Spatial distribution of nests of the European pond turtle, *Emys orbicularis* (Reptilia: Testudines: Emydidae), from long-term studies in central Poland

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Abstract. Nest sites of the European pond turtle *Emys orbicularis* were marked in the Borowiec Nature Reserve (central Poland) from 1987 to 2002. In this area the turtle could lay eggs once a year. For 13 females, four to 12 nest sites per individual are known from the period studied. Spatial distribution of the sites is presented on maps. Only a small proportion of the female turtles displayed fidelity to a particular nesting sites, whilst others changed their nesting area. Even if there are nesting areas near water bodies, some of the females opt to use other sites. The results of the study suggest that, to gather accurate data about nesting areas used by the turtle, long-term studies are needed. Protection of the used as well as potential nesting areas (on which during short term studies laying was not recorded) could be important for conservation of the turtle.

Kurzfassung. Nester der Europäischen Sumpfschildkröte, *Emys orbicularis*, wurden in der Zeit von 1987 bis 2002 im Naturschutzgebiet Borowiec (Zentralpolen) markiert. In diesem Gebiet legen die Schildkröten einmal im Jahr Eier. Von 13 Weibchen wurden in diesem Zeitraum vier bis 12 pro Individuum gefunden und untersucht. Die räumliche Verbreitung der Nester wird in Karten dargestellt. Nur ein kleiner Teil der weiblichen Schildkröten zeigte eine Bindung an den Nistplatz, während andere den Eiablageplatz wechselten. Besonders wenn sich die Nistplätze nahe von Wasserflächen befanden, neigten einige Weibchen zur Nutzung anderer Plätze. Die Ergebnisse lassen vermuten, dass Langzeitstudien notwendig sind, um zuverlässige Daten über die, von den Schildkröten genutzten Nistplätze zu erhalten. Der Schutz der genutzten und potenziellen Nistplätze, die in den Kurzzeitstudien nicht erfasst werden konnten, können wichtig für den Schutz der Schildkröte sein.

Key words. Reptilia, Testudines, Emydidae, *Emys orbicularis*, behaviour, distribution of nests, freshwater turtle, nesting area fidelity, reproduction ecology, Poland

1. Introduction

The European pond turtle, *Emys orbicularis*, lives in North Africa, the Iberian Peninsula, most parts of South and Central Europe, as well as in Asia Minor and Central Asia (Fritz, 1998). It is an endangered species in many parts of its range (cf. Fritz & Andreas, 2000). Now it is an intensively studied species (Ota, 1999; Hödl & Rössler, 2000; Fritz, 2003), although most reports about the natural history of the turtle are based on short term research. However, turtles are considered as long-living organisms (Wilbur & Morin, 1988; Shine & Iverson, 1995) and as such, for planning protection of the European pond turtle, the value of such studies are limited.

Schneeweiss & Steinhauer (1998) reported that three females of the European pond turtle migrated probably to the same areas as 24 years previously. However, data concerning the localities of freshwater turtles' nests in subsequent years are scarce (cf. Mitrus, 2006). Such information is important for understanding the ecology of the species, as well as for making plans for its conservation. If nesting areas are used during long periods, knowledge about their localities could be essential in order to protect populations of the turtle. However, as turtles are long-living animals it is very probable that during their life, the ecological parameters of nesting areas could change and females would be forced to look for new nesting areas.

In a previous article (MITRUS, 2006) I have shown that some females of the European pond turtle from central Poland, do display a long-term fidelity to a specific nesting area, but that other individuals do not exhibit such behaviour. However, I provided a map showing the spatial distribution of all known nest sites from the period 1987–2002 only; without data for those sites were used by specific individuals (cf. MITRUS, 2006). I think that precise data about the spatial distribution of nest sites of different individuals is important. Such information could be very useful for planning research on populations of the turtle, and plans to establish new protected areas. In this article, I provide precise data about nest site localisations during the period 1987 to 2002, of individuals for which four or more nest sites are known.

2. Materials and Methods

Fieldwork was conducted from 1987 to 2002 in the Borowiec Nature Reserve (Zwolenka River valley, central Poland, the Radom district). The location of the study site is presented in MITRUS & ZEMANEK (2004), and more information about the reserve – in ZEMANEK (1992).
Turtles were marked by notching the marginal scutes (PLUMMER, 1989) or – before 1991 – the numbers on the second vertical scute of carapace were engraved (MITRUS & ZEMANEK, 1998). For each year during the egg-laying period (mid May to mid June, depending on the weather), the European pond turtle females were observed with binoculars on their way to nesting areas or while nesting. The age of most females is not known (cf. MITRUS, 2006). Nests were marked by placing four pegs at the corners of a 50 cm square centered on the nest. In all sites marked as nest sites, eggs were deposited (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 & ZEMANEK, 1998), and/or pieces of eggshells from disturbed nests were observed.
The sites were located on a map in the scale of 1 : 5.000, drawn on the ground on the basis of an aerial photo from 1997. Due to the precise descriptions given in the fieldwork notes it was possible to show nest site localities with precision to within 10 m.
Statistical analyses were done using the software package Statistica, ver. 5 (STATSOFT INC., 1999). Between-stand similarities of nest sites distribution were identified using cluster analysis with three methods of agglomeration: unweighted pair-group average (UPGA), weighted pair-group average (WPGA) and Ward's (MANLY, 1989; HAIR *et al.*, 1992). Euclidean distances were used. In the analysis data were used for females for which three or more nest sites are known.
Arbitrarily, a distance of 20 m or less between consecutive nests for a given female was taken to indicate that the female displays nesting area fidelity.

3. Results

Each year (from 1987 to 2002), in the studied area, from 2 to 15 nest sites of the European pond turtle were marked. No multiple nesting by one female during one season was observed. A total of 118 nests for the turtle were marked: 115 nest sites of 23 different females, and three nest sites of unknown females.
The nests of six females were found a total of 29 times (range 4–6 per female) during the 16-year study (Fig. 1.). For the next seven females, 65 nest sites are known (range 8–12 per female; Figs 2A, B). For another four females three nest sites per individual are known.
The three dendrograms obtained by clustering sites according to the nests' localities were quite similar for the different agglomeration methods used. All the methods divided nest sites in similar groups, although, there were differences with the aggregations of the groups. The

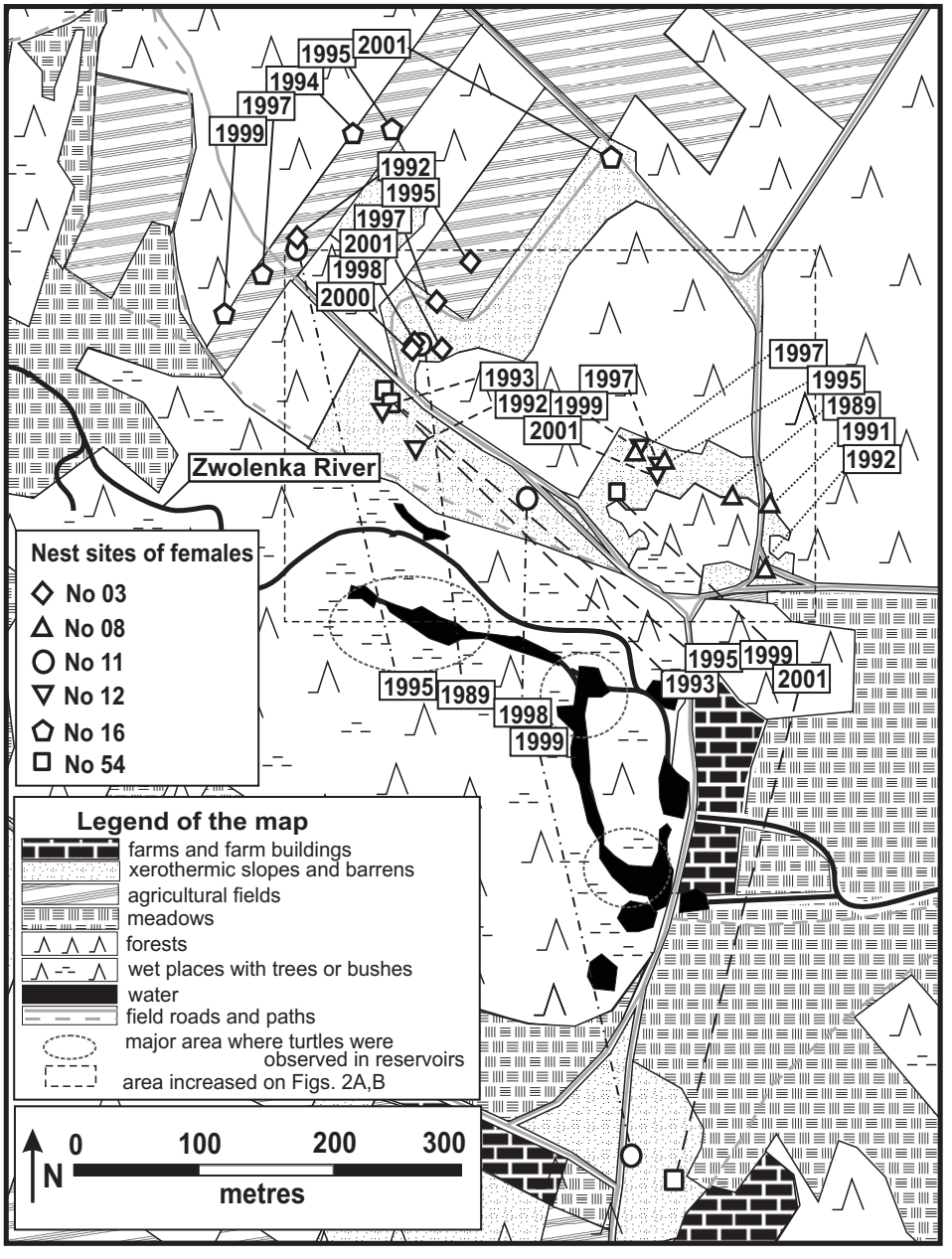

Fig. 1. Nest sites localities in the Borowiec Nature Reserve (central Poland) and years of laying; data for the females of the turtle *Emys orbicularis* for which 4 to 6 nests per female from the 16-year period (1987-2002) are known. Different figures represent the nest sites of different individuals. The "E" numbers are the identification numbers of the animals.

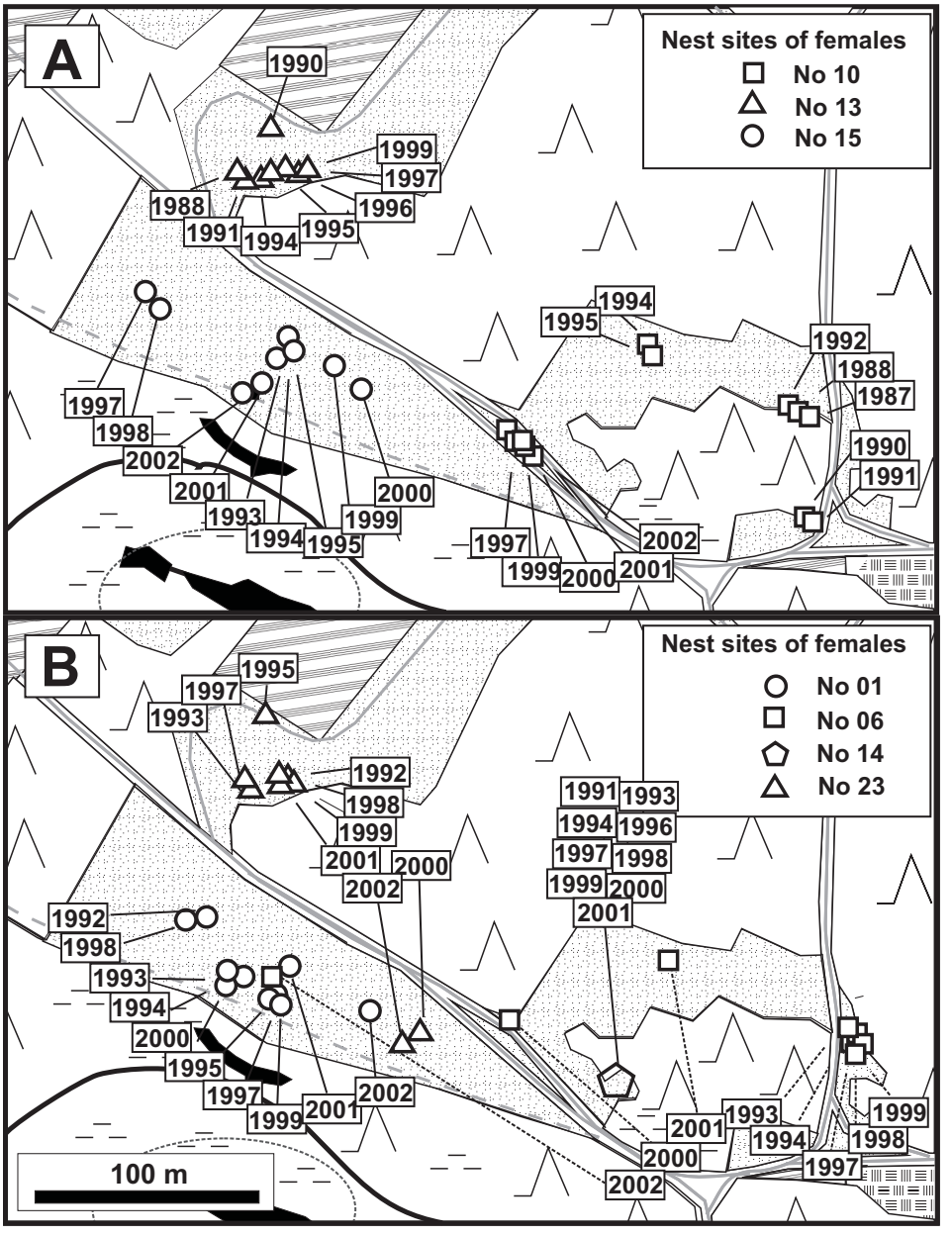

Fig. 2A, B. Nest site localities in the Borowiec Nature Reserve (central Poland) and years of laying; data for the females of the turtle *Emys orbicularis* for which 8-12 nests per female from the 16-year period (1987-2002) are known. Different figures represent the nest sites of different individuals. The "E" numbers are the identification numbers of the animals. Map legend – see Fig. 1.

dendrogram based on UPGA agglomeration corresponded to distances between nesting areas in the field, so I have printed this one (Figs 3A, B).
Two females (E13 and E14; the "E" numbers are the identification numbers of the animals) displayed nesting area fidelity during throughout the studied period (Figs 2A, B and Figs 3A, B). Some others showed nesting area fidelity over a shorter period – from two to four consecutive nestings (e.g. E06, E10, E15, E23; Figs 2A, B and Figs 3A, B). However, other females did not show such behaviour (e.g. E11, E54; Fig. 1 and Figs 3A, B).

4. Discussion

During the study, no multiple nestings by the European pond turtle during one season were observed. This supports the results of other studies; namely, that in central Europe the turtle lays eggs once a year (Andreas & Paul, 1998; Jabłoński & Jabłońska, 1998; Mitrus & Zemanek, 1998; Schneeweiss *et al.*, 1998).
In order to show the spatial distribution of nest sites, I have chosen the nesting sites of females for which 4 or more clutches are known. Some of the females display long-term (> 10 years) fidelity to a nesting area (Figs 2A, B and Figs 3A, B – females E13 and E14; cf. Mitrus, 2006), whilst for others the fidelity period is shorter (Figs 2A, B and Figs 3A, B – E06: 1997–1999, E10: 1999–2002, E15: 1993–1995; cf. Mitrus, 2006). Knowledge about used nesting areas could be important for protecting a particular turtle population. However, some females do not show fidelity to a particular nesting area (Fig. 1 and Figs 3A, B; cf. Mitrus, 2006); thus, for population conservation, protection of known as well as potential nesting areas could be essential.
In the studied population most turtle nests were localised in a distance shorter than 150 meters from water bodies (Mitrus, 2006). Such behaviour was reported earlier for the European pond turtle (Rovero & Chelazzi, 1996; Paul & Andreas, 1998). However, in the studied population there are also females that deposit their clutches distinctly farer away from shorelines (about 150 m from the closest water bodies, in the studied population e.g. females E03, E16, Fig. 1), and during nesting migrations they crossed nesting areas of other turtles (e.g. female E03 during breeding migrations crossed areas used by females E01 and E15, cf. Fig. 2A, B; S. Mitrus, M. Zemanek – unpublished data). The reason for such behaviour is not known. However, it could be important for plans to protect the turtle: even if there are good nesting areas close to water bodies and some individuals lay eggs on these areas, other individuals could use different areas (sometimes a long distance from water).
Some individuals of the European pond turtle in the studied population displayed fidelity to a particular nesting area, but changed the nesting areas when vegetation grew larger and the original site was overshadowed by growing trees, e.g.: areas used by female E10 in years 1987–1992 (Fig. 2A), by female E06 between 1993 and 1999 (Fig. 2B), as well as by female E08 in years 1989, 1991, 1992 (Fig. 1; S. Mitrus & M. Zemanek – unpublished data). Thus, as proposed by Lindeman (1992) in his model, the females probably changed nesting areas when certain ecological characteristics changed and were no longer suitable for egg incubation. In the model, a female selects a nest site, and then returns there on subsequent nesting forays as long as the site retains the features for which it was selected; the site is changed, when they are disturbed by man or shaded by growing trees and bushes (Lindeman, 1992).
However, some of the female turtles changed nesting areas without visible changes in the environment. Sometimes, it was observed that a female visited the nesting area used in the previous year, started to look for place to lay her eggs, but after some hours changed the nesting area: in 2000, female E23 initially visited nesting area used in years 1992–1999,

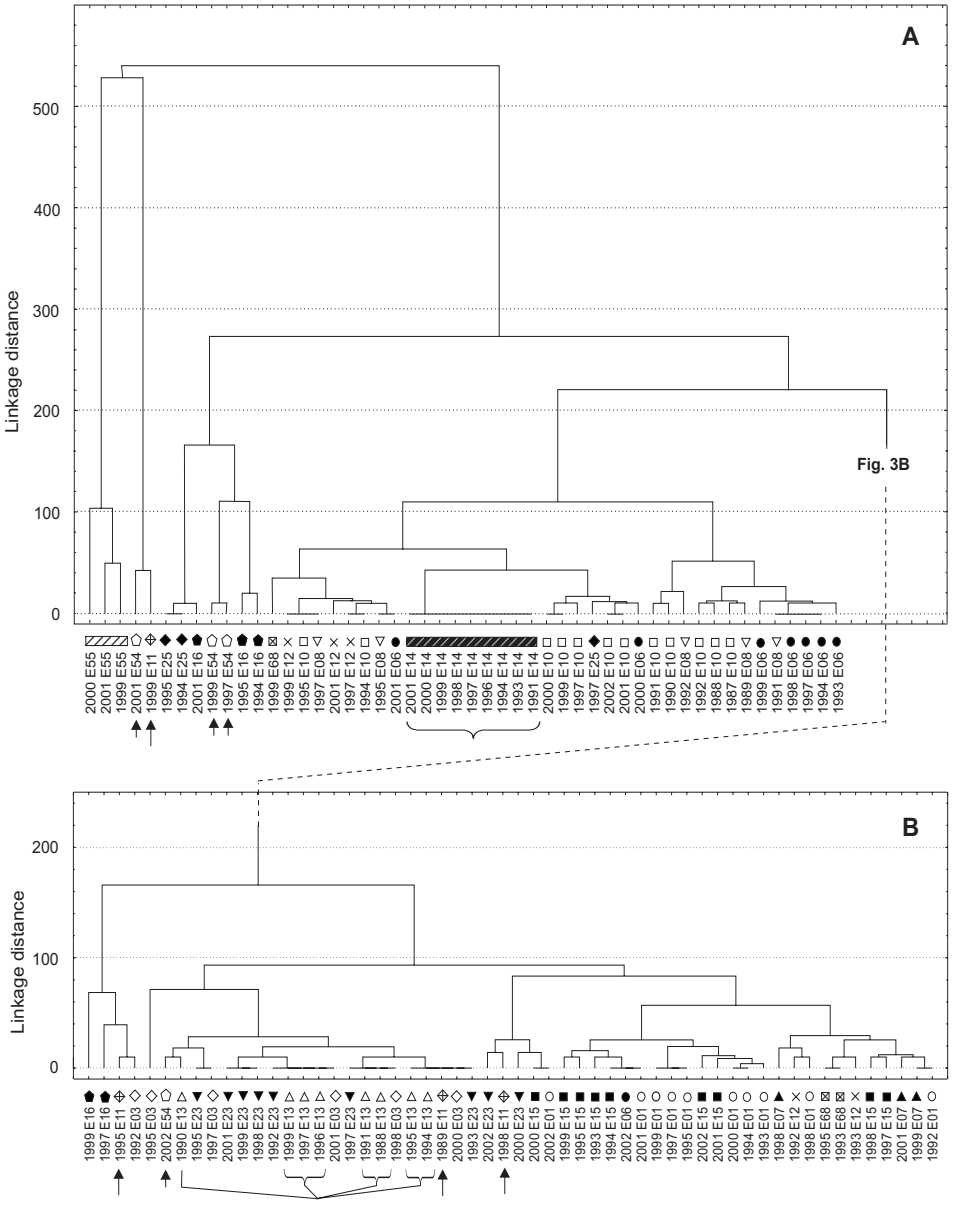

Fig. 3A, B. Clustering of nest sites of the turtle *Emys orbicularis* from central Poland (Euclidean distances, unweighted pair-group average). As the distances were measured with a precision to 10 m, the true distances between nesting sites could be greater than presented on the figure. The "E" numbers are the identification numbers of the animals. The arrows show an example of two females, which do not show fidelity to any one nesting area; braces – two females, which display fidelity to a given nesting area during some successive seasons.

but afterwards laid her eggs on a different area (Fig. 2B); likewise, female E06 in years 1997–1999 and 2001 (Fig. 2B; S. MITRUS & M. ZEMANEK – unpublished data). But in central Poland no research on environmental parameters was undertaken, and it is not possible to generalise the information.
I have shown that some females of the European pond turtle could use the same area during up to 10 consecutive years, sometimes even more (e.g. E14, Figs 2B, 3A). JABŁOŃSKI & JABŁOŃSKA (1998, p. 143) estimated that the length of time during which turtles use the same or nearby nesting sites was a minimum of 60–70 years. However, the authors presented no empirical data to support this conclusion, thus the information (and probably even the estimation of the females' age) are rather anecdotal. To understand the life history of freshwater turtles, information about their longevity as well about the length of the reproduction cycle and long-term distribution of the nest sites are needed.

5. Conclusions

1. To gather information about the selection of nesting areas by the European pond turtle, long-term and concern on many individual studies are needed.
2. In central Poland only some female turtles displayed fidelity to a particular nesting area.
3. Even if there are nesting areas near water bodies, some female turtles use other ones, sometimes a long distance from water.
4. Female turtles are able to change nesting area even if there are not easily visible changes in the used nesting areas. Reason for such behaviour is not yet known, but for the turtle conservation it is also important to protect potential nesting areas (e.g. on which laying was not observed during short-term studies). It is probable, that after renaturalisation of disturbed nesting areas, females (or part of them) return to lay eggs on the area.
However, as in different parts of the turtle distribution area, the reproductive behaviour could be different; thus fidelity to nesting areas could also be different.

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