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Distribution of amphibians and reptiles in central Poland: 1980–2000

Abstract: Based on 3047 records from 97 recorders distribution maps were drawn for the amphibians and reptiles of central Poland (from 51°00'N to 52°15'N and from 18°20'E to 20°20'E). The study area was divided into 180 atlas fields based on the geographic grid. All data were gathered in 1980–2000, most of them (67%) however, in 1995–2000. 13 taxa of amphibians were found in 143 atlas fields and 6 species of reptiles were found in 121 atlas fields. The amphibians were (given with the number of atlas fields with the species found): 119 – Common frog *Rana temporaria* Linnaeus, 1758; 114 – Common toad *Bufo bufo* (Linnaeus, 1758); 97 – Moor frog *Rana arvalis* Nilsson, 1842; 94 – Fire-bellied toad *Bombina bombina* (Linnaeus, 1761); 93 – Pool frog *Rana lessonae* Camerano, 1882; 87 – Tree frog *Hyla arborea* (Linnaeus, 1758); 85 – Green toad *Bufo viridis* Laurenti, 1768; 72 – Smooth newt *Triturus vulgaris* (Linnaeus, 1758); 70 – Spadefoot *Pelobates fuscus* (Laurenti, 1768); 69 – Edible frog *Rana* kl. *esculenta* Linnaeus, 1758; 39 – Great crested newt *Triturus cristatus* (Laurenti, 1768); 30 – Marsh frog *Rana ridibunda* Pallas, 1771 and 28 – the Natterjack *Bufo calamita* Laurenti, 1768. The reptile species (given with the number of atlas fields) were: 94 – Sand lizard *Lacerta agilis* Linnaeus, 1758; 72 – Slow-worm *Anguis fragilis* Linnaeus, 1758; 67 – Common lizard *Lacerta vivipara* Jacquin, 1787; 60 – Grass snake *Natrix natrix* (Linnaeus, 1758), 57 – Adder *Vipera berus* (Linnaeus, 1758) and 4 – the Smooth snake *Coronella austriaca* Laurenti, 1768. Six adult specimens of the European pond terrapin *Emys orbicularis* (Linnaeus) were also found, but breeding of this species in the area studied was not confirmed.

Key words: faunistics, atlas project, amphibians, reptiles, central Poland.

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1. Introduction

Data on the distribution of different species are invaluable in estimating abundance of a given species, in evaluating hotspots of species richness and in determining regional or country priorities for conservational purposes (HAILA, MARGULES 1996; GASC et al. 1997). Studies on the distribution of species are usually carried out on the basis of their presence or absence in national or regional atlas grid squares. The mapping method used, although not perfect (STRAYER 1999), has been widely employed in many regional or country atlas projects (TAYLOR 1948, TAYLOR 1963; PLANT 1983; HEATH et al. 1984; FOG 1988; NILSON, ANDRÉ 1988; BUCKLEY 1989; KUIPER et al. 1989; ZEMANEK, RAFIŃSKI 1989; MAJERUS et al. 1990; TERHIVUO 1993; ARNOLD 1995; GASC et al. 1997; CLEMONS 1998; HARRISON, BURGER 1998).

The records gathered often by amateur fieldworkers are biased in many ways. Some regions are poorly covered with either no or very fragmentary data on species richness and distribution. In addition "rare" and "attractive" species are usually favoured amongst recorders more than "common" ones. However, in spite of the deficiency of the data, every effort should be undertaken to make full use of all the existing data. The data set could help us to determine species or area priorities or even safeguard a single locality where particular species occur.

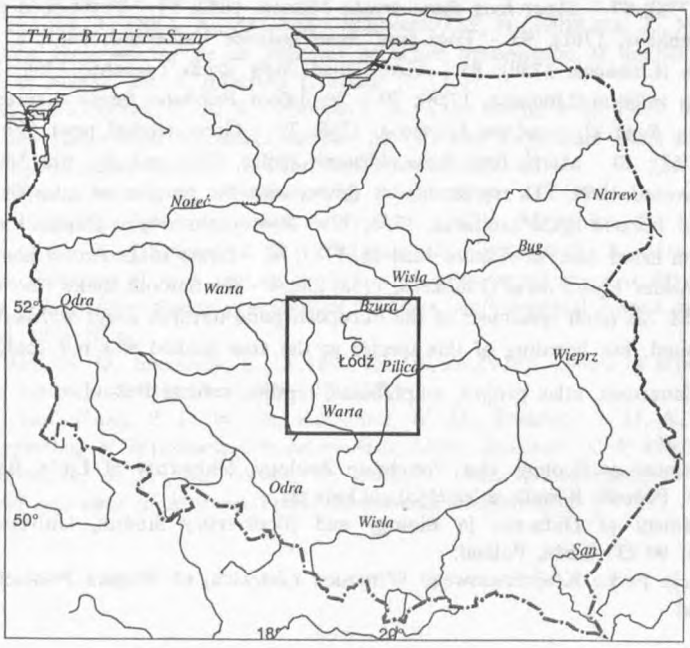

Fig. 1. Map of Poland with the study area

The herptiles of central Poland had not been mapped before this study and very few data on herpetofauna distribution were available. In 1995 we started collecting records on the distribution and status of amphibians and reptiles of central Poland (Fig. 1). The first compilation of records (ZIELIŃSKI et al. in press) is based on data gathered up to the end of 1997. This paper summarizes records supplied up to the end of 2000.

The aim of this paper is to provide a summary on the distribution of amphibians and reptiles in central Poland. The distribution maps which follow are provisional rather than definitive, and it is sincerely hoped that their publication will stimulate more detailed studies.

2. Material and methods

The database consists of records for the presence of herptiles collected for the last twenty (1980–2000) years by 97 recorders. Names of all the observers together with the number of records supplied by each recorder are given below: Adam Danielak (2), Adam Misiak (1), Agnieszka Bała (5), Andrzej Gęgotek (40), Andrzej Klimkowski (60), Anna Frankiewicz (16), Anna Traut (5), Arkadiusz Wojcieszek (6), Barbara Efenberger (1), Barbara Nowak (2), Blazuk (29), Bogdan Kowalski (2), Bogusław Bartos (12), Bogusław Soszyński (20), Cezary Watała (3), Daniel Majewski (2), Dariusz Jędrasiak (3), Dariusz Knapik (10), Dorota Hejduk (11), Dorota Łuszczyńska (1), Dorota Pietrzak (140), Ewa Maciejewska (41), Grzegorz Juszczak (11), Grzegorz Tończyk (14), Grzegorz Zięba (17), Grzegorz Radzicki (28), Hieronim Andrzejewski (2), Iwona Michalak (2), Jacek Dymitrowicz (87), Jakub Szymański (15), Janusz Hejduk (362), Janusz Markowski (48), Jarosław Wawrzyniak (1), Jerzy Sosnowski (80), Joanna Matusiak (65), Katarzyna Watała (5), Katarzyna Wieteska (3), Krzysztof Adamus (8), Krzysztof Gara (12), Krzysztof Kurowski (1), Krzysztof Sokalski (22), Leszek Kucharski (4), Lidia Marszał (44), Maciej Czyżykowski (11), Maciej Rydzyński (12), Maciej Stolarczyk (7), Magdalena Janiszewska (9), Magdalena Kurczewska (24), Magdalena Nowakowska (1), Małgorzata Karczewska (13), Małgorzata Olejniczak (1), Marcin Kaźmierczak (36), Marcin Kociniak (81), Marcin Wężyk (139), Marek Nejman (174), Marek Strzałka (41), Marek Trojak (133), Marian Us (12), Mariusz Glubowski (30), Marta Głowińska (18), Michał Ciepłucha (97), Michał Grabowski (10), Michał Jasiński (57), Michał Stopczyński (341), Mieczysław Gruszka (7), Mirosław Nowicki (16), Mirosław Przybylski (1), Olszycki (5), Piotr Gaszyński (1), Piotr Sosnowski (4), Piotr Zieliński (413), Przemysław Ciszewski (9), Radomir Jaskuła (16), Radosław Jaros (19), Radosław Włodarczyk (3), Rafał Bargiel (2), Roman

Pędziwiatr (9), Ryszard Sąsiadek (4), Ryszard Wojciechowski (47), Sławomir Głuszek (59), Sławomir Góral (11), Sławomir Mielczarek (16), Szymon Milczarek (2), Tadeusz Kurzac (69), Tadeusz Osicki (42), Tomasz Janiszewski (45), Tomasz Kaleta (20), Tomasz Kamiński (21), Tomasz Stoszek (72), Władysław Grochala (1), Zbigniew Kołudzki (60), Zbigniew Tracz (3), Zbigniew Wojciechowski (117).

All the records have been carefully checked before use. Doubtful records were verified by contacting the observers and asking for additional information or by direct examination at a site. Additional data were found in the literature. Apart from occasional records supplied by volunteer observers, many records resulted from field trips organized to search for amphibians and reptiles in some under-recorded fields. Starting with the year 1995, based on the records compiled up to the end of the previous year, provisional distribution maps were drawn for each species. The maps in the form of a booklet, together with the recording cards, tapes with the amphibians advertisement calls and the instruction on how to survey herptiles, were sent or given to contributors at the end of winter, during yearly meetings of all the recorders. Thus, each year before the breeding season observers were supplied with the most up to-date distribution maps. Altogether six booklets were produced (ZIELIŃSKI, HEJDUK 1995, 1996, 1997, 1998, 1999, 2000. *Płazy i gady Polski środkowej – wyniki wstępne*. Uniwersytet Łódzki) and the present paper compiles all of them and also the data gathered in the year 2000. All the records gathered are stored in the Department of Ecology and Vertebrate Zoology, University of Łódź.

The study area was divided into 180 fields based on the geographic grid (Fig. 2). Each atlas field covers the area of 5 minutes of latitude (south to north) and ten minutes of longitude (east to west), that is about 110 km^2. In all the distribution maps shown in this paper the single atlas field (5' high and 10' wide) is used as the recording unit. Each atlas field has its unique identification. Apart from the field name (usually the name of the biggest town or village in the field) each atlas field has two types of identification codes: the country code and the regional code. The role of the country code is to make it possible to identify fields at the country level. For example the atlas field with Zgierz has a country level code 84-06-1-11. However, at the regional level it is much easier to use the simplified version of codes indicated on the left and upper margins of Fig. 2. The regional code for the atlas field with Zgierz is E7.

Green frogs were identified according to the Berger's book (BERGER 1975). In addition the marsh frog was identified on the basis of the males advertisement calls.

Fig. 2. Map of the study area

Sites where herptiles have been artificially introduced have not been mapped. In the distribution maps (Figs. 4–9) all the atlas fields with the species found are black and all the atlas fields with at least one reliable record of an amphibian species or one reliable record of a reptile species (amphibians and reptiles are treated separately) are shaded. Thus it is possible to distinguish atlas fields without any data from fields examined at least partially.

Table 1: Frequency of occurrence of a species in space

Scale of the frequency of occurrence	Percentage of atlas fields with the species recorded (in %)
Very infrequently recorded	< 10
Infrequently recorded	10–20
Less frequently recorded	20–40
Frequently recorded	40–80
Very frequently recorded	⩾ 80

Frequency of occurrence of a species in space (Table 1) refers to the percentage of atlas fields with the species recorded. However, a serious deficiency of the atlas data is that atlas fields differ greatly with respect to the degree of survey effort. In this paper, in addition to the simple frequency measure, an index of a species' frequency of occurrence in space was calculated based on the number of fields and the number of species found in fields studied (ZIELIŃSKI 2001). Abundance refers to the number of specimens recorded at a site. A site is an area of 1 ha in which the herptiles were recorded and counted. The following scale of species abundance at a site was used: very low abundance – 1 or 2 adult specimen recorded, low abundance – from 3 to 10 adults recorded, less abundant – from 11 to 100 adults recorded, abundant – from 101 to 1000 adults recorded, vary abundant – over 1000 adults recorded. However, very few quantitative data on the numbers of amphibians and reptiles of central Poland exist, and this paper gives only a crude estimation of herptiles abundance.

The study area – approx. 20,000 km^2 – covers central, chiefly lowlad Poland from 51°00'N to 52°15'N and from 18°20'E to 20°20'E (Fig. 1, 2). The study area comprises mainly agricultural expanses and is bordered by the Ner and Bzura Rivers in the north, the Pilica and Rawka Rivers in the east, the Warta River in the west and Wieluń Upland in the south. The whole area lies in the Pilica, Warta and Bzura River basins. There are no lakes in the study area. However, there are two big reservoirs situated on the Warta (Jeziorsko Reservoir) and the Pilica (Sulejów Reservoir) River. In addition there are many fishing ponds mainly for carp production.

3. Results

A total of 3047 records of amphibians and reptiles were gathered. 749 records for amphibians were supplied in 1980–1994, 241 in 1995, 322 in 1996, 290 in 1997, 322 in 1998, 349 in 1999 and 95 in 2000. 245 records for reptiles were supplied in 1980–1994, 96 in 1995, 79 in 1996, 72 in 1997, 98 in 1998, 52 in 1999 and 37 in 2000. Thus, majority of records were gathered in 1995–2000 (amphibians – 68%, reptiles – 64%) and the maps represent the most up-to-date distribution of amphibians and reptiles in central Poland.

The data covered 143 (71%) atlas fields with at least one reliable record of an amphibian and 121 (67%) atlas fields with at least on reliable record of a reptile out of the total number of 180 atlas fields. 13 amphibian species were found in 4 atlas fields (Fig. 3), 12 species in 12 fields, 11 species in 16 fields, 10 species in 8 fields, 9 species in 14 fields, 8 species in 9 fields, 7 species in 12 fields, 6 species in 16 fields, 5 species in 14 fields, 4 species in 11 fields, 3 species in 7 fields, 2 species in 12 fields and 1 species was found in 8 fields. Thus, on average, 7 amphibian species were found in one field. The value is certainly underestimated, as not all atlas fields are equally well studied. 6 reptile species were found in 1 atlas field (Fig. 3), 5 species in 24 fields, 4 species in 21 fields, 3 species in 23 fields, 2 species in 23 fields and 1 reptile species was found in 29 fields. Thus, on average, 3 reptile species were found in one atlas field. The value is certainly underestimated, as not all atlas fields are equally well studied.

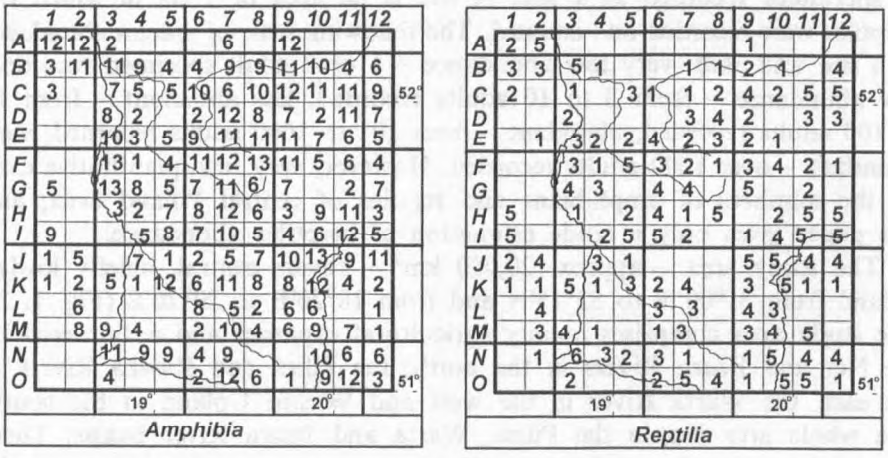

Fig. 3. Number of species of amphibians and reptiles recorded in the atlas fields in 1980–2000. In the background the river system of central Poland

Table 2: Frequency of occurrence in space (FOS) of amphibians in central Poland. A total of 143 atlas fields were studied

Species recorded	Number of fields with the species recorded	FOS (%) without considering the number of species found in each atlas field	FOS (%) after considering the number of species found in each atlas field
Common frog *Rana temporaria*	119	83	92
Common toad *Bufo bufo*	114	80	91
Moor frog *Rana arvalis*	97	68	83
Fire-bellied toad *Bombina bombina*	94	66	79
Pool frog *Rana lessonae*	93	65	80
Tree frog *Hyla arborea*	87	61	76
Green toad *Bufo viridis*	85	59	74
Smooth newt *Triturus vulgaris*	72	50	68
Spadefoot *Pelobates fuscus*	70	49	65
Edible frog *Rana* kl. *esculenta*	69	48	62
Great creasted newt *Triturus cristatus*	39	27	40
Marsh frog *Rana ridibunda*	30	21	32
Natterjack *Bufo calamita*	28	20	26

Table 3: Frequency of occurrence in space (FOS) of reptiles in central Poland. A total of 121 atlas fields were studied

Species recorded	Number of fields with the species recorded	FOS (%) without considering the number of species found in each atlas field	FOS (%) after considering the number of species found in each atlas field
Sand lizard *Lacerta agilis*	94	78	88
Slow-worm *Anguis fragilis*	72	60	77
Common lizard *Lacerta vivipara*	67	55	67
Grass snake *Natrix natrix*	60	50	67
Adder *Vipera berus*	57	47	62
Smooth snake *Coronella austriaca*	4	3	6

Tables 2 and 3 provide approximation of a species' frequency of occurrence in space based on the frequency measure with and without considering the number of specie found in each field. The frequency index calculated after considering the number of species found in each square resulted in higher frequency values for all the species. Data on the number of species of amphibians and reptiles found in each field are presented in Fig. 3 and 4 respectively.

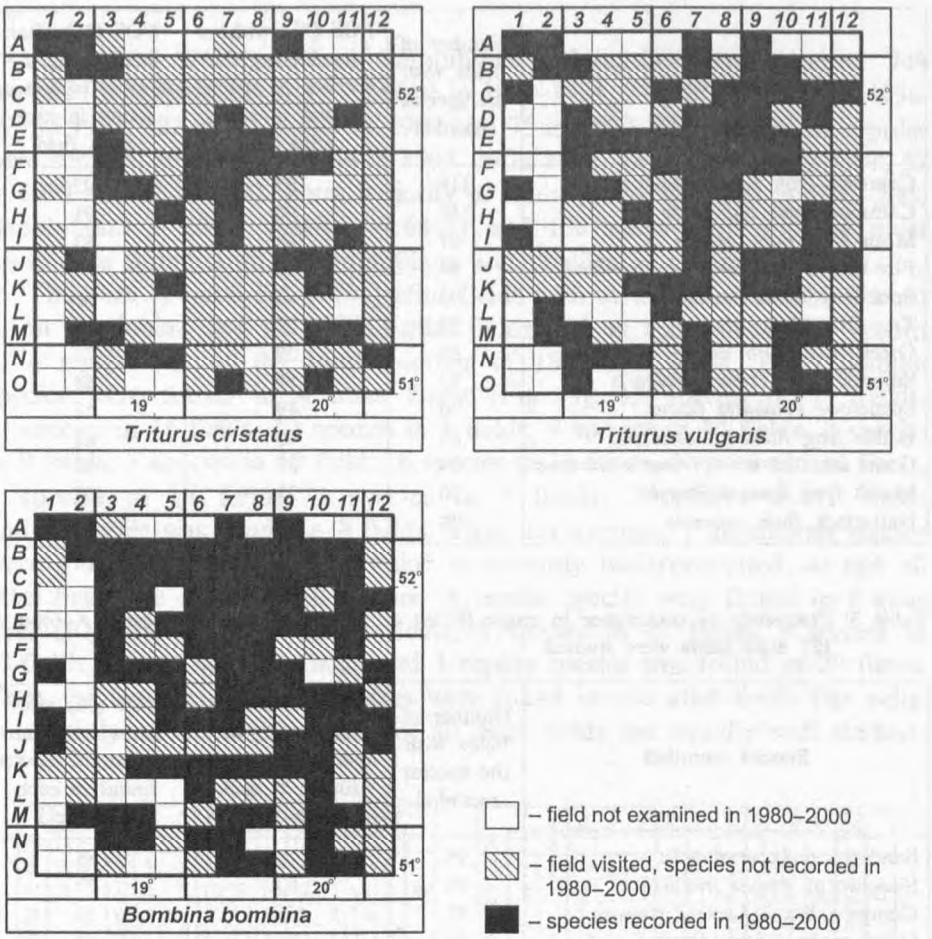

Fig. 4. Distribution of the great crested newt, smooth newt and the fired-bellied toad in central Poland

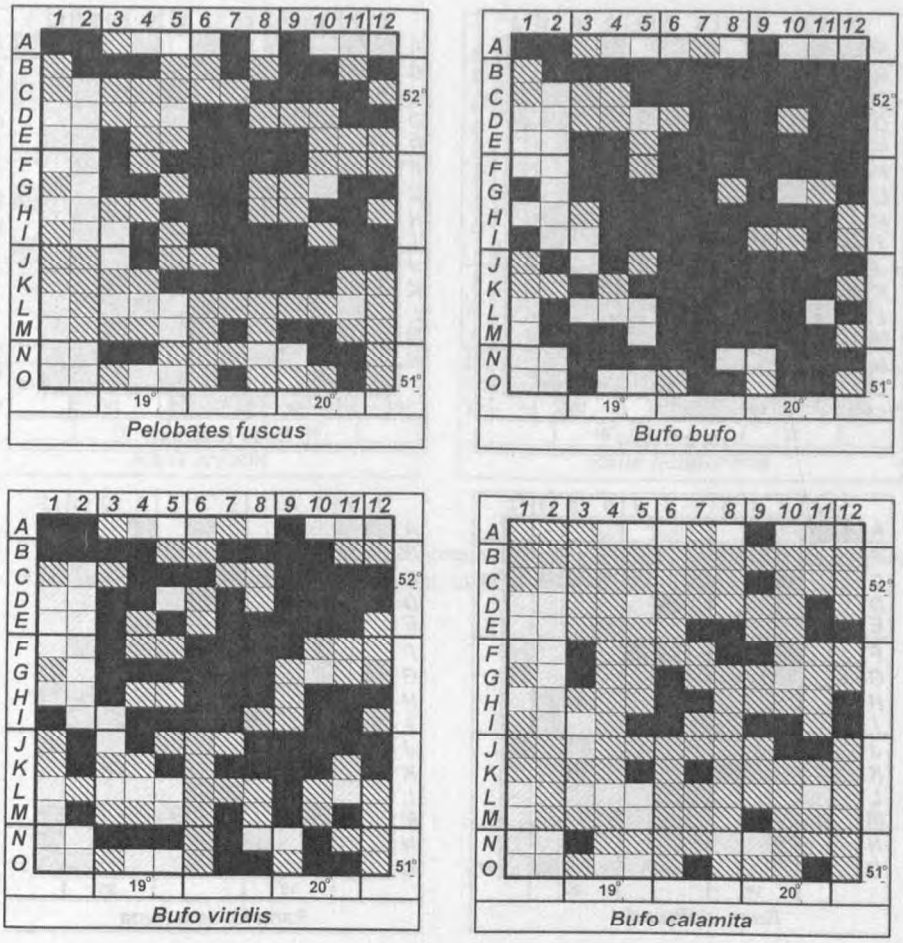

Fig. 5. Distribution of the spadefoot, common toad, green toad and the natterjack in central Poland. For explanation see legend to Fig. 4

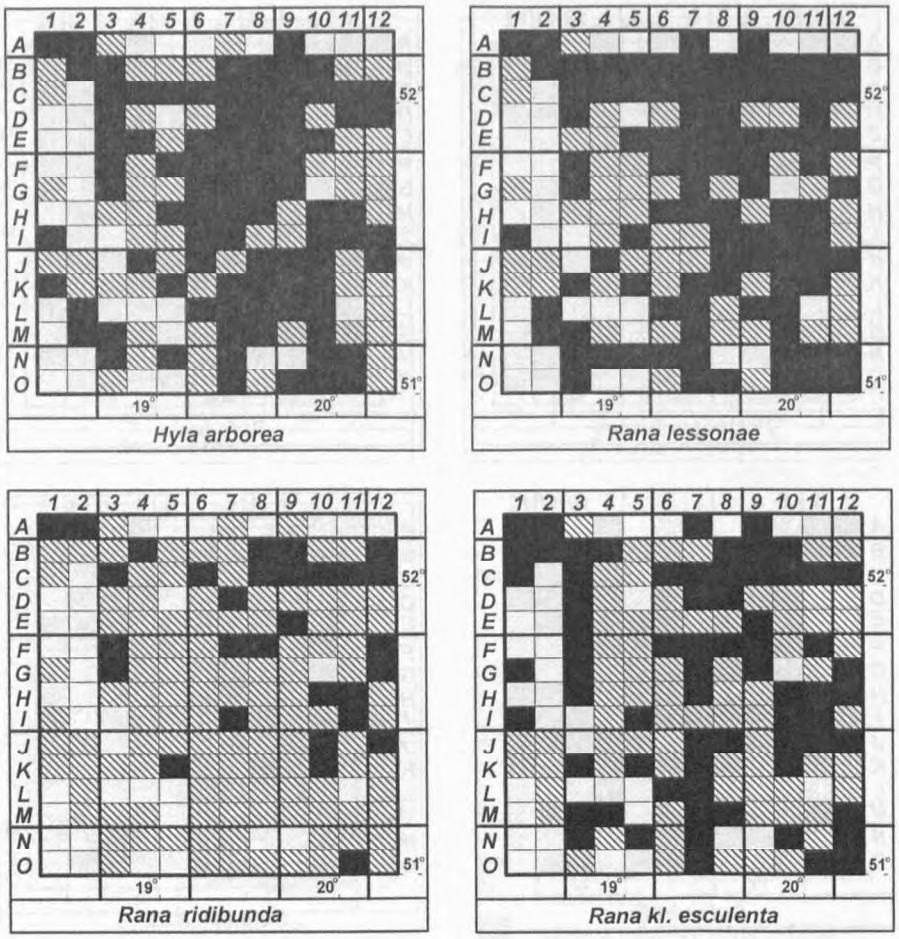

Fig. 6. Distribution of the tree frog, pool frog, marsh frog and the edible frog in central Poland. For explanation see legend to Fig. 4

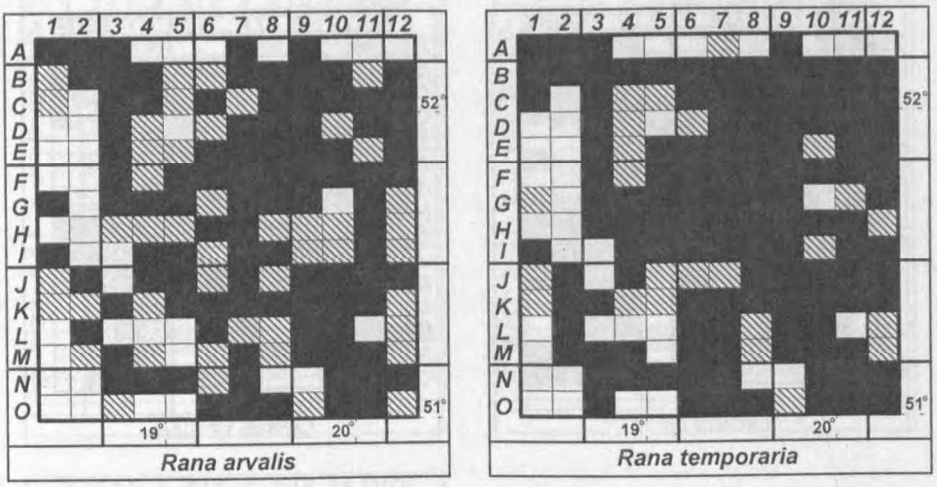

Fig. 7. Distribution of the moor frog and the common frog in central Poland. For explanation see legend to Fig. 4

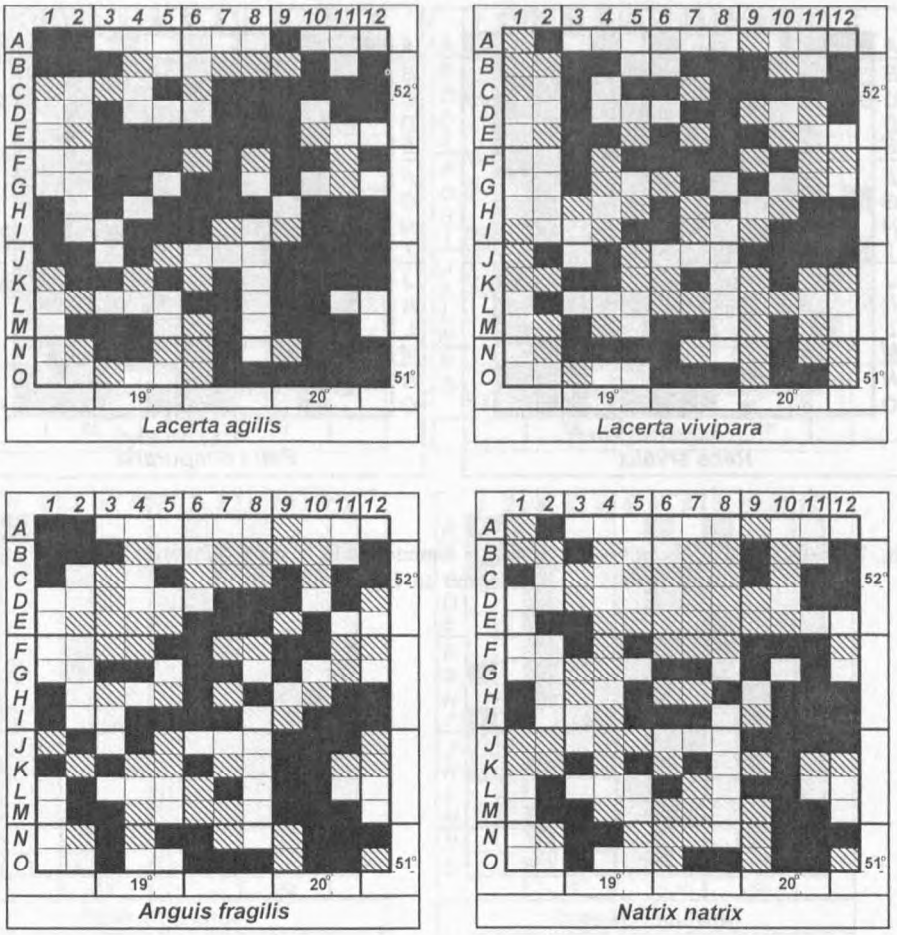

Fig. 8. Distribution of the sand lizard, common lizard, slow-worm and the grass snake in central Poland. For explanation see legend to Fig. 4

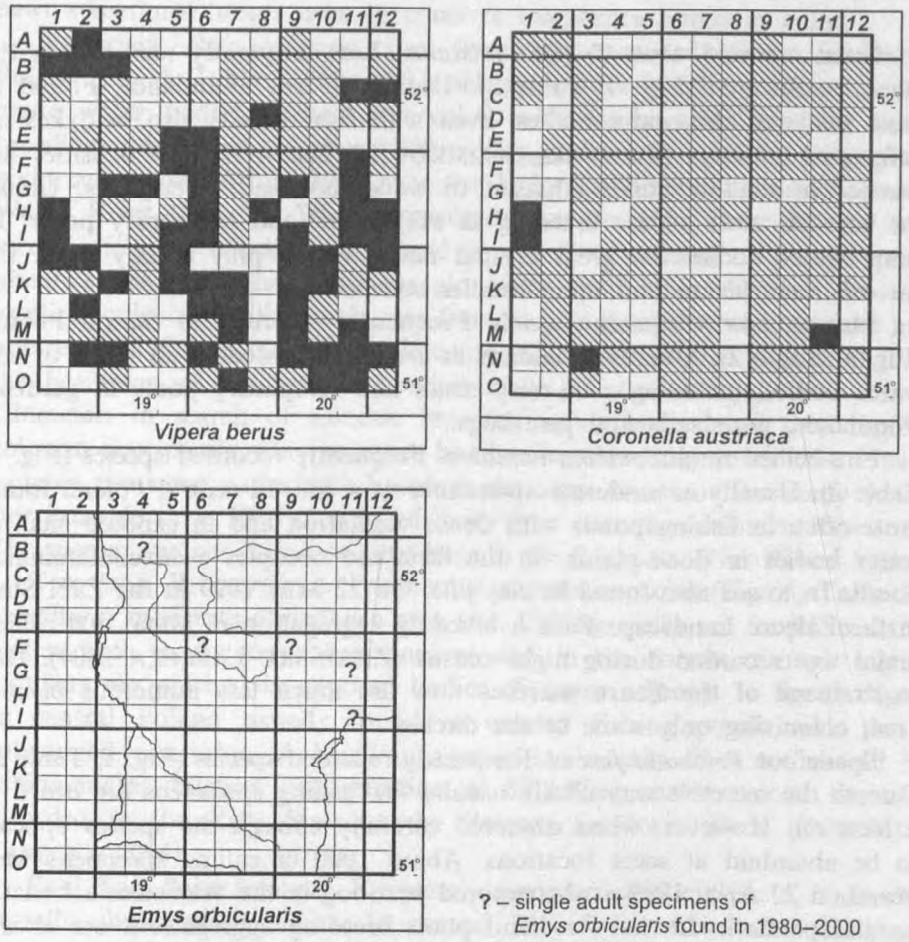

Fig. 9. Distribution of the viper, smooth snake and the European pond terrapin in central Poland. For explanation see Fig. 4

Central Poland supports 13 taxa of amphibians and 6 species of reptiles (Fig. 5–9). The common frog and the common toad were the most frequently recorded species (Table 2, Figs. 5, 7). None of the amphibian species appeared to be very infrequently recorded and only the index of frequency of the natterjack was lower than 30% (Table 2, Fig. 5). Among reptiles the sand lizard was the most frequently recorded species (Table 3, Fig. 8) while the smooth snake appeared to be very infrequently recorded.

The following species of amphibians were found

Great creasted newt *Triturus cristatus*. Less frequently recorded in the whole study area (Fig. 4, Table 2). Usually in low abundance. Found in most kinds of still water bodies, even with fish. Breeds also in dykes on deforested pit-bogs (ZIELIŃSKI, KLIMKOWSKI 2003). Highest densities are reached in shallow ponds adjacent to woodlands and in clay-pits. Unlike the smooth newt avoids breeding in very small and temporary pools. In some water bodies the great crested newts larvae prey mainly upon the smooth newt larvae and upon smaller conspecifics.

Smooth newt *Triturus vulgaris*. Frequently recorded in central Poland (Fig. 4, Table 2). Usually abundant at a site. Recorded in all kinds of still water bodies, including even very small and temporary pools in gardens, woodlands, grasslands and peat-bogs.

Fire-bellied toad *Bombina bombina*. Frequently recorded species (Fig. 4, Table 2). Usually in moderate abundance at a site. In central Poland found most often in fishing ponds with dense vegetation and in exposed shallow water bodies in flood-plains. In the farmland occupies even contaminated ponds. In towns also found in clay-pits. On 22 May 1999 in the Żabi Staw in the Załęcze Landscape Park a breeding aggregation of about 400 calling males was recorded during night census (ZIELIŃSKI, ŁABĘCKA 2004). Due to drainage of the Bzura marshes now are much less numerous in that area, colonizing only some of the ditches.

Spadefoot *Pelobates fuscus*. Frequently recorded species (Fig. 5, Table 2). Due to the secretive way of life usually few calling specimens are heard at a location. However, when observed carefully enough the species appears to be abundant at some locations. About 1000 of calling specimens were heard on 23 April 1999 at the exposed peat-bog in the Wzniesienia Łódzkie Landscape Park. In the woodland pools breeding aggregations are always much smaller. Breeding adults are found in most kinds of water bodies. Breeds even in temporary spring pools on arable fields and pastureland.

Common toad *Bufo bufo*. Very frequently recorded species in central Poland, present in every well-studied atlas field (Fig. 5, Table 2). Usually abundant or very abundant at a breeding site. Highest numbers, even over one thousand of breeding individuals are reached in big and permanent woodland ponds (STOPCZYŃSKI et al. 2004). In the urban and suburban environment abundant only when permanent water bodies are accessible for breeding.

Green toad *Bufo viridis*. Frequently recorded species (Fig. 5, Table 2). Usually in moderate abundance at a breeding site. Prefers exposed water bodies without dense vegetation. Avoids forests (SOSNOWSKI 1997). Often the only amphibian species breeding in new quarries or gravel pits. Also

found in contaminated village and farm ponds. Together with the smooth newt sometimes breeds even in concrete temporary ponds in cities.

Natterjack *Bufo calamita*. Less frequently recorded species in central Poland (Fig. 5, Table 2). The natterjack prefers for breeding exposed, newly made water bodies (ponds, reservoirs) with sandy areas around. Large breeding aggregation of about 300 calling males was recorded during the night census on 12 July 1995 near the Jeziorsko Reservoir situated on the Warta River (Fig. 2). Wood complexes are avoided. There is only one record of a natterjack being found in April in a small woodland pond about 2 km from the wood margin (atlas field H6). However, at that location only one calling male was found and subsequent night checks had not revealed the species at this location. Our observations suggest that at the beginning of the breeding period males of the natterjack move even kilometers in search of suitable breeding water bodies and they rapidly colonize new ponds. On the other hand, when breeding conditions remain roughly the same natterjacks breed at the same locations for many years. For example since 1988 they breed every year near the Jeziorsko Reservoir. The species was not found on peat-bogs in the Bzura and Ner Rivers Valley.

Tree frog *Hyla arborea*. Frequently recorded species (Fig. 6, Table 2). Usually in moderate abundance at a site. Calling males are found in water bodies both in the open environment and in the forests, though higher numbers are reached in exposed bodies of water adjacent to forest edges. In central Poland usually found in unused fishing ponds with dense submerged vegetation. A breeding aggregation usually does not exceed 50 calling males. Highest concentration of 80 calling males at one site was recorded in the Żabi Staw in the Załęcze Landcape Park (ZIELIŃSKI, ŁABĘCKA 2004).

Pool frog *Rana lessonae*. Frequently recorded species (Fig. 6, Table 2). Usually abundant at a site. In central Poland found in most kinds of permanent water bodies, even in acidic pools originating from peat excavation. Avoids only shadowed woodland ponds.

Edible frog *Rana* kl. *esculenta*. Frequently recorded (Fig. 6, Table 2). In central Poland found most often in fish ponds with dense vegetation and in exposed shallow water bodies in flood plains.

Marsh frog *Rana ridibunda*. Less frequently recorded species. (Fig. 6, Table 2). In central Poland breeding adults found most often in large oxbows, large fishing ponds with dense vegetation and in large and exposed shallow water bodies in flood plains. In the southern part of central Poland the marsh frog was found only at the Piskorzeniec (atlas field O11) fishing ponds (KRAWCZYK, ZAMACHOWSKI 1998). The higher number of records from the northern part of the study area may result from the higher number of large fishing ponds in that area.

Common frog *Rana temporaria*. The most frequently recorded amphibian species in central Poland, present in every well-studied atlas field (Fig. 7, Table 2). The species is doing well also in the suburban environment. Usually abundant or very abundant at a site. Only on open meadows and marshes less numerous than the moor frog (ZIELIŃSKI, KLIMKOWSKI 2003). Breeds in aggregations in all kinds of still water bodies, even in small and shadowed forest pools. Biggest aggregations reach up to 2500 adults. Highest densities are reached in small woodland ponds or in water bodies adjacent to the wood.

Moor frog *Rana arvalis*. Frequently recorded species in central Poland (Fig. 7, Table 2). Abundant or very abundant at most locations. In woods and gardens less numerous than the common frog. Prefers bigger and deeper water bodies than the common frog. Breeds in aggregations of up to 2500 adults.

The following species of reptiles were found

Sand lizard *Lacerta agilis*. The most frequently recorded and the most abundant reptile species in central Poland (Fig. 8, Table 3). Absent from agricultural land, cities, damp habitats and the inner part of dense forests. Highest densities (over 100 adult individuals/ha) recorded at sunny forest clearings and meadows adjacent to the forest edges in the Bolimów Landscape Park.

Common lizard *Lacerta vivipara*. Frequently recorded species (Fig. 8, Table 3). Abundant at most locations. Recorded in many isolated populations. Occupies more damp habitats than the sand lizard. Always observed in the woodland or very close to it. Highest densities (over 100 adults/ha) are recorded in the Bolimów Landscape Park on damp forest clearings or in open wet meadows adjacent to forest edges. The only reptile species found on the marshes along the Ner and Bzura Rivers.

Slow worm *Anguis fragilis*. Frequently recorded species (Fig. 8, Table 3). Usually in low abundance. Highest densities (over 10 adult specimens/ha) recorded in the pine forests of the Bolimów Landscape Park. In the forests highest numbers observed at sunny forest clearings. Recorded also from the Łagiewnicki Forest within the Łódź boundaries. Avoids open habitats far from the forest. Completely absent from the deforested marshes along the Ner and Bzura Rivers. Heavily influenced by road traffic. The most frequently found reptile species killed on roads separating wood areas.

Grass snake *Natrix natrix*. Frequently recorded species in central Poland (Fig. 8, Table 3). Usually observed in low or moderate abundance. Found in woodlands adjacent to water bodies. Avoids open habitats. Highest numbers recorded in the forests along the Pilica (Sulejów Landscape Park, Spała

Landscape Park) and Rawka (Bolimów Landscape Park) Rivers. Absent from most of the deforested and agricultural fields. Completely absent from the marshes along the Ner and Bzura Rivers.

Smooth snake *Coronella austriaca*. Very infrequently recorded (Fig. 9, Table 3). Always in low or very low abundance. Recorded only at four atlas fields in central Poland: field N3 – 1991, one adult; M12 – 1997, one adult; I1 – 1998, 6 adults – three gravid females and three males; H1 – 1998, one adult. In all cases the smooth snakes were found on small and dry pine forest clearings far from water. In three cases out of four the clearings originated from the forest fire. Observed density – six adults/ha (ZIELIŃSKI et al. 2000).

Adder *Vipera berus*. In woodlands frequently recorded species (Fig. 9, Table 3). Always in very low or low abundance. Found exclusively in the forests or very close to it, both wet and dry. Recorded in many isolated populations. Highest densities are reached in old and remote from towns and villages forests of the Spała and the Bolimów Landscape Park. Also found in many fields with dry and intensively used pine monocultures around Bełchatów. Infrequently recorded from the northern part of central Poland, completely absent from the deforested marshes along the Bzura and Ner Rivers. Due to strong human pressure absent from many atlas fields with and around towns. Only in damp and undisturbed forest habitats, inaccessible to man, the species is able to survive even very close to the Łódź agglomeration (fields F6, G6, H6 and H8, Figs. 2 and 10).

European pond terrapin *Emys orbicularis*. There are six records of single specimens found in 1991–2000 in central Poland at five different sites (Fig. 9). However, all the terrapins were adult individuals and these might be no more than survivors of relict populations. No evidence of breeding of this species in the area studied was found. Two individuals were found walking on the asphalt roads (F6 – 1997, male; G11 – 1998, male). One was found walking in the pine forest (I11 – 1992) north of Spała and one was found dead in a stream (I11 – 1991) south of Spała. One female was caught near Dąbie (B4) in 1997 and one specimen was seen in 1999 in small fishing pond in Brzeziny (F9) and after wintering in that pond was seen again in 2000.

4. Discussion

The alpine newt *Triturus alpestris* Laurenti was not found in the study area though the species breeds in the adjacent Świętokrzyskie Mountains (KOWALEWSKI 1985) and Nida Basin (JUSZCZYK et al. 1988). The present

status of the fire salamander *Salamandra salamandra* Linnaeus and the European pond terrapin in the area studied is not clear. Fire salamander was found in two atlas fields (M3 – 1992, N3 – 1991). However, after careful examination of the sites and the surrounding area the conclusion was that both records resulted from introductions (for details see ZIELIŃSKI et al. in press). The European pond terrapins probably don't breed in the area studied. The possible origin of the specimens found is that some adult individuals still live in central Poland but due to drainage of marshes and disappearance of suitable water bodies they don't reproduce nowadays and move in search for suitable habitats. However, it is not absolutely sure that they don't breed in central Poland and more survey work is necessary, particularly in the marshes near Dąbie upon the Ner River and in the Spała Landscape Park. In two cases (male – atlas field F6, female – atlas field B4) blood sample and photographs were taken and the results indicate that the specimens belong to the Polish population (A. JABŁOŃSKI, C. MITRUS – pers. comm.). Breeding of this species is still possible as it breeds naturally near Radom in adjacent region (ZEMANEK 1988). Previous (before 1980) sites of the European pond terrapin occurrence in central Poland have been described and discussed in ZIELIŃSKI et al. (in press).

The amphibian species recorded in the area studied are typical for lowland Poland. The three most common species (common frog, common toad and the moor frog) are also the most common species in Poland (JUSZCZYK 1987). None of the species appears to be very rare. Even the natterjack, very rare species in the adjacent Nida Basin (JUSZCZYK et al. 1988) in central Poland was found in 28 atlas fields. Surprisingly the species was still found in 1998 at Wiaderno village near Tomaszów Mazowiecki (J. SOSNOWSKI – pers. comm.) – 51 years after the first recording of this species at this site (KLEKOWSKI 1949).

Although the fire-bellied toad is seriously declining in Western Europe (BRIGGS et al. 1988) it is still frequently recorded in central Poland. However, the destruction of flood-plain habitats resulted in disappearance of this species from many former localities in the Bzura marshes. The same applies to the tree frog. In central Poland the species is still frequently recorded, though the destruction of small water bodies and the elimination of litoral vegetation in ponds results in disappearance of many former localities of the tree frog, particulary in and around cities.

Due to drainage of marshes and the construction of riverside flood banks, flood-plain habitats, at least in central Poland, are no longer the most important breeding places for amphibians. The vast majority of amphibian sightings are from localities associated with artificial water bodies like fishing, recreational or farm ponds. However, infilling of farmland and suburban ponds with waste and rubbish is a now a serious

threat to amphibians, particularly for species with low dispersal ability like the great creasted newt (BAKER, HALLIDAY 1999).

The reptile species found in the area studied are typical for lowland Poland (JUSZCZYK 1987; BERGER 2000). The very surprising result of this atlas study is the frequent occurrence of the adder in central Poland. Unlike breeding amphibians this secretive snake is very difficult to find during occasional checks. However, when data are gathered for many years and many observers supply records it is possible to detect adders in high percentage of fields. The species is absent from open country in central Poland and thus its main requirement appears to be the existence of undisturbed forests providing shelter. It is interesting to note that in Britain the typical habitat of the adder is usually described as the sunny slopes of heathland and moorland (PREST 1971). Also other species of reptiles are often found on open habitats (ARNOLD 1995). In woodlands the adder is able to survive in most atlas fields in central Poland. Although the species is diurnal it may feed on mammals underground thus making contacts with its main enemy – man, very rare (PREST 1971). The extremely vulnerable period to human attack is end of March and April when basking vipers remain near hibernation places. Later they move to low-lying wet and boggy areas and are less vulnerable to humans since summer visitors avoid such places (PREST 1971). It seems that the absence of adders from the Łagiewnicki Forest and other woods located within the Łódź agglomeration results from high human pressure all year round, including spring – the critical period for adder survival.

The smooth snake is almost extinct from central Poland (ZIELIŃSKI in press). The species was not recorded at the former site near Sochaczew (JUSZCZYK 1987). Three new locations are based on recording single specimens only. The only viable population (field I1) is now under efforts (University of Łódź and Łódź ZOO project) to enhance breeding of this species (ZIELIŃSKI et al. 2001). It is interesting to note that in the studied population 1:1 sex ratio was found (ZIELIŃSKI et al. 2000), which was similar to the values obtained in southern Britain (GODDARD 1984) and western Poland (NAJBAR 1997). Several localities with the smooth snake were also recorded north of the study area in the Gostynin-Włocławek Landscape Park (ZIELIŃSKI et al. 2002). A serious difficulty concerning this species is the isolation of suitable and undisturbed smooth snake habitats in central Poland. This is particularly dangerous for a species which exhibits a low dispersal capability (PHELPS 1978).

Unlike amphibians, the vast majority of reptile sightings are from localities associated with woods. Thus, it seems that in central Poland, dominated by agricultural land, forest habitats are necessary to keep viable reptile populations.

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5. REFERENCES

ARNOLD, H. R. 1995. *Atlas of amphibians and reptiles in Britain*. HMSO, London.

BAKER, J. M., HALLIDAY, T. R. 1999. *Amphibian colonization of new ponds in an agricultural landscape*. Herpetol. J., 9: 55–63.

BERGER, L. 1975. *Gady i płazy, Reptilia et Amphibia*. Fauna słodkowodna Polski, 4, PWN, Warszawa–Poznań.

BERGER, L. 2000 *Płazy i gady Polski*. PWN, Warszawa.

BRIGGS, L., FOG, K., RIIS, N., WEDERKINCH, E. 1988. *Status for Bombina bombina in Denmark*. Mem. Soc. Fauna Flora Fenn., 64: 97–99.

BUCKLEY, J. 1989. *The distribution and status of newts in Norfolk*. Trans. Norfolk Norwich Nat. Soc., 28: 221–232.

CLEMONS, J. 1998. *A provisional atlas of the amphibians & reptiles of Warwickshire*. Warwickshire Museum Service, Warwick.

FOG, K. 1988. *The atlas investigation of Amphibians and Reptiles in Denmark*. Mem. Soc. Fauna Flora Fenn., 64: 94–96.

GASC, J.-P., CABELA, A., CRNOBRNJA-ISAILOVIC, J., DOLMEN, D., GROSSENBACHER, K., HAFFNER, P., LESCURE, J., MARTENS, H., MARTINEZ RICA, J. P., MAURIN, H., OLIVEIRA, M.E., SOFIANIDOU, T. S., VEITH, M., ZUIDERWIJK, A. (Eds.) 1997. *Atlas of Amphibians and Reptiles in Europe*. Societas Europaea Herpetologica & Muséum National d'Histoire Naturelle (IEGB/SPN) Paris.

GODDARD, P. 1984. *Morphology, growth, food habits and population characteristics of the Smooth snake Coronella austriaca in southern Britain*. J. Zool., 204: 241–257.

HAILA, Y., MARGULES, C. R. 1996. *Survey research in conservation biology*. Ecography, 19: 323–331.

HARRISON, J.A., BURGER, M. 1998. *Frogs and frog atlasing in Southern Africa*. Avian Demography Unit, Cape Town.

HEATH, J., POLLARD, E., THOMAS, J. 1984. *Atlas of butterflies in Britain and Ireland*. Viking, Tring.

HENKE, S. 1998. *The effect of multiple search items and item abundance on the efficiency of human searchers*. J. Herpetol., 32: 112–115.

JUSZCZYK, W. 1987. *Płazy i gady Polski*. PWN, Warszawa.

JUSZCZYK, W., ZAKRZEWSKI, M., ZAMACHOWSKI, W., ZYSK, A. 1988. *Płazy i gady w Niecce Nidziańskiej*. Stud. Ośr. Dok. Fizjogr., 16: 93–111.

KLEKOWSKI, R. 1949. *Contribution à la connaissance du Crapaud calamite Bufo calamita Laurenti 1768*. Acta Zool. Oecol., Univ. Lodz., 3: 5–23.

KOWALEWSKI, L. 1985. *Płazy i gady (Amphibia et Reptilia) Świętokrzyskiego Parku Narodowego*. Fragm. Faun., 29: 235–274.

KRAWCZYK, S., ZAMACHOWSKI, W. 1998. *Płazy i gady*. [In:] Z. WNUK (red.), *Przedborski Park Krajobrazowy*. Zespół Nadpilicznych Parków Krajobrazowych, Moszczenica, 119–127.

KUIPER, J. G. J., OKLAND, K. A., KNUDSEN, J., KOLI, L., VON PROSCHWITZ, T. 1989. *Geographical distribution of the small mussels (Sphaedidae) in North Europe (Denmark, Faroes, Finland, Norway and Sweden)*. Ann. Zool. Fenn., 26: 73–101.

KONDRACKI, J. 1988. *Geografia fizyczna Polski*. PWN, Warszawa.

MAJERUS, M. E. N., FORGE, H., WALKER, L. 1990. *The geographic distribution of ladybirds in Britain (1984–1989)*. Br. J. Ent. Nat. Hist., 3: 153–165.

NAJBAR, B. 1997. *Występowanie gniewosza plamistego Coronella austriaca na Środkowym Nadodrzu*. Chrońmy Przyr. Ojcz., 53: 41–46.

NAJBAR, B. 2000. *Gniewosz plamisty*. Monografie Przyrodnicze, 5, Lubuski Klub Przyrodników, Świebodzin.

NILSON, G., ANDRÉ, C. 1988. *Mapping of Swedish reptiles and amphibians*. Mem, Soc. Fauna Flora Fenn., 64: 92–93.

PHELPS, T. E. 1978. *Seasonal movement of the snakes Coronella austriaca, Vipera berus and Natrix natrix in southern England*. Br. J. Herpetol., 5: 775–761.

PLANT, C. W. 1983. *A provisional atlas of the amphibians and reptiles of Essex*. Esex Biological Record Centres, London.

SOSNOWSKI, J. 1997. *Płazy Spalskiego Parku Krajobrazowego*. „Kulon", 2 (1): 57–62.

STOPCZYŃSKI, M., ZIELIŃSKI, P., WOJCIECHOWSKI, Z. 2004. *Płazy Lasu Łagiewnickiego w Łodzi*. Chrońmy Przyr. Ojcz., 60: 5–31.

STRAYER, D. L. 1999. *Statistical power of presence-absence data to detect population declines*. Cons. Biol., 13: 1034–1038.

TAYLOR, R. H. R. 1948. *The distribution of reptiles and amphibia in the British Isles with notes on species recently introduced*. Br. J. Herpetol., 1: 1–38.

TAYLOR, R. H. R. 1963. *The distribution of amphibians and reptiles in England and Wales, Scotland and Ireland and the Channel Isles*. Br. J. Herpetol., 3: 95–115.

TERHIVUO, J. 1993. *Provisional atlas and status of populations for the herpetofauna of Finland in 1980–1992*. Ann. Zool. Fenn., 30: 59–69.

ZEMANEK, M. 1988. *Składanie jaj przez żółwie błotne, Emys orbicularis (L), w Polsce Środkowej w warunkach naturalnych*. Przegl. Zool., 32: 405–417.

ZEMANEK, M., RAFIŃSKI, J. 1989. *Atlas rozmieszczenia płazów i gadów w Polsce – wstępne wyniki mapowania*. Przegl. Zool., 33: 599–605.

ZIELIŃSKI, P. 2001. *Dealing with uneven recording effort in regional atlas projects on the distribution of amphibians and reptiles*. Acta Zool. Crac., 44 (2): 85–92.

ZIELIŃSKI, P. (in press). *Czy gniewosz plamisty jest gatunkiem ginącym w Polsce?* Prace Komitetu Ochrony Przyrody PAN.

ZIELIŃSKI, P., PIETRZAK, D., GARA, K. 2000. *Nowe stanowisko gniewosza plamistego (Coronella austriaca Laur.) w Polsce środkowej*. Przegl. Zool., 44: 89–91.

ZIELIŃSKI, P., STOPCZYŃSKI, M., HEJDUK, J. 2001. *Gady okolic Łodzi*. Łódzkie Koło PTOP Salamandra, Łódź.

ZIELIŃSKI, P., STANISŁAWSKI, W., PRZYSTALSKI, A. 2002. *Występowanie gniewosza plamistego w Gostynińsko-Włocławskim Parku Krajobrazowym*. Chrońmy Przyr. Ojcz., 58 (4): 107–109.

ZIELIŃSKI, P., KLIMKOWSKI, A. 2003. *Herpetofauna doliny Słudwi*. Chrońmy Przyr. Ojcz., 59 (2): 43–55.

ZIELIŃSKI, P., HEJDUK, J. MARKOWSKI, J., WOJCIECHOWSKI, Z., WĘŻYK, M., DYMITROWICZ, J., KURZAC, T., NEJMAN, M. (in press). *Herpetologiczne obserwacje z Polski środkowej*. Acta Univ. Lodz., Folia Biol. Oecol.

ZIELIŃSKI, P., ŁABECKA, A. (2004). *Płazy Żabiego Stawu w Załęczańskim Parku Krajobrazowym*. Chrońmy Przyr. Ojcz, 60(2): 43–51.