period of inactivity in April and then was active through September. It had two extensive movement events (185 and 330 m) in October, then remained inactive through February. Turtle #59 (male) was radio-telemetered in November, and was the second largest turtle (CL = 360 mm, 13.8 kg) captured during this study. It was inactive, with brief periods of movement in January, March and April. Turtle #73 (male) was radio-telemetered in October and traveled 190 m for the first recorded movement event, then remained inactive until March.

Trapping

Periods of trapping continued throughout this study. As of August 1998, the known population of snapping turtles was 103 individuals, including juveniles. A point plot was made on a map of Spring Lake, showing the locations of first captures for each of these turtles (Fig. 15). It was noted that most of these captures were in the slough region of the lake, supporting previous reports that snapping turtles were found in shallow, lentic waters with a muddy substrate (Feuer, 1971; Hammer, 1971; Ernst *et al.*, 1994; Froese, 1978).



0 50 100 150 200 Meters

Scale 1:5,500

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Created by: SWTSU Biology Dept.
April 1999
Projection: UTM Zone 14
Source: 1m Texas DOQQ for
San Marcos N-SE

Fig. 15. First capture locations of 103 snapping turtles at Spring Lake.

DISCUSSION

Home Range

The data presented here suggest extensive overlap of home ranges among five male snapping turtles, but not between the three female turtles. Two of the three females and two of the five males remained in a relatively small area, according to radio-tracking data. The home range of one female (#26) overlapped considerably with all five males, while the other two radio-telemetered females remained in close proximity to their capture/release points. Froese (1974), Obbard and Brooks (1981), and Galbraith *et al.* (1987) reported extensive home range overlap between and within sexes.

All home ranges were calculated as planimetric water surface areas only, and home range boundaries bordered shorelines because snapping turtles were not observed on land. Reports of overland movements (Cagle, 1944; Hammer, 1971; Obbard and Brooks, 1980) suggest that snapping turtles migrate in search of food, nesting grounds, or more suitable habitat. Cagle (1944), however, reported turtles would remain in the same body of water as long as there was suitable habitat and available food.

There were no confirmed sightings or captures of snapping turtles immigrating or emigrating at my study site, but snapping turtles frequently were seen migrating at other sites along the San Marcos River (F. L. Rose, *pers. Comm.*). There were concurrent studies of three other turtle species (Pseudemys texana, Sternotherus odoratus, and Trachemys scripta) at this site.

Nesting females of these species frequently were seen, but nesting snapping turtles were not observed.

There were 103 snapping turtles known to be in this population with a sex ratio of approximately 1:1 (F. L. Rose, *unpubl. data*). Because no snapping turtles were seen on land, it was assumed that suitable resources were available at this site, and extensive home range overlap must exist among these turtles. Territoriality and aggression of this species were reported (Raney and Josephson, 1954; Hammer, 1969, 1971; Galbraith *et al.*, 1987), but no clear explanations for these behaviors were given. Galbraith *et al.* (1987) found no evidence of territoriality in a northern population of snapping turtles exhibiting aggression. Bouts of aggression between snapping turtles at Spring Lake were observed during this study. In addition, more than one snapping turtle, and other turtle species, commonly were captured in a single hoop trap.

I observed aggressive/mating behavior between free-swimming snapping turtles on three occasions during my study. During each episode, it was confirmed that at least one turtle in each encounter was male. There have been few reports on this behavior of snapping turtles, but Galbraith *et al.* (1987) reported that spacing was due to aggressive encounters rather than territoriality.

Distance Traveled

Mean distances traveled between "fixes" among male and female radio-telemetered turtles were similar. The three female turtles had movements ranging from 0 to 485 m, while the five males had movements ranging from 0 to 435 m. All eight turtles had numerous "fixes" where no movement was recorded, and were found to spend a seemingly large amount of time inactive.

However, four turtles (#18, #23, #26, and #73) also had numerous "fixes" where some movement was recorded. Based on estimates of home range areas and distances traveled among all eight turtles studied, male snapping turtles at Spring Lake might have been more active than females.

Activity/Inactivity

Turtles did not return to a specific site at the end of each day, however, I found turtles to return to a specific location (home site) repeatedly. Individual turtles used one or more home sites within their home range area. Turtle #26 (female) had five different home sites that were used variably throughout the entire study period. These five home sites, however, were all within 50 meters of each other, along the shoreline, so she did return to the same general area of the lake. Turtle #32 (male) had three different home sites, one being an abandoned nutria burrow. Six months into the study, this turtle was recaptured at this nutria burrow site with another male snapping turtle in the same trap. The turtle then shifted its home site to a new location, and became inactive at this location for almost four months (November - February). This turtle shifted home sites again, and was eventually recaptured at the original home site. Turtle #18 (male) also had three home sites during this study. One site was a nutria burrow in the hollow base of a large willow tree. Another site was just ten meters away within a deep undercut beneath a concrete slab, and the third site was about 40 meters away in shallow water with a deep muddy substrate. Turtles #23 (male), #44 (female), #59 (male), #68 (female), and #73 (male) were found to use only one home site. Turtle #44 used an active nutria burrow.

Snapping turtles were found to be active both day and night. Ernst *et al.* (1994) reported that snapping turtles, throughout the southern range, generally were believed to be primarily nocturnal. Obbard and Brooks (1981) reported turtles to be nearly strictly diurnal in southern Canada, moving into shallow waters at the end of each day. They suggested that nocturnal activity was "a result of using lights when searching for specimens." While trapping and radio-tracking turtles at night, I often encountered free-swimming snapping turtles. Most turtles did not react to spotlights, the canoe or to my presence.

As an additional observation during this study, snapping turtles were not observed to bask. Basking behavior was a common activity reported for turtles in southern Canada (Obbard and Brooks, 1979). Cagle (1944) reported that snapping turtles and musk turtles bask by resting in shallow water, and occasionally above water. It was possible that turtles in Spring Lake basked aquatically, but were difficult to observe due to aquatic vegetative cover.

Individual turtles were active in all seasons with periodic episodes of inactivity, during this yearlong study. Brumation was reported in northern turtle populations (Obbard and Brooks, 1981; Ultsch and Lee, 1983; Meeks and Ultsch, 1990; Pettit *et al.*, 1995). These studies reported all snapping turtles in study populations to brumate during the winter months. I found individual turtles to have alternating periods of activity and inactivity year-round. Some turtles were inactive while other turtles remained active, regardless of the time of year. Winter months were mild, and the water temperature at my study site remained relatively constant, contrasting with study sites of northern populations of snapping turtles.

Cagle (1944) and Galbraith *et al.* (1987) reported that turtles became inactive when not stimulated by the need for "key" resources such as food, shelter, basking, and mating. Diurnal and nocturnal movements of eight radio-telemetered turtles alternated between activity and inactivity among a known population of 103 turtles. It might be possible that individual turtles at this location not only forage at different times of the day and night, but also during different months or seasons of the year to avoid competition for resources.

Home ranges are assumed to be limited by available resources. Spring Lake is a stable, spring-fed system supporting large populations of endemic and exotic plants and animals (Groeger *et al.*, 1997; Seaman, 1997). Additionally, snapping turtles are both habitat generalists and omnivorous, and apparently eat "aquatic invertebrates, fish, reptiles, birds, mammals, carrion, and a surprisingly large amount of vegetation" (Conant and Collins, 1991). Snapping turtles at this site were observed feeding upon elephant ear leaves, and elephant ear bulbs were found in the gut of one specimen (F. L. Rose, *unpublished data*).

Trapping

Trapping for snapping turtles in this lake began in April 1996. By March, 1997, 30 turtles were marked and released. Between March, 1997 and August, 1998, 73 additional turtles were captured and marked. Most of my trapping efforts were concentrated throughout the slough, with relatively high trap success. Snapping turtles are known to inhabit the edges of deep lakes (Ernst *et al.*, 1994), such as Spring Lake, so trapping was done in the main lake. Trap success was low in the main lake, except for the headwater region where the main springs are located. Snapping turtles often were seen in this area, rising up from the deep water to forage along the shallow water near the edges. Turtles usually were captured easily with a dip net or by hand.

CONCLUSION

Individual snapping turtles did not utilize the entire lake. The mean home range size for females was similar to the mean home range size for males. Extensive overlap of home ranges was observed among the males, but not among the females. Turtles were found to have home sites, and home sites changed over the course of my study. Turtles were radio-tracked in areas of shallow, slow-moving water where they were submerged below soft, muddy substrates. Abundant aquatic vegetative cover and submerged organic debris usually were associated with these sites. More turtles were captured in the slough area rather than the main lake. Likewise, turtles were radio-tracked most often in the slough area.

Turtles were observed to be active both day and night, and were active during the seasons with periodic inactivity throughout the year. They were not observed to bask, but they may have basked aquatically. Aggressive encounters were observed, but further study of this behavior is needed to explain these encounters.

Data presented in this paper represents the first study of the common snapping turtle conducted at Spring Lake. Behavioral differences in activity/inactivity and basking were observed in comparison between common snapping turtles in northern populations. These findings offer initial behavioral and space use information unreported from a population at the southern limit of its range in the United States. Future studies at this location might focus on locating nesting sites and possible nesting migration behavior, aggressive interactions, home range fidelities from year-to-year, and population densities.

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VITA

Paul Bernal Aguirre was born in San Antonio, Texas on May 22, 1965, the son of Hortencia Bernal Aguirre and Fernando Cervantes Aguirre. After high school he entered St. Mary's University in San Antonio, Texas. In 1984 he began work at San Antonio Savings Association where he worked until 1990. From 1990 – 1993 he worked for a veterinarian while taking courses at San Antonio College. In 1993 he entered the University of North Texas in Denton, Texas. While a student in Denton, he worked at United Parcel Service, Denton Independent School District, and Davis Purity Bakery. He received the degree of the Bachelor of Science in biology from the University of North Texas in August 1996. He moved to San Marcos, Texas and entered the Graduate School of Southwest Texas State University. While at Southwest Texas State University, he worked as an instructional assistant for Zoology, Natural History of the Vertebrates, and Herpetology laboratory sections. He completed thesis research and will receive the degree of Master of Science in biology in May 1999.

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