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Fidelity to nesting area of the European pond turtle, *Emys orbicularis* (Linnaeus, 1758)

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ABSTRACT. During a 16-year study (1987-2002) in the Borowiec Nature Reserve (central Poland), 118 nest sites of the turtle *Emys orbicularis* were marked : 115 nest sites of 23 different known females and 3 nest sites of unknown females. For seven females, 8 to 12 nest sites per individual are known from the studied period. For ten other females, 3 to 6 nest sites per individual are known. Two turtles presented long-term (>10 years) fidelity to the nesting area (defined arbitrary as : distances between nest sites were 20 m or less), and several other individuals did so for shorter periods (2-4 years consecutively). Other females did not display such behaviour. Thus, female turtles differed in their fidelity to the nesting area in the studied population.

KEY WORDS : long-term studies, nesting area fidelity, freshwater turtles.

INTRODUCTION

Turtles are considered long-living organisms (Gibbons & Semlitsch, 1982; Wilbur & Morin, 1988; Congdon et al., 2001). Many freshwater turtle species can lay eggs every year, and sometimes several times a year (Wilbur & Morin, 1988; Iverson, 1992). The nest site can influence the hatchlings' sex ratio (Vogt & Bull, 1984; Janzen & Paukstis, 1991), the probability of nest predation (Escalona & Fa, 1998; but see : Burke et al., 1998), as well as the behaviour and survival of neonates (Kolbe & Janzen, 2001). Vogt & Bull (1982) suggested that female turtles can return to the site of their own hatching success. However, females of some freshwater turtle species mature at the age of around ten years (Iverson, 1992; Girondot & Pieau, 1993; Shine & Iverson, 1995), and the conditions of the natal nesting site can change in the interval between hatching and maturity.

Data about the locations of freshwater turtle nests in successive years are scarce. Joyal et al. (2000) reported that some females of the Blanding's turtle (*Emydoidea blandingii*) deposited eggs at distances less than 50 m from their previous nests in consecutive years, while others could lay eggs over 1500 m away. In another study, 8 of 11 Blanding's turtles showed fidelity to a general nesting area (Congdon et al., 1983). Lindeman (1992) found that painted turtles (*Chrysemys picta*) exhibited nest site fixity; he proposed a model in which the female turtle selects a nest site based on certain ecological characteristics that influence offspring survival, and then returns there on subsequent nesting forays as long as the site retains the features for which it was selected. Collecting data to verify such a hypothesis is very difficult, requiring information about many physical parameters, nest locations, and survival of eggs and hatchlings.

Most publications about nesting area fidelity concern marine turtles, and only provide information about placement patterns (distances from the nest to several landscape features, without precise nest site locations) (e.g., Chaves et al., 1996; Kamel & Mrosovsky, 2004; Nordmoe et al., 2004). Publications about freshwater turtles are typically based on short-term studies and present few data (e.g., Lindeman, 1992; Joyal et al., 2000). However, for species that live as long as some freshwater turtles do, long-term studies are important for understanding their natural history. The European pond turtle, *Emys orbicularis* (Linnaeus, 1758), is a long-living freshwater species (Mitrus & Zemanek, 2004). In this study I used nest location data recorded from 1987 to 2002 to determine whether these turtles exhibit fidelity to the nesting area.

MATERIAL AND METHODS

Fieldwork was conducted from 1987 to 2002 in the Borowiec Nature Reserve (BNR), situated in the Zwolenka River valley (central Poland, Radom district). Each year during the egg-laying period (mid May to mid June, depending on the weather), European pond turtle females, on their way to nesting areas or while nesting, were observed with binoculars. Some open areas were raked so that the tracks of females could be followed easily. Nests were marked by placing four pegs at the corners of a 50 cm square with the nest in the centre. All sites where eggs were deposited were marked as nest sites (abandoned digs were very rare during the study, and were not included in the analysis) : the egg-laying process was observed, hatchlings were taken for rearing as part of an active protection program (Mitrus, 2005), and/or pieces of eggshells from disturbed nests were observed.

Turtles were marked by notching the marginal scutes (Plummer, 1989), or (before 1991) numbers were engraved on the second vertical scute of the carapace. It was impossible to state the age of the observed females, except for E06, E85, and E101 (the "E" numbers are the identification numbers of the animals). Female E06 was marked when young in 1987 (about 6 years old as judged by the number of growth rings on scutes; M. Zemanek, pers. comm.), and was first observed during egg-laying in 1993. Individuals E85 and E101 had 11 growth rings in 2000 and 2001, respectively, when they were seen during nesting; previously they had not been spotted on land during the egg-laying period.

Nest sites were located on a 1 :5000 map of the study area, drawn on the basis of an aerial photo taken in 1997. Distances between the successive nest sites of each female were measured using the map. The map scale and precise descriptions in fieldwork notes made it possible to mark the nest sites on the map to an accuracy of 10 m. Based on the aerial photo and field observations, eight types of habitat were distinguished (see map symbol inset, Fig. 1). All the nest sites were classified as localized in one of the eight types of habitats.

Statistical analyses were done using Statistica ver. 5 (StatSoft Inc., 1999). For each female for which three or more nest sites were known, a distance matrix was calculated by cluster module analysis in Statistica. Average distances between nests for different intervals between nestings (1 year, 2 years, etc.) were calculated, and graphs of the average distances for the different intervals were drawn. Although statistically the average distances between nests of a single individual are not independent quantities, females that show nesting area fidelity are marked on the graph as points nearest the horizontal axis.

Arbitrarily, a distance of 20 m or less between consecutive nests of a given female was taken to indicate that the female displays nesting area fidelity.

RESULTS

Each year from 1987 to 2002, from 2 to 15 nest sites were marked in BNR. No multiple nesting by one female within the same season was observed. A total of 118 turtle nests were marked (Fig. 1) : 115 nest sites of 23 different known females and 3 nest sites of unknown females.

Seven females were found nesting a total of 65 times (range 8-12 per female) during the 16-year study. Ten other females were found nesting a total of 41 times (range 3-6 per female) during the same period.

Two females (E13 and E14) presented nesting area fidelity during the whole studied period (Fig. 2A, B). Some others presented nesting area fidelity during shorter periods, from two to four consecutive nestings. The rest did not show such behaviour.

The two highest measured distances between two nests of one female were about 840 m (female E54, nest sites in 1997 and 1999 vs. 2001) and about 690 m (female E11, nest sites in 1995 vs. 1999). The two highest distances between two nests of one female from two consecutive seasons was about 650 m (E54, nest sites in 2001 and 2002) and about 470 m (female E11, nest sites in 1998 and 1999).

Most clutches were deposited on xerothermic slopes and barrens (105 of 118 known nests; Fig. 1). Eggs were also deposited on agricultural fields that were in use or lying fallow (11 of 118), and on field roads and paths (2 of 118). Several more were deposited on barrens but less than 2 m from field roads).

Nest sites of probably young females are indicated in Fig. 1.

DISCUSSION

Most freshwater turtles lay eggs close to bodies of water, but some species or individuals can lay eggs even hundreds of meters from water (Burke & Gibbons, 1995; Burke et al., 1998). Such behaviour was reported earlier for the European pond turtle (Rovero & Chelazzi, 1996; Paul & Andreas, 1998) and observed during this study. In the studied population, however, most of the turtle nests were located less than 150 meters from water bodies (Fig. 1).

In studies of Blanding's turtles, only a proportion of individuals were found to present fidelity to the nesting area (Congdon et al., 1983; Joyal et al., 2000). The same was true in the present study. Very prolonged fidelity to the nesting area characterized only two of the seven European pond turtle females for which 8-12 nest sites per female were marked (females E13 and E14, Fig. 2A, B). Some females showed fidelity for shorter periods (2-4 consecutive nestings). Most known nests of each of the individuals were located not far from previous nesting sites. The shortest distance (measured in the field) between nest sites was about 1.2 m (for female E14, nests in years 2000 and 2001; S. Mitrus, unpublished data).

Some females presented fidelity to the nesting area in some seasons but later changed the area. My field observations suggest that usually this was because the area was shaded by growing trees or destroyed. As Lindeman (1992) proposed in his model, probably the females started to lay eggs at other nesting areas when ecological characteristics had changed and no longer were good for egg incubation. However, from 1989 to 1997 the eggs or hatchlings from all known clutches were taken for breeding as part of an active protection program (Mitrus, 2005), so the data about hatchling survivorship versus nesting area and versus individual female are fragmentary and cannot be generalized.

None of the six females for which only 3 to 6 nest sites per female are known presented fidelity to the nesting area as arbitrarily defined. Two of them laid eggs on both slopes of the river valley. However, during egg-laying time (or on the way to nesting areas) it is easier to locate a female that presents nesting area fidelity and whose nesting area is well known. Thus, large distances between nests from consecutive nestings could be more frequent than presented in this study.

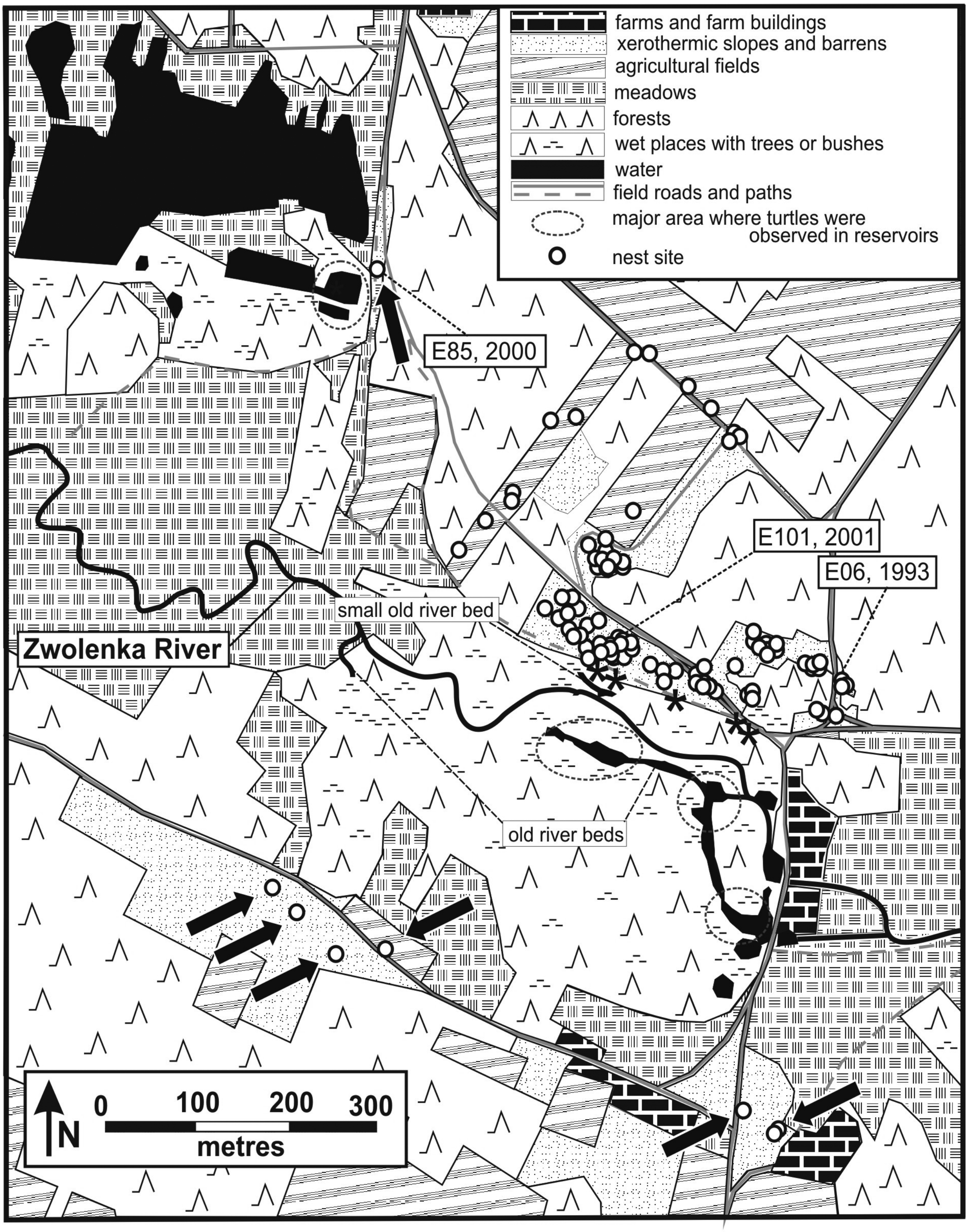

Fig. 1. – Distribution of nest sites of the turtle *Emys orbicularis* from 1987 to 2002 in the Borowiec Nature Reserve (central Poland). Each circle represents a nest site. Some circles are obscured in densely nested areas. Nests marked E06, E85 and E101 followed by year of oviposition probably belong to young females (see text for details). Arrows point to nest sites away from the main groups.
The map was drawn on the basis of a 1997 aerial photo. "E" numbers are the animal identification numbers. Asterisks show areas where females were typically observed on land at the beginning of nesting migrations.

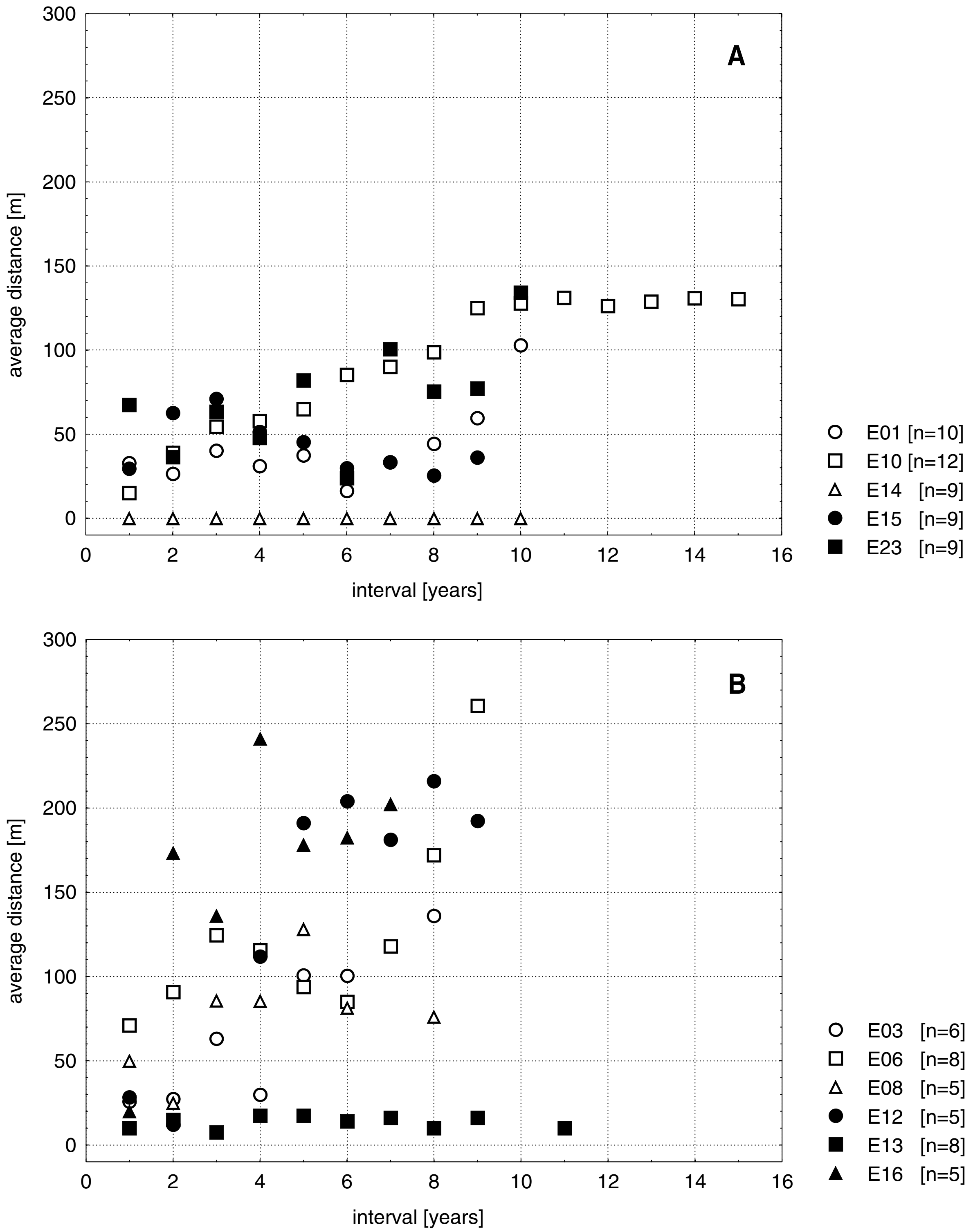

Fig. 2. – Average distance between nest sites at different intervals between nestings of the turtle *Emys orbicularis* from central Poland. Data is shown for females for which 5 or more nest sites are known. ”E” numbers are the animal identification numbers. Numbers in brackets are the numbers of known nest sites of each female from the 16-year study.

Another kind of fidelity is habitat fidelity : 105 of 118 known nests (89%, cf. Fig. 1) were made in areas described as xerothermic slopes and barrens. Most females laid eggs only in such areas, but 4 of the 5 known nest sites of female E16, for example, were laid on agricultural fields, and 1 of the 5 was on a field road (S. MITRUS, unpublished data). Apparently, turtles generally display habitat fidelity and some also exhibit nesting area fidelity within that habitat.

No data about the home ranges of turtles from BNR are available. During the summer, mature turtles are typically found in large old river beds and ponds (Fig. 1). Just before the nesting season, however, several can be seen in a small old river bed; on 14 and 15 May 2000, five mature females and one male were captured in the small old river bed. It is probably part of the migration route, but females starting from the same area could use different nesting areas (Fig. 1, and S. MITRUS, unpublished data). During nesting migrations, some individuals crossed areas used by other turtles for nesting and went on farther. It is impossible to say whether the turtles found the area unfavourable for egg development or else presented fidelity to other nesting areas (S. MITRUS, unpublished data).

Young females, perhaps laying for the first time, laid eggs rather close to water bodies (Fig. 1), but the paucity of information makes it impossible to characterize nest site selection by young females. Another problem is age estimation. For the turtle in Poland, the number of growth rings on scutes seems to be a good gauge of age up to 14 years (c.f. MITRUS & ZEMANEK, 2004), but the method can be fallible (cf. GERMANO & BURY, 1998), so the description of females as young cannot be unequivocal.

The indicator of fidelity to the nesting area was defined arbitrarily as a distance of 20 m or less between consecutive nest sites of the same female. For the turtle in Poland it seems a good indicator of such behaviour. For other populations of the species, or for other species, a different indicator might be more appropriate.

CONCLUSIONS

In the studied population, females of the European pond turtle differed in their fidelity to the nesting area. Some individuals observed in the study presented fidelity to the nesting area, and others did not. I believe that some turtles changed nesting areas apparently because the vegetation there grew and the former nesting area was shaded. Others changed nesting areas when there were no visible changes in the nesting area environment, and other females laid eggs in those abandoned areas (S. MITRUS, personal observations), indicating that the ecological parameters of the abandoned areas still favoured egg incubation. The reasons for such differences in behaviour are not known.

The turtle exhibits temperature-dependent sex determination (PIEAU, 1971; PIEAU & DORIZZI, 1981). Nest location can influence survival and behaviour (see : Introduction) as well as the hatchling sex ratio (e.g., VOGT & BULL, 1984; JANZEN & PAUKSTIS, 1991). Nests of females laying eggs in the same area could produce larger proportions of males in successive years as the vegetation grows and the nesting area becomes more shaded (cf. VOGT & BULL, 1982). Thus, females that do not exhibit nesting area fidelity could have a larger influence on the offspring sex ratio. Such behaviour might also be a useful strategy if predators can learn where turtle nests are located and return to them in succeeding years.

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