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Report No. 1291

HOMING BEHAVIOR OF THE PAINTED AND
MUSK TURTLES IN A LAKE

By

John E. Williams

Abstract

A total of 98 painted and 50 musk turtles were captured during a 9 week fishing experiment during the summer of 1949, at 36.5 acre Fish Lake, Livingston County, Michigan. Three men separately fished 3 stations the first 3 weeks, 3 stations the second 3 weeks and 66 stations the last 3 weeks. All turtles caught were released at the dock in the evening after having a white number painted on their backs. Records were kept of (1) original capture station of turtle, (2) recapture stations of turtle and (3) stations where turtles were only seen but not caught (sight-record recaptures).

The experiment indicated that smaller painted turtles (2 1/2 - 4 inches) returned more often to their original capture stations than larger painted turtles (4 1/2 - 6 inches) and that the larger musk turtles (3-4 inches) returned more often than the smaller musk turtles (2 1/2 inches). Forty-one of the painted turtles returned to their capture station at least once and one returned 15 times during a period of 29 days, covering a minimal distance of 4 1/3 miles. In a total of 97 returns, painted turtles averaged 900 feet per day (maximum - 2,100

ft. per day). Fifteen of the musk turtles returned to their original stations at least once, one returning 8 times in 34 days, travelling a minimal total distance of 5,600 feet. Maximum distance travelled per day was 1,525 feet, while the average for returning musk turtles was only 400 feet. Observations indicated that turtles probably returned to stations by following the shore line and not by crossing the lake.

Painted turtles were seen 22 times and musk turtles 69 times as often at their home stations after marking as they would have been if they had been moving in a random manner. Evidently some painted and musk turtles show very definite indications of homing behavior and some no evidence of it whatsoever. What causes the homing is not clear, but it undoubtedly is either one or a combination of such things as instinct, steady travel along the shore line until a recognized location is reached, learning and curiosity or other factors which are unsuspected.

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Relatively little has been done in attempting to learn about movements or migrations of fresh-water turtles. Cagle (1944) studied movements, homing behavior and migration in Pseudemys scripta elegans, Chrysemys picta spp. and Terrapene carolina. He found that individual aquatic turtles, removed from a particular region in a lake or stream, will usually return to that region when released; that aquatic turtles (except soft-shelled species) may move long distances overland; and that territoriality seems to be non-existent. He further noted that seasonal movements occur as wandering in the early spring and hunting for suitable hibernating quarters in the late fall. Pearse (1923) reported that of 166 painted turtles that were recaptured, 50 (30%) had travelled, while 116 (70%) had not. The average distance travelled was only 112 meters in an average of 5 months and 19 days. He states "Even after a year or two most of the tagged turtles were close to the place where they had been released. This shows that painted turtles are rather sedentary animals and, if their environment remains favorable, will remain in one locality for years." Risley (1933) noted that the number of musk turtles in shallow water in summer is apparently less than in the spring, probably due to increased activity and range, rather than migration from shallow to deeper water after the breeding season.

During the summer of 1949, while engaged in a fishing experiment for the Outboard Boating Club of America (Lagler, Hazzard, Hazen and Tompkins, 1950), I had the opportunity of conducting observations on the homing behavior of the central painted turtle (Chrysemys picta marginata Agassiz) and the common musk turtle (Sternotherus odoratus (Latreille)). The locality was Fish Lake, Green Oak Township, Livingston County, Michigan, located about twelve miles north of Ann Arbor, Michigan. Fish Lake is a marl- and muck-bottomed lake of 36.5 acres with considerable encroaching shore line and a very rapid drop-off along most of its perimeter.

Sixty-eight stations were marked off around the shore of the lake approximately 50 feet apart, except on a section of the east shore line where only two widely separated stations were located (Fig. 1). Fishing was done from 2 to 8 p.m. daily, June 20 to August 24, 1949, by three persons each in a separate boat. From June 20 to July 11 inclusive, only stations 19, 56 and 67 were fished, each station being fished by one person for the entire twenty-two days. From July 12 to August 2 inclusive, the same thing was done at stations 28, 46, and 68. From August 3 to August 24 inclusive each person drew randomly each day one of the sixty-eight stations to be fished. Each fishing station was at a depth of approximately 10 feet.

All fishing was done with cane poles or fly rods, using worms for bait, and all turtles were caught in this manner except for a few individuals unwary enough to be caught with the hands from the boat. The turtles apparently were never seriously injured by the hook, as the hook usually never penetrated their bony jaws and they were seldom hooked in the gullet. The turtles were measured to the nearest one-half

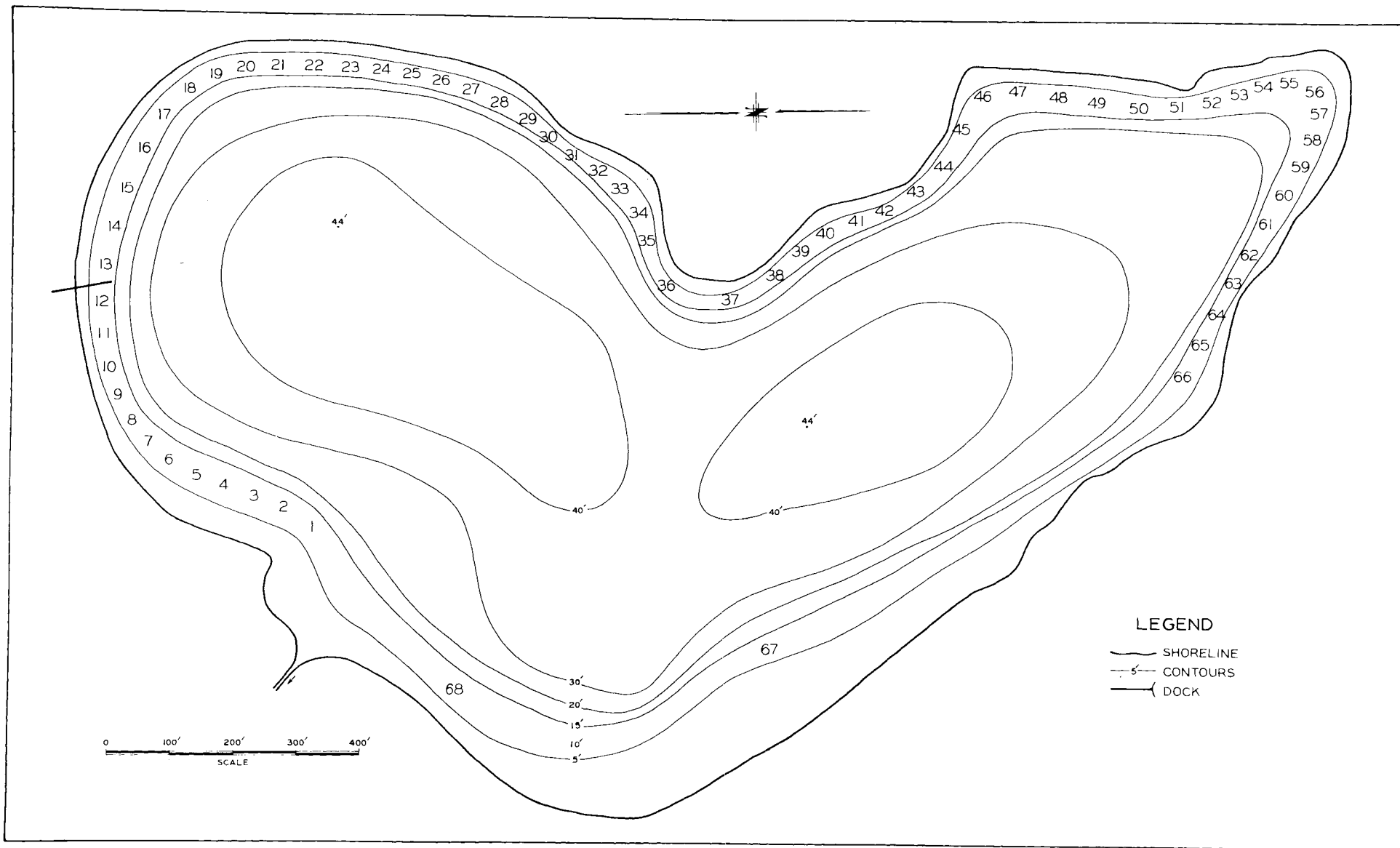


Fig.1. Map of Fish Lake, Livingston County, Michigan showing location of 68 fishing stations. (All stations were located as close to the 10 foot contour line as possible)

inch, and were given a number which was painted on their backs with white enamel. Unfortunately some of the turtles started to shed their shields in August and thus lost part or all of their numbers, making it impossible, during the later period, to identify them. The white numbers had a distinct advantage over other methods of marking in that turtles could be identified in the water should they show no inclination to being caught. All turtles caught were kept in the boat until the end of the day when they were released near the dock (Station 12). Records were kept of (1) original station of capture, (2) recapture station, and (3) station at which numbered turtles were seen but not caught (sight-record "recaptures"). Turtles for which recapture or sight-record "recapture" data were secured are listed on Fig. 2, which also lists the stations at which turtles were caught or seen. Uncircled numbers indicate that the turtle was captured at that station and released near the dock, while circled numbers indicate that the turtle was only seen at that station on that date.

In all, 98 painted turtles, averaging 4 1/2 inches in length of carapace (range 2 1/2 to 6 inches), and 50 musk turtles, averaging about 3 1/4 inches in length of carapace (range 2 1/2 to 4 inches), were marked (Table 1).

Table I
Length-frequency distribution of marked turtles

Length	Painted	Musk
2.5	1	4
3.0	7	25
3.5	10	17
4.0	33	4
4.5	14	
5.0	15	
5.5	11	
6.0	7	
TOTAL	98	50

In comparing the number of times the painted turtles returned to their original capture stations with their size, it seems that the smaller turtles (from 2 1/2 to 4 inches) averaged a greater number of round trips than the larger turtles (4 1/2 to 6 inches). This can be shown as follows:

Length of painted turtles:	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
Average number round trips:	1.0	1.1	1.5	1.2	0.8	0.6	0.7	0.4

Evidently the larger turtles have a greater tendency not to return to their original capture station, but instead to wander around the lake. This can be further shown by the fact that 51% of the turtles from 2 1/2 to 4 inches returned to their original capture site at least once, while only 36% of the 4 1/2- to 6-inch turtles returned. While this difference is not statistically significant, it indicates a trend which possibly could have been proven statistically if a larger sample had been involved.

There is a different trend with the musk turtles however, which can be shown as follows:

Length of musk turtle	:	2.5	3.0	3.5	4.0
Average number round trips:		0.0	0.6	1.1	0.5

Here the small (2 1/2-inch) turtles were never seen to return, while the medium- and large-size turtles returned more often. Again the differences are not statistically significant due probably to the small sample. Of the 50 musk turtles marked, none of the 2 1/2-inch, 31% of the 3-inch, 38% of the 3 1/2-inch and 25% of the 4-inch group returned, as far as could be determined. Musk turtles are bottom-dwelling species and therefore may have been at stations and not been noticed and recorded. The painted turtle, being more active, a more agile swimmer, and more

apt to bask at the surface, is more likely to be noticed.

Of the painted turtles, 57 were never seen to return to their original station (or within 100 feet of it) while 41 returned to their original station at least once. However, during the last twenty-two days no two stations were fished twice and painted turtles had begun losing their shields; therefore the first forty-four days of the problem are more revealing in this part of the study. Of 60 turtles marked during this period, 24 never returned to their original station, while 36 returned at least once. For these 36 turtles, the returns were:

Number of returns:	1	2	3	4	5	6	7	15
Number of turtles:	17	6	7	1	2	1	1	1

As can be seen above, one turtle (No.44, 5 inches in length) returned to its original station (No.46, fished by the author) 15 times. This was during a period of only 29 days. In one seven-day stretch, during this period, No. 44 was caught every day. This means that after being released every evening at 8:15 p.m. at the dock, it had travelled to station 46 (a distance of 1525 feet by the shortest route, directly across the lake) by 2 to 8 p.m. (nearly always by 2 p.m.) the next day. Thus in one week it had travelled a minimum of $1 \frac{3}{4}$ miles. After skipping one day, No.44 was captured 7 additional times and made 7 more trips from the dock in the next 10 days. After every one of these 7 releases at the dock, it was back at station 46 again the next day. Thus in 18 days it was captured 14 times and made 13 trips from the dock for a total minimum distance of 6608 yards or $3 \frac{3}{4}$ miles. It could have travelled along the shore between stations for a considerably greater distance. This turtle was taken again at station 45 three days after the 18 day period and again 8 days later at station 48. Both stations are within 100 feet of the original station. During the 29 days, this

turtle travelled a minimum of $4 \frac{1}{3}$ miles. Turtle No.44 seemed to be exceptionally curious and unafraid and there may be some possibility that learning had an influence on its exceptional record.

In a total of 97 returns to original stations painted turtles averaged 900 feet per day. This is certainly a minimum figure for several reasons partially explained above. Turtles may have gone along the edge of the lake and thus travelled considerably further. Also these 97 returns include those whose returns were noted after long periods in which no observers were present. Again, many turtles had undoubtedly been at stations several days before being observed, even when observers were present. Basking spots were few and far between on Fish Lake and at least 95% of the observations by sight were made while turtles were in the water. The maximum speed obtained was for turtles which returned to station 56 (2100 feet) in 18-23 hours.

Of the 50 musk turtles marked, 35 were never seen to return to their original stations. However, if turtles marked only in the first 44 days are considered, then only 15 of 28 never returned. For the 13 turtles which returned, the number of turtles making various number of returns can be shown as follows:

Number of returns:	1	2	3	4	8
Number of turtles:	4	4	3	1	1

As with the painted turtles, one musk turtle made an exceptional record, considering the more secretive habits of musk turtles. This turtle (No.46, $3 \frac{1}{2}$ inches in length) was captured 8 times and returned to station 28 (or within 50 feet of it) 8 times over a period of 34 days. Station 28 was at least 700 feet from the dock (across the lake), so this turtle travelled a minimum of 5,600 feet in 34 days. However, three times it returned the 700 foot distance in the 18 hour interval

between release one evening and capture the next afternoon. An example of even more rapid travel is indicated by turtle No.63 which returned to station 46 (at least 1,525 feet) in 18-23 hours. However the average for the 33 return trips made by 13 turtles was only a distance of slightly over 400 feet per day.

The question of whether turtles returned to their original stations by the most direct route across the lake or not is difficult to answer. It is my opinion that they follow the shoreline in either direction around the lake until they reach their original or home grounds. Turtles were never seen crossing the lake or surfacing in the center, even though a motorboat was operating on the lake for a considerable part of the time. Again, several times turtles were observed at a station between the dock and their original capture point and then observed a day or two later at their original station (turtles No.5 and 23).

As opposed to those turtles with seemingly definite homing traits, other turtles seemed to wander about the lake, with no apparent home location. Turtles No.17 and 59 were seen in nearly every part of the lake at various times. Other turtles stayed fairly close to their original sites for the entire summer (No.5 and 96). Others would seem to spend longer periods at various locations in the lake (No.6). The fact that these locations were occupied by fishermen may be an indication of the curiosity of turtles.

In all, 60 painted turtles were caught at the 6 fishing stations during the first 44 days. These turtles were seen a total of 188 times at the stations at which they were marked and 59 times elsewhere. After the turtles were marked they were seen 128 times at their home stations and 59 times elsewhere. Turtles marked in the latter part of the fishing had a lessened chance of being seen repeatedly at their home station. Disregarding this for the moment, if the turtles were distributed evenly

among the stations after being marked, one would expect that they would have been seen eight times as often away from their home stations (of 9 periods fished (three, three-week periods and three men fishing) 8 are at stations away and one is at the home station) instead of a little less than half as often ($\frac{59}{128}$). Attempting to take account of the lessened exposure to being seen at their home stations, I calculate that the 60 painted turtles had 654 days of exposure to being seen at their home stations after marking and 6,600 days of exposure to being seen elsewhere (simply adding up for each turtle the number of days left after marking for it to be seen at its home station and the number of days left for it to be seen during each of the other 8 fishing periods and totalling for all 60 turtles). Now $\frac{6600}{654} = 10.1$. Thus assuming the marked turtles to be evenly distributed among all stations, they should have been seen more than 10 times as often away from their home stations as at them. Actually they were seen less than half as often away from their home stations. Therefore marked painted turtles were seen about 22 times ($10.1 \times \frac{128}{59}$) as often at their home stations as they would be on the random distribution hypothesis. Separate analysis for each of the stations show a similar result in each case; there is an excess of marked turtles seen at home stations over those seen elsewhere by ratios of 5:1 and up. These figures show a very highly significant difference between the painted turtle returns to original stations and random movements.

Similarly, with the musk turtles, 38 turtles were caught at 6 stations in the first 44 days. These turtles were seen a total of 42 times at their home stations after marking (80 times counting marking capture) and only 7 times elsewhere. Thus, where one would expect after marking, to see them 8 times as often away from their home stations,

they were actually seen 6 times as often at their home stations. This is 48 times as often as they would be expected to be seen. Again, attempting to take account of the lessened exposure to being seen at their home stations, I calculate that the 38 musk turtles had 318 days of exposure to being seen at their home stations after marking and 3,660 days of exposure to being seen elsewhere. Now $\frac{3660}{318} = 11.5$. Thus assuming the marked musk turtles to be evenly distributed among all stations, they should have been seen more than 11 times as often away from their home stations as at them. Actually they were seen 6 times as often at their stations as away from them. Thus marked musk turtles were seen 69 times ($11.5 \times \frac{42}{7}$) as often at their home stations as they would be on the random distribution hypothesis. A very highly significant difference is thus also shown between musk turtle returns and random movements.

The phenomenon of returns from the dock to the home station for individual turtles is even more striking. As noted before, the champion No.44, returned to station 46 thirteen times in eighteen days. This would seem, on almost any theory, far from a coincidence. To make a rough estimate of the chance that a turtle moving at random would be seen 3 or more times back at his home station would require some assumptions to start with. Whether the ones made are at all in conformance with the facts would require additional knowledge of the mobility, wanderlust, etc. of turtles. However the assumption that a turtle is never present at two different fishing stations where observers were present, in the same day (and this occurrence is not reported), and that turtles travel at random from the dock, seem weaker than necessary. If we assume that the chance is no more than 1 in 10 that a turtle travelling at random would return to a particular station within two

days, the chance that a turtle would do this 3 consecutive times would be 1 in 1000. When 148 turtles are involved the chance that a single turtle would return 3 times in 6 days is about 1 in 7. Yet actually 6 painted and 1 musk turtle did as well or better. Statistically this is extremely improbable if the movements were of a random nature. If we relax the time restrictions slightly, nearly twice as many turtles would be included. To this we must add that a turtle may be hindered in returning by disease, death or shock and that a turtle may be at or near a station but not observed.

It is therefore felt from this experiment that some painted and musk turtles show very definite indications of homing behavior, some individuals exhibiting it more strikingly than others. What reason lies behind this homing behavior is not so well shown. It may be entirely instinct or it may be a more or less steady travelling around the lake perimeter after release, until a recognized location is reached. In this study it was not possible to make numerous enough observations on the turtles from the time of release to arrival at their home station, to indicate whether turtles always headed home along the closest shore line route or not. There is of course the possibility that learning or curiosity on the part of the turtles may have played a part in the experiment.

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