

9.

GIS technique used for managing data on distribution in Romania of the species belonging to fam. Lacertidae

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ABSTRACT. The present paper shows details on the structure of the GIS-based data-base created in order to carry out accurate analyzes of the spatial distribution on national level of the species belonging to the Lacertidae family. The results of the data processing shows that there are 1015 records (on a total number of 613 local administrative territories) of Sand Lizards (*Lacerta agilis*), 775 records (on a total number of 446 local administrative territories) of Green Lizards (*L. viridis*), 65 records (on a total number of 30 local administrative territories) of Balkan Green Lizards (*L. trilineata*), 66 records (on a total number of 38 local administrative territories) of Meadow Lizards (*L. praticola*), 440 records (on a total number of 226 local administrative territories) of Viviparous Lizards (*L. vivipara*), 328 records (on a total number of 202 local administrative territories) of Wall Lizards (*Podarcis muralis*), 288 records (on a total number of 126 local administrative territories) of Balkan Wall Lizards (*P. taurica*) and 34 records (on a total number of 12 local administrative territories) of Steppe Runners (*Eremias arguta*) made in Romania up to the year 2007.

Key words: data-base, lizards, *Lacerta*, *Podarcis*, *Eremias*, distribution, arealography, Romania

INTRODUCTION

For the proper assessment of the current status and evolution of wild species on there were developed various technical means that allow comparative analysis of the available data. Most of the data-bases includes information on the current presence of various species in a certain area (e.g. in protected areas). Only in the Romanian mainland there were recorded almost 25,000 animal species [20] and at about 4,000 species of superior plants (out of which more than 3,300 are native species) [6]. Furthermore, in the marine waters that belong to Romania, there were recorded at more than 1,700 species of plant and animal species [22]. Taking into account these facts, it is highly probably that in the forthcoming future there will not be developed a single (unic) data-base that will include such details that allow analyses on the distribution all species recorded up to now in the country. Consequently, more specialised data-bases are focused on certain taxonomic groups. In the present work we provide an example of a data-base developed for analysing only the informations on the spatial distribution of some lizard species recorded up to the year 2007 (inclusively) in Romania.

Various works were dealing with the distribution of species belonging to Lacertidae family on national level. The first these kinds of publications could be considered the work of Kirişescu, published in 1930 [16] and the work of Călinescu, published in 1931 [5]. In the early 60's, there was published the volume of the monographical series Fauna R.P.R., that includes further details on the distribution (on national level) of the lizards [12]. Other works that includes distribution of lizards are focused on smaller areas, either some local administrative territories or some (or all) counties of a certain historical region (the most representative of the later category being the work published in 2002 by Ghira et al. [13]), meanwhile some sinthetical works on the status of the species on national level contain maps, but they are not very accurate and concrete sites are difficult to locate [23].

MATERIALS AND METHODS

The data-base was designed using ArcView (version 3.1) soft. The back-ground layers were topographical maps having 1:100,000 and 1:50,000 scale (in some cases being used maps of 1:25,000 scale). For informations on the administrative territories of various localities we have used the digitised and georeferenced version of the maps published in volume No. 1 of the work entitled "Judeţele şi oraşele României în cifre şi fapte" [21].

RESULTS AND DISCUSSIONS

The data-base contains separate themes (layers or shapefiles) for each species, with "Point" and "Polygon" feature types. The themes with "Point" feature type include fields with the following categories of information:

- year of record;
- name of the person (in case that this information was available) who recorded the species in the respective site/area;
- details on the publication (year, authors etc.) which included the data on the respective record;

- name of the record site;
- details related to the record (precise location, number of specimens etc.);
- administrative territory (locality and county) inside which the record-site is located;
- other details (subspecies – if indicated by the source -, data on the same site or the same record in other bibliographical sources etc.).

For analysis of the records, there were used the following codes that allow the selection, classification etc. of the data introduced into the fields of the themes with "Point" feature type:

- reliable record, made after 1990 (exclusively);
- the record was made after 1990, but there is a certain possibility that the species were miss-identified (e.g. instead of *Lacerta viridis* there has been mentioned *Lacerta trilineata*, or if in the respective area there are no suitable habitats for the respective species and it was not recorded before in that site);
- the record was made after 1990, but it is sure that the species were miss-identified (e.g. instead of *Podarcis taurica* there was mentioned *Podarcis muralis* from a site well-investigated by many specialists and none of these later ones recorded *Podarcis muralis* at that site etc.);
- the record was made after 1990, but there are the information on the site is very general (e.g.: „Cibinului mountains”, „Oltului valley”, „Transilvaniei Plain” etc.);
- the record was made after 1990, there is mentioned a concrete site, but the author probably used information from some bibliographical source and indicated a site somewhere nearby the original record-site (which can be in other administrative territory);
- the record was made after 1990, but the mentioned record-site could not be identified on the georeferenced topographical maps;
- the record was made after 1990, there is mentioned a concrete site, but it is certainly a wrong location (or miss-typing of the locality-name);
- the record was made after 1990, there is mentioned a concrete site, but it is highly probable that it is a wrong location (or miss-typing of the locality-name);
- the record was made after 1990, but there is not mentioned a concrete record-site (e.g. there is a map in the publication without specification on the concrete record-sites);
- the record was made after 1990, but there is not mentioned a concrete record-site and the record seems to not be reliable (e.g. being at huge distance from the known area of distribution of the respective species);
- the record was made after 1990, but the species is certainly introduced by man into the respective site;
- the record was made after 1990, it is highly probable that the identification of the species was correct, but there is need to be reconfirmed the presence of the species in the respective location.

In case of records made before 1990 (inclusively) there were used other codes which referred to the same types of criteria as in case of the above mentioned categories.

The themes with "Polygon" feature type include the polygons representing the 2946 local administrative territories that cover the whole Romanian mainland. The themes contains fields with the following categories of information:

- year of the most recent record;
- name of the person (in case that this information was available) who most recently recorded the species in the respective site/area;
- details on the publication (year, authors etc.) which included the data on the respective record;
- name of the record site;
- administrative territory (locality and county) inside which the record-site is located;
- other details (subspecies – if indicated by the source -, data on the same site or the same record in other bibliographical sources etc.).

In case of the records (either made before 1990 or after 1990) there were used the same codes as in case of the themes with "Point" feature type.

1990 was considered a reference year because up to that year data on the lizards distribution were gathered by few people (generally they were zoologists of various state institutes – universities, museums, research institutes), meanwhile after 1990 the number of individual field investigations, official projects, research programs (consequently, the number of faunistical works, too) radically increased and the amount of available and concrete information is obviously bigger in comparison with the possibilities for proper documentation that existed before 1990.

The Sand Lizard (*Lacerta agilis* Linnaeus 1758): the species is distributed in all historical regions of Romania, most of the record sites being in Transilvania, second-most faunistical data having provided from Dobrogea (**Fig. 1**). After introducing into the data-base the author's (personal) records and the data found in various herpetological publications nominated in two recent checklists [1; 7], respectively those from works published in 1998 – 2007 period, the analyses show that in 1856 [2] – 2007 period there are 1015 records distributed on a total number of 613 local administrative territories (**Fig. 1**). **Fig. 2** shows a visual representation of the results of the analysis which takes into account the two main reference period (records up to 1990 and records after 1990). It can be easily seen that in most of the local administrative territories the Sand Lizards were recorded after 1990, but we have to mention that in many of the respective areas the species was also recorded before 1990. We

assume that the species is more widely distributed in other historical regions (Banat – the southwestern part of Romania, Moldova the north-eastern part of the county, Muntenia and Oltenia – both in the southern part of Romania), and the lack of information is due to the scarce investigations carried out in those areas up to 2007.

The Green Lizard (*Lacerta viridis* Laurenti 1768): the species is distributed in all historical regions of Romania and – as in case of the Sand Lizard - most of the record sites being in Transilvania, second-most faunistical data having provided from Dobrogea (Fig. 3). After introducing into the data-base the author's (personal) records and the data found in various herpetological publications nominated in two recent checklists [1; 7], respectively those from works published in 1998 – 2007 period, the analyses show that in 1856 [3] – 2007 period there are 775 records distributed on a total number of 446 local administrative territories (Fig. 3). As in case of *Lacerta agilis*, we assume that *Lacerta viridis* is also more widely distributed in other historical regions (Banat – the southwestern part of Romania, Moldova the north-eastern part of the county, Muntenia and Oltenia – both in the southern part of Romania), and the lack of information is due to the scarce investigations carried out in those areas up to 2007. Fig. 4 shows a visual representation of the results of the analysis which takes into account the two main reference period (records up to 1990 and records after 1990). In most of the local administrative territories the Green Lizards were recorded after 1990, but we have to mention that in many of the respective areas the species was also recorded before 1990. Also, some of the records made before 1990 are based on misidentification (as it is the record from the administrative territory indicated by the white arrow in Fig. 3 and Fig. 4).

The Balkan Green Lizard (*Lacerta trilineata* Bedriaga 1886): up to know, there are only from Dobrogea reliable data on the occurrence of the Balkan Green Lizard (*Lacerta trilineata*) (Fig. 5). The species was also indicated in Mehedinți countz (south-western part of Romania) by Șerban M. [19], but that data is based on a misidentification (we assume that the observed specimens were probably Green Lizards – *Lacerta viridis* – consequently, the record was included into the themes containing data on the distribution of *Lacerta viridis*, with a specific code that indicates that in the bibliographical source the respective record was for *Lacerta "trilineata"*). After introducing into the data-base the author's (personal) records and the data found in various herpetological publications nominated in two recent checklists [1; 7], respectively those from works published in 1998 – 2007 period, the analyses show that in 1863 [18] – 2007 period there are 65 records of Balkan Green Lizards (*Lacerta trilineata*), distributed on a total number of 30 local administrative territories (Fig. 5). Most of the records on occurrence of the Balkan Green Lizards (*Lacerta trilineata*) were made in 1991 – 2007 period (Fig. 6), even if only on few administrative territories are sites where the species was recorded for the first time.

The Meadow Lizard (*Lacerta praticola* Eversman 1834): the species is distributed in the southern half of Romania (Fig. 7), the populations probably being bigger in Caraș-Severin county (belonging to Banat region - south-western part of the country) than in other counties (Hunedoara, Constanța, respectively the neighbourhood of Bucharest and some counties from Oltenia – south-eastern part of Romania). After introducing into the data-base the records available in various herpetological publications nominated in two recent checklists [1; 7], respectively those from works published in 1998 – 2007 period, the analyses show that in 1895 [17] – 2007 period there are 66 records distributed on a total number of 38 local administrative territories (Fig. 7). The analysis of the data, which takes into account the two main reference period (records up to 1990 and records after 1990) shows that the presence of the species was reconfirmed after 1990 in only few areas (Fig. 8), but there are four local administrative territories where the species was recorded for the first time after 1990.

The Viviparous Lizard (*Lacerta vivipara* Jacquin 1787): the species is distributed mainly in the upper parts of the Apuseni Mountains and the Carpathians, respectively in various depressions between mountain ranges (Fig. 9), even if there are some populations that exist in the lowlands from the north-western counties of Romania [8]. At least one record (that one from Slătiniul Mic – located in the eastern part of Mehedinți county [19]) (see the area indicated by the white arrow in Fig. 9 and Fig. 10) is probably based on misidentification. It may be possible that in respective area exists a population Meadow Lizard (*Lacerta praticola*), the specimens belonging to this species having a habitus, size and even colour and drawing somehow similar to the ones of the Viviparous Lizards (*Lacerta vivipara*), and the respective morphological characteristics mislead the author. The respective record was introduced into the data-base (both on the theme with "Point" feature type and on the themes with "Polygon" feature type) with a specific code that indicates that the record is possibly based on a misidentification. After introducing into the data-base the author's (personal) records and the data (based on observations made, till 2007 inclusively) found in various herpetological publications nominated in two recent checklists [1; 7], respectively those from works published in 1998 – 2008 period, the analyses show that in 1888 [4] – 2007 period there are 440 records distributed on a total number of 226 local administrative territories (Fig. 10). Fig. 100 shows a visual representation of the results of the analysis which takes into account the two main reference period (records up to 1990 and records after 1990). It can be easily seen that in most of the local administrative territories the Viviparous Lizards (*Lacerta vivipara*) were recorded after 1990, but we have to mention that in many of the respective areas the species was also recorded before 1990.

The Wall Lizard (*Podarcis muralis* Laurenti 1768): the species is distributed mostly in the mountains, but isolated populations exist in lowlands (in the western and southern part of the country, including the Danube valley and the southern half of Dobrogea – a historical region south-eastern Romania) (Fig. 11). After introducing into the data-base the author's (personal) records and the data found in various herpetological publications nominated

in two recent checklists [1; 7], respectively those from works published in 1998 – 2007 period, the analyses show that in 1863 [18] – 2007 period there are 328 records distributed on a total number of 202 local administrative territories (Fig. 11). Fig. 12 shows a visual representation of the results of the analysis which takes into account the two main reference period (records up to 1990 and records after 1990). In most of the local administrative territories the Wall Lizards (*Podarcis muralis*) were recorded after 1990, but we have to mention that in many of the respective areas the species was also recorded before 1990. Some of the records after 1990 are based on misidentification. For example, Ghira et al. mentioned the species [13] on the administrative territory indicated by the white arrow in Fig. 11 and Fig. 12. In the respective case probably specimens of *Lacerta vivipara* were recorded as *Podarcis muralis*. The respective record was maintained in the data-base at the themes for *Podarcis muralis* (both on the theme with "Point" feature type and on the themes with "Polygon" feature type) with a specific code that indicates that the record is based on a misidentification. Another example is represented by the record from Histria fortress (located in the area indicated by the orange circle in Fig. 11 and Fig. 12), where M. Jessat in 1992 – 1997 period identified as belonging to *Podarcis muralis* [14] some specimens of *Podarcis taurica*, this later species being relatively common in the respective ruins (and, in spite of this fact, Jessat did not list *Podarcis taurica* in his work). The respective record was introduced in the data-base into the themes for *Podarcis taurica* (both on the theme with "Point" feature type and on the themes with "Polygon" feature type) and into the theme with "Point" feature type, in all of them with a specific code that indicates that the record is based on a misidentification. We have to mention that on almost the same latitude with Histria, at about 60 km westward of it, in the rocky areas along the Danube shore (at Canaralele Hășovei – the administrative territory which includes the site is indicated by the orange arrow in Fig. 11 and Fig. 12) there is a population of *Podarcis muralis*, discovered by the author in May 17th, 2007 (Fig. 17). Furthermore, there are quite many records in the work published by Ghira et al. [13] that are probably based on misidentification (see white ovals in Fig. 11 and Fig. 12). We assume that in these cases too, some specimens of *Lacerta vivipara* were reported as specimens of *Podarcis muralis*. The respective records were introduced into themes (with "Point" feature type and with "Polygon" feature type) of *Podarcis muralis* with a specific code that indicates that the record is probably based on a misidentification.

The Balkan Wall Lizard (*Podarcis taurica* Pallas 1814): the Balkan Wall Lizard (*Podarcis taurica*) is present mostly in the southern part of the country, but this species was recently recorded in some sites from northwestern Romania [9] (Fig. 13), these later ones representing the easternmost parts of the distribution area of the populations from north-eastern Hungary, recorded in the '60s [10; 11]. After introducing into the data-base the author's (personal) records and the data found in various herpetological publications nominated in two recent checklists [1; 7], respectively those from works published in 1998 – 2007 period, the analyses show that in 1901 [15] – 2007 period (although the first record was probably the one of Ray, mentioned in the work of Bedriaga, published in 1886 [2] – according to Călinescu, 1931 [5]) there were 288 records distributed on a total number of 126 local administrative territories (Fig. 13). Fig. 14 shows a visual representation of the results of the analysis which takes into account the two main reference period (records up to 1990 and records after 1990). It can be easily seen that in most of the recent records on the Balkan Wall Lizards (*Podarcis taurica*) are from Dobrogea (south-eastern region of Romania) and Crișana (western region of Romania), but we consider that the scarcity of recent records from other southern regions of the country (as Muntenia and Oltenia) is due to the few field-investigations carried out in the respective regions even after 1990.

The Steppe Runner (*Eremias arguta* Pallas 1773): the species is present only in the south-eastern parts of the country, most of the populations inhabiting the sandy areas from the eastern part of Dobrogea, the others being recorded in three administrative territories from Galați county, at about 150 km westward of the sites from Dobrogea where *Eremias arguta* was recorded (Fig. 15). After introducing into the data-base the author's (personal) records and the data found in various herpetological publications nominated in two recent checklists [1; 7], respectively those from works published in 1901 [15] – 2007 period, the analyses show that in 1901 [15] – 2007 period there were 34 records distributed on a total number of 12 local administrative territories (Fig. 15). The results of the analysis which takes into account the two main reference period (records up to 1990 and records after 1990) show that in most of the Steppe Runners (*Eremias arguta*) were recorded after 1990 (Fig. 16), even if in all of the respective areas the species was recorded before 1990.

CONCLUSIONS

The results of the analysis carried out with the help of a data-base designed specially for processing the information on the species-distribution show that in the 1856 – 2007 period there were 3011 records from Romania of lizards belonging to the Lacertidae family, as follows: 1015 records (on a total number of 613 local administrative territories) of Sand Lizards (*Lacerta agilis*), 775 records (on a total number of 446 local administrative territories) of Green Lizards (*L. viridis*), 65 records (on a total number of 30 local administrative territories) of Balkan Green Lizards (*L. trilineata*), 66 records (on a total number of 38 local administrative territories) of Meadow Lizards (*L. praticola*), 440 records (on a total number of 226 local administrative territories) of Viviparous Lizards (*L. vivipara*), 328 records (on a total number of 202 local administrative territories) of Wall Lizards (*Podarcis muralis*), 288 records (on a total number of 126 local administrative territories) of Balkan Wall Lizards (*P. taurica*) and 34 records (on a total number of 12 local administrative territories) of Steppe Runners (*Eremias arguta*). Beyond the fact that the data-base provides an accurate overview on the species distribution on

various levels (national – see Fig. 18 -, regional, county or local level), it is also a useful tool for selection of reliable or doubtful information on various local populations, quick identification of scarcely investigated areas etc.

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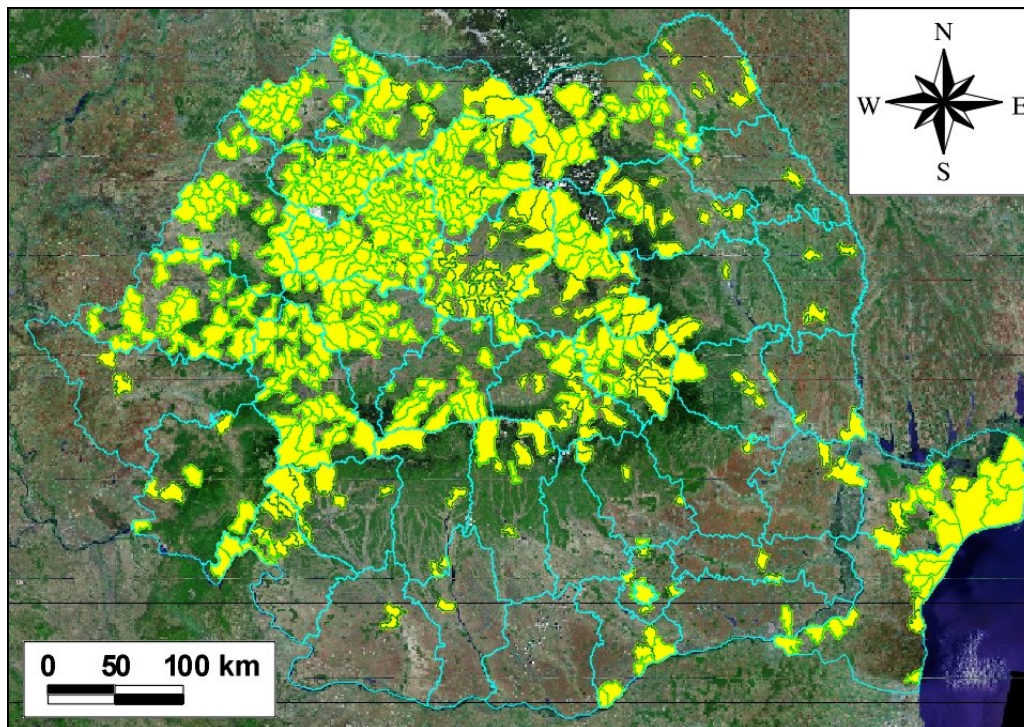


Fig. 1. Administrative territories from Romania where there was at least one record on Sand Lizards (*Lacerta agilis*) up to the year 2007.

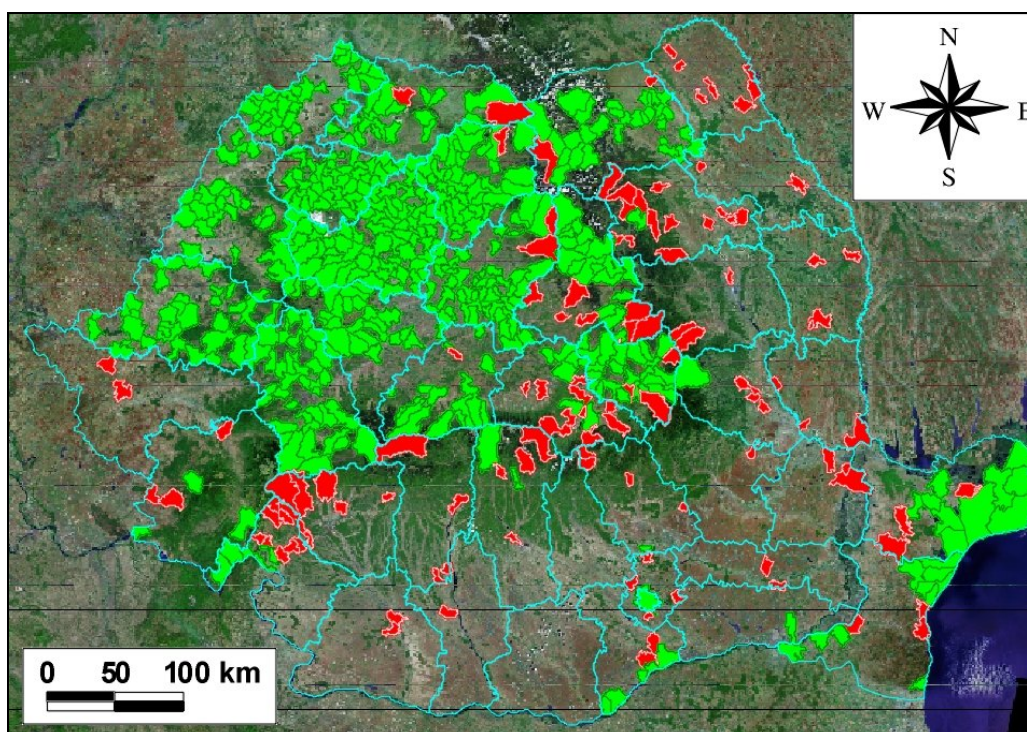


Fig. 2. . Administrative territories from Romania where there was at least one record on Sand Lizards (*Lacerta agilis*) before 1990, respectively after 1990.

Note. With red there are highlighted the administrative territories where the species was recorded at least one times, but only before 1990; with green there are highlighted the administrative territories where the species was recorded at least one times after 1990 (either it is the first record in that area or it a reconfirmation of the presence of the species).

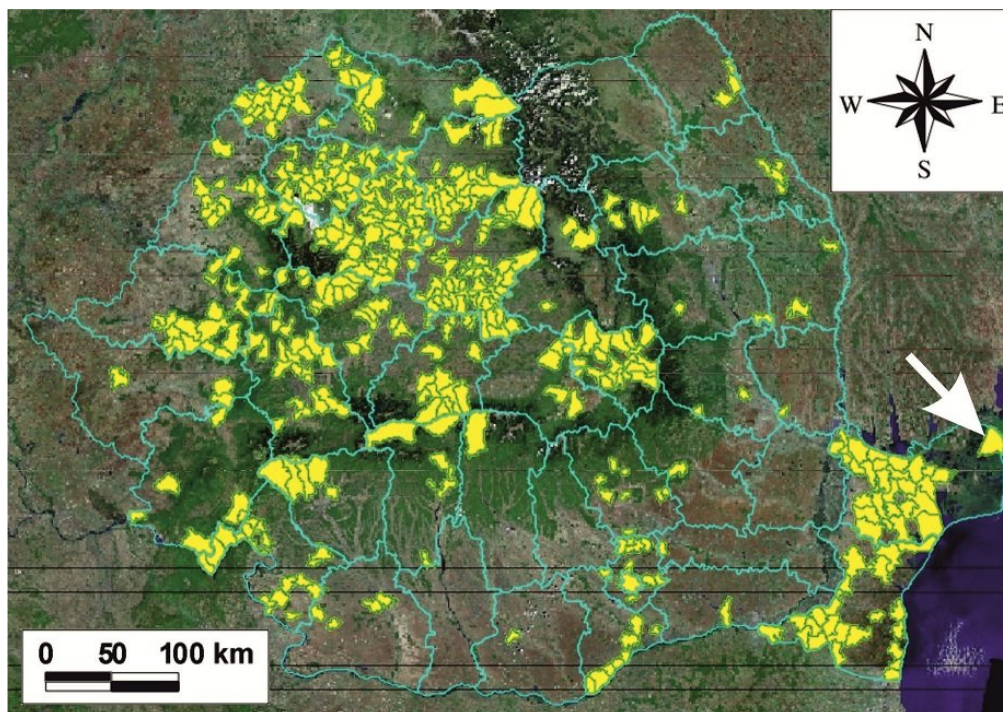


Fig. 3. Administrative territories from Romania where there was at least one record on Green Lizards (*Lacerta viridis*) up to the year 2007.

Note. white arrow – record based on misidentification.

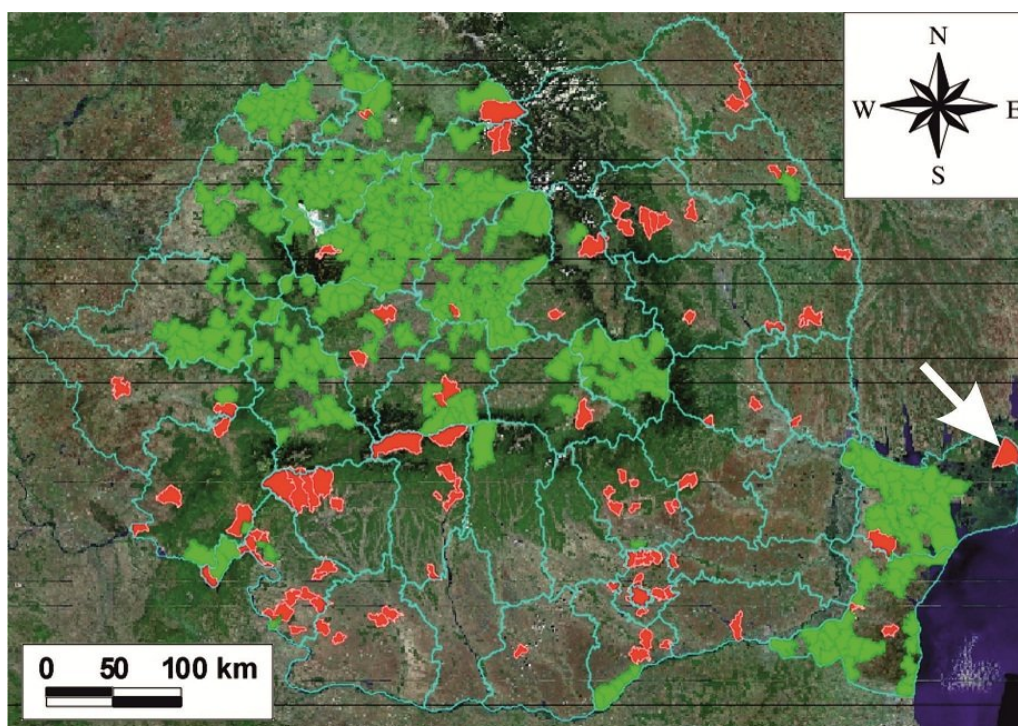


Fig. 4. Administrative territories from Romania where there was at least one record on Green Lizards (*Lacerta viridis*) before 1990, respectively after 1990.

Note. With red there are highlighted the administrative territories where the species was recorded at least one times, but only before 1990; with green there are highlighted the administrative territories where the species was recorded at least one times after 1990 (either it is the first record in that area or it a reconfirmation of the presence of the species); white arrow – record based on misidentification.

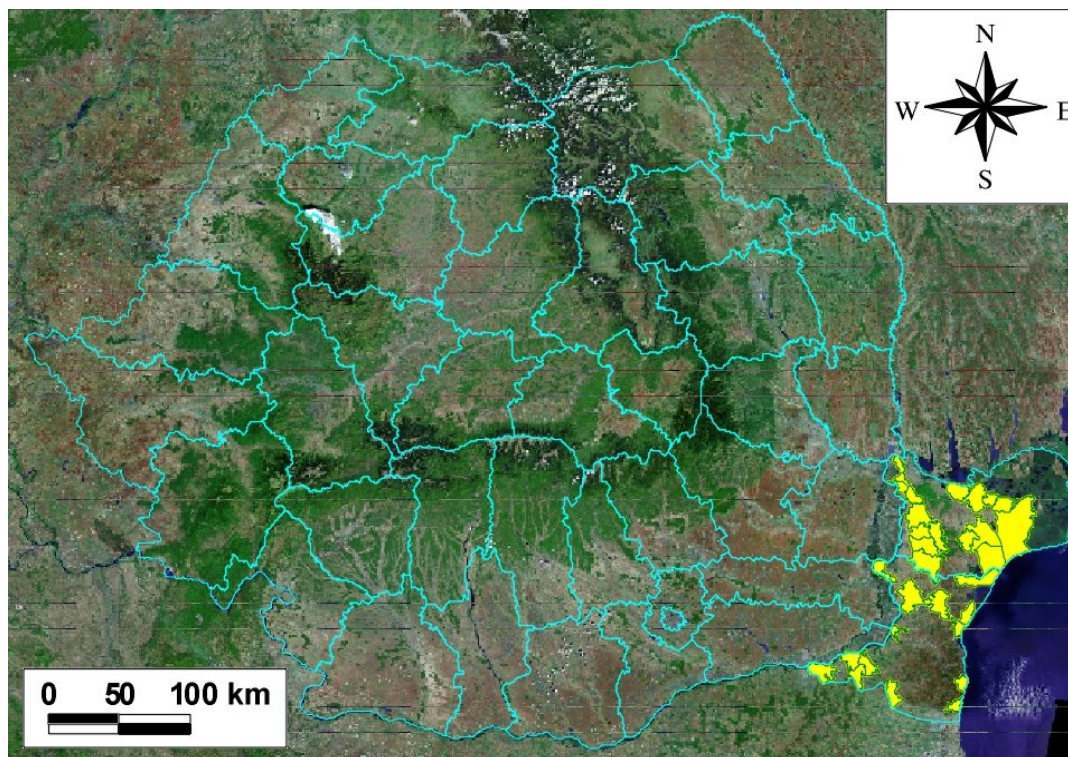


Fig. 5. Administrative territories from Romania where there was at least one record on Balkan Green Lizards (*Lacerta trilineata*) up to the year 2007.

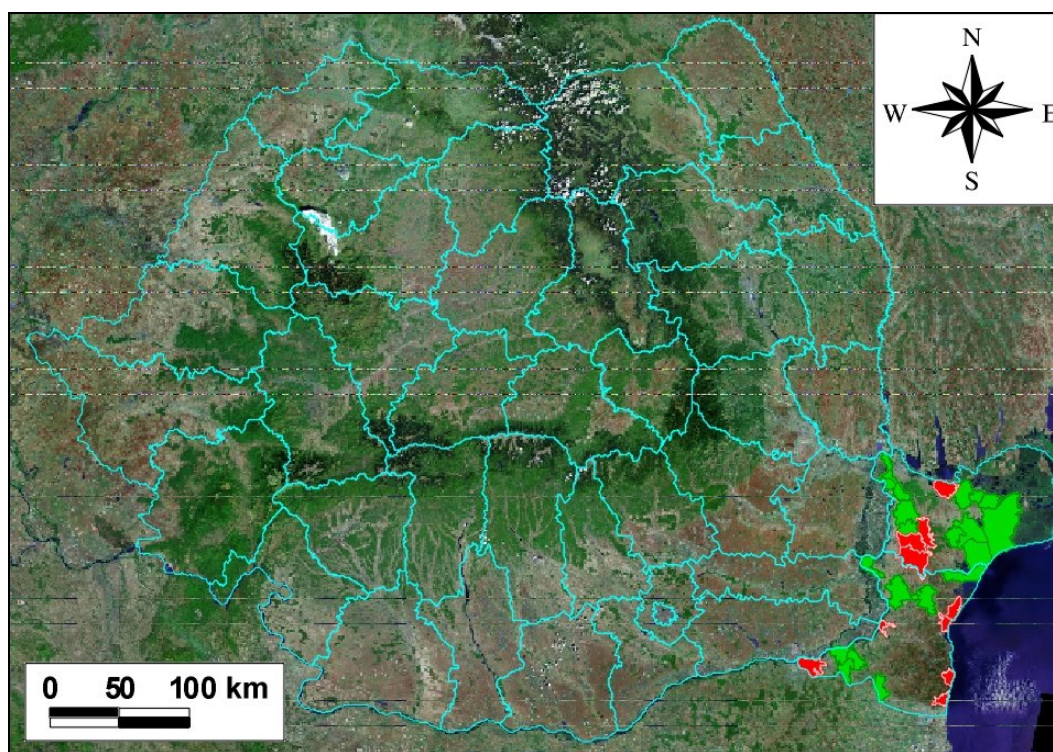


Fig. 6. Administrative territories from Romania where there was at least one record on Balkan Green Lizards (*Lacerta trilineata*) before 1990, respectively after 1990.

Note. With red there are highlighted the administrative territories where the species was recorded at least one times, but only before 1990; with green there are highlighted the administrative territories where the species was recorded at least one times after 1990 (either it is the first record in that area or it is a reconfirmation of the presence of the species).

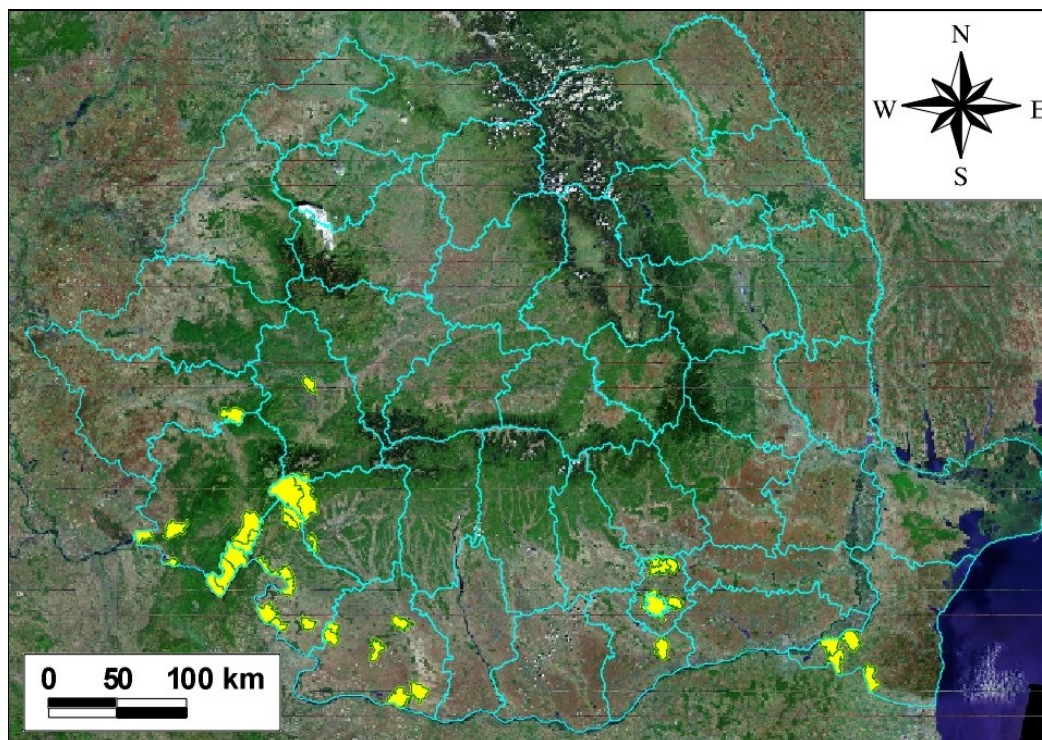


Fig. 7. Administrative territories from Romania where there was at least one record on Meadow Lizards (*Lacerta praticola*) up to the year 2007.

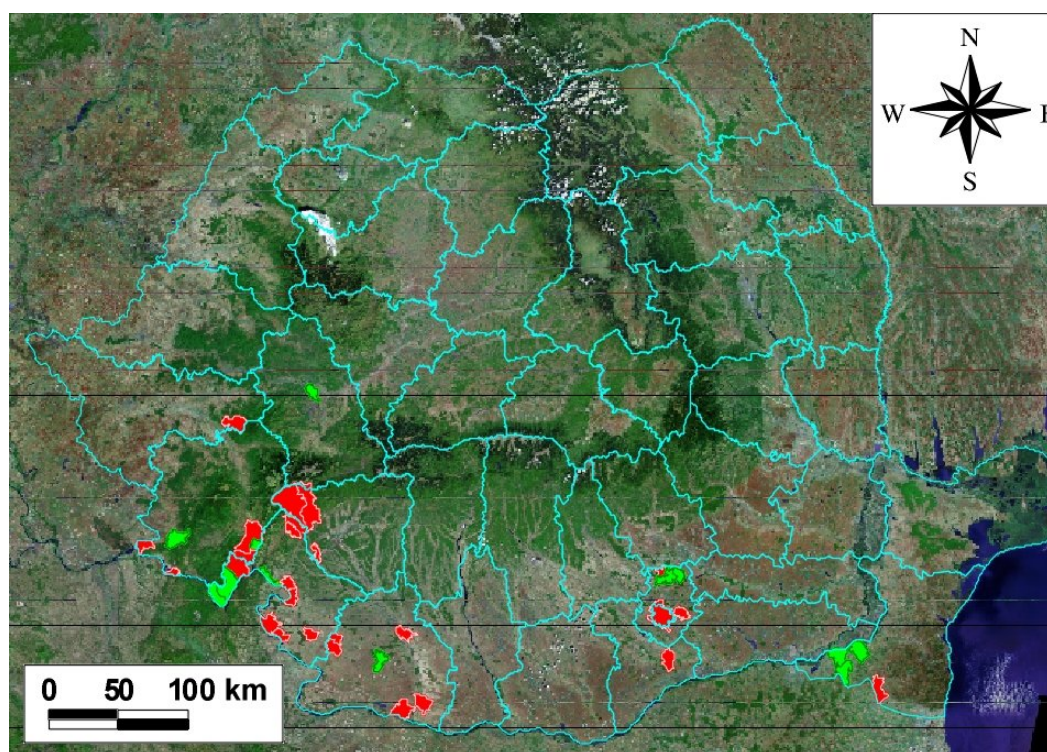


Fig. 8. Administrative territories from Romania where there was at least one record on Meadow Lizards (*Lacerta praticola*) before 1990, respectively after 1990.

Note. With red there are highlighted the administrative territories where the species was recorded at least one times, but only before 1990; with green there are highlighted the administrative territories where the species was recorded at least one times after 1990 (either it is the first record in that area or it a reconfirmation of the presence of the species).

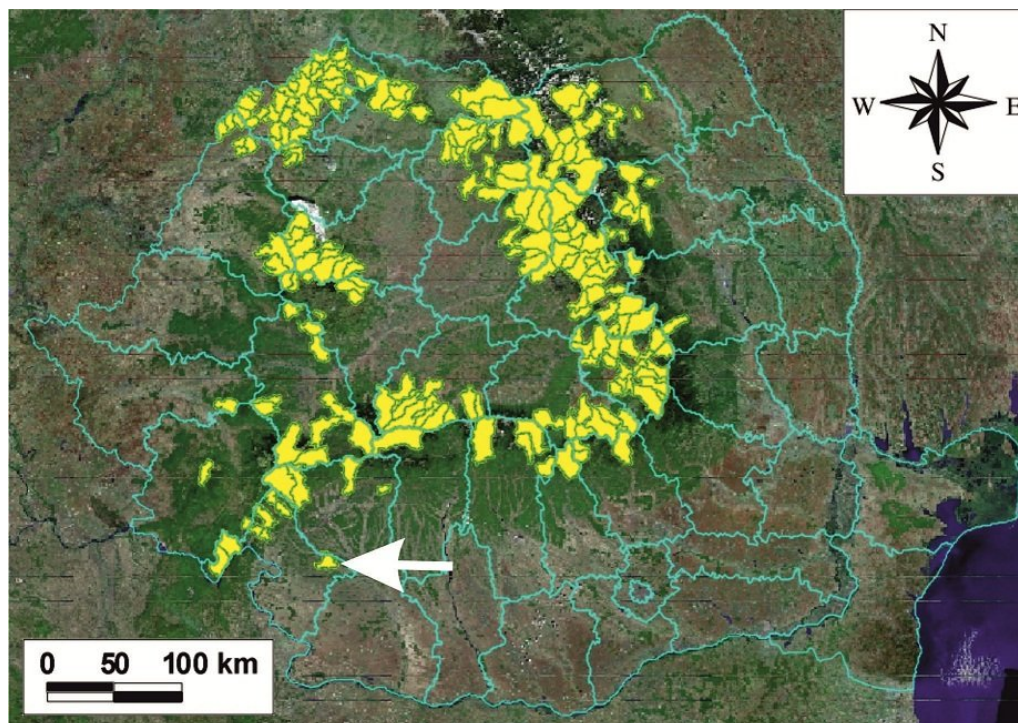


Fig. 9. Administrative territories from Romania where there was at least one record on Viviparous Lizards (*Lacerta vivipara*) up to the year 2007.

Note. white arrow – record probably based on misidentification.

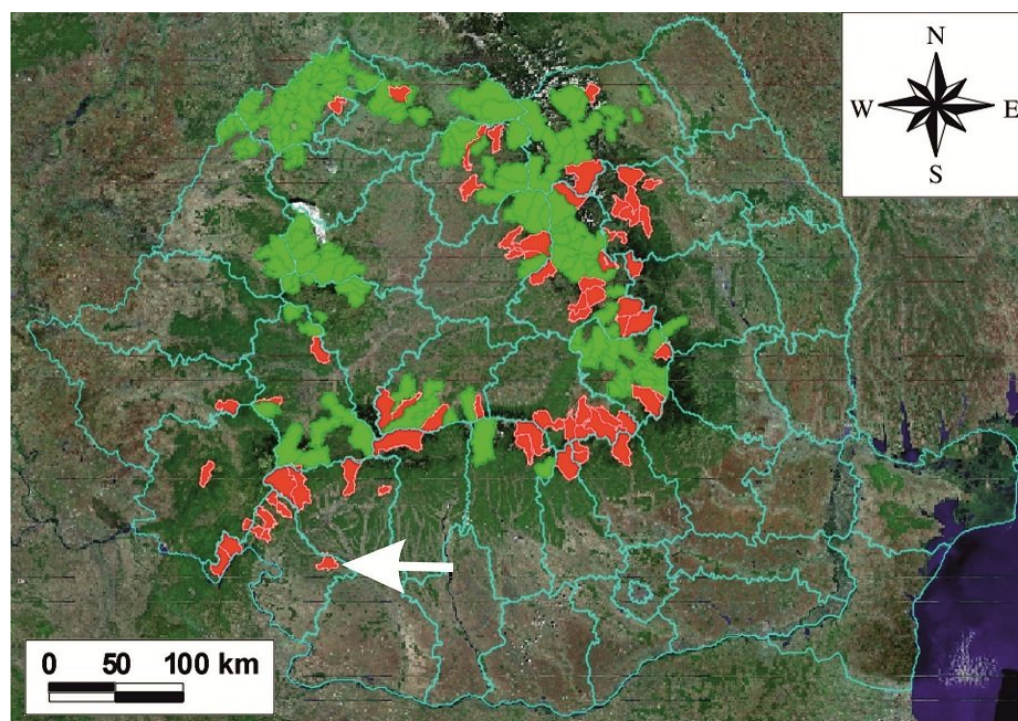


Fig. 10. Administrative territories from Romania where there was at least one record on Viviparous Lizards (*Lacerta vivipara*) before 1990, respectively after 1990.

Note. With red there are highlighted the administrative territories where the species was recorded at least one times, but only before 1990; with green there are highlighted the administrative territories where the species was recorded at least one times after 1990 (either it is the first record in that area or it a reconfirmation of the presence of the species); white arrow – record probably based on misidentification.

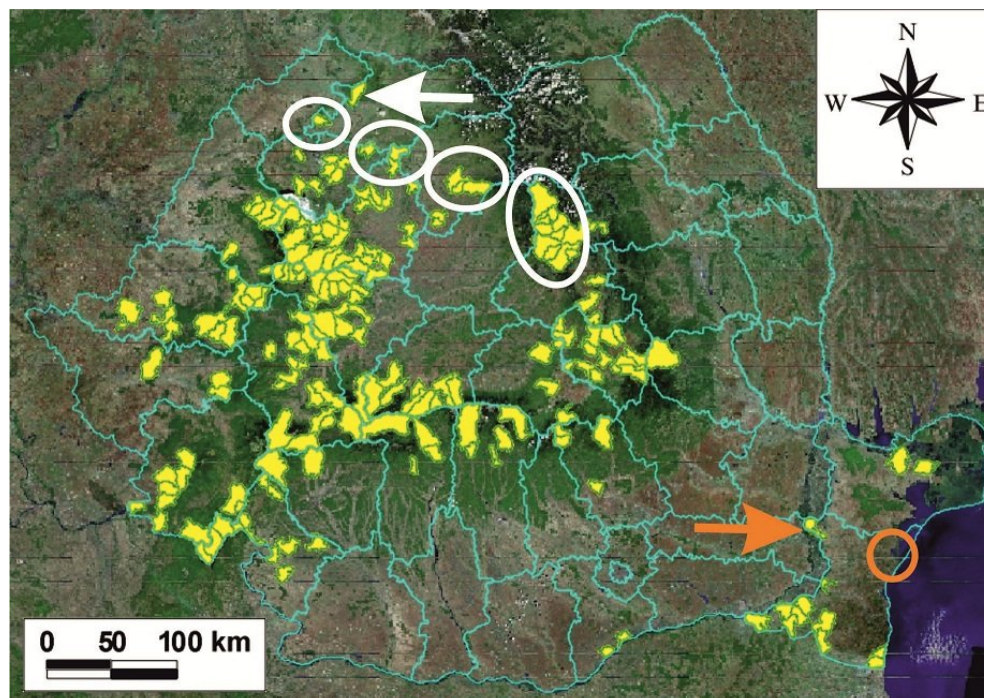


Fig. 11. Administrative territories from Romania where there was at least one record on Wall Lizards (*Podarcis muralis*) up to the year 2007.

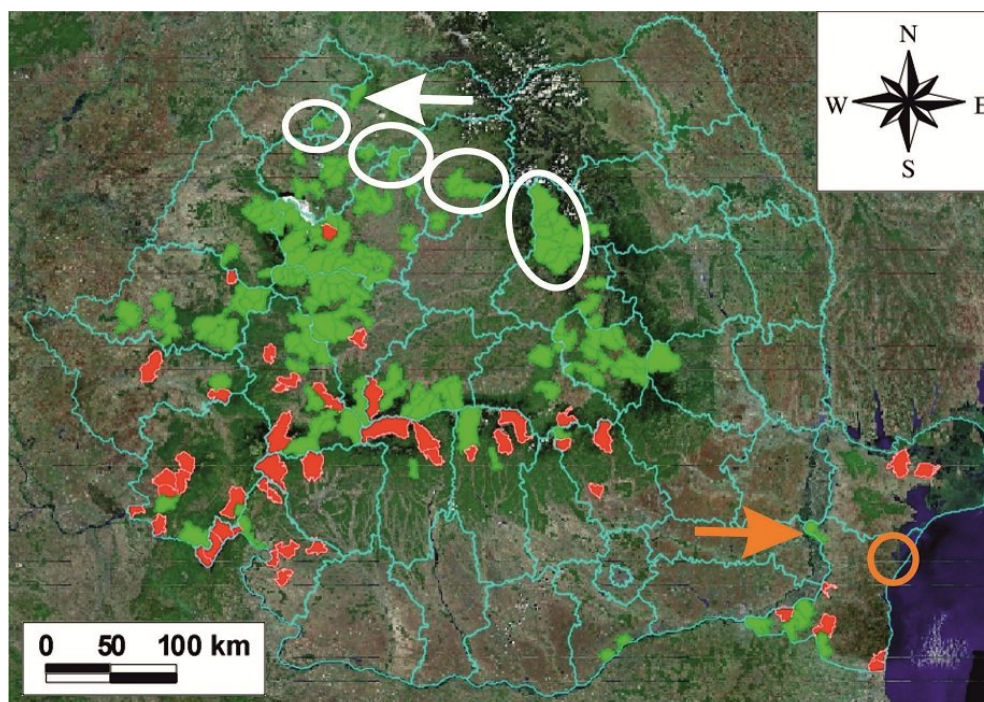


Fig. 12. Administrative territories from Romania where there was at least one record on Wall Lizards (*Podarcis muralis*) before 1990, respectively after 1990.

Note. With red there are highlighted the administrative territories where the species was recorded at least one times, but only before 1990; with green there are highlighted the administrative territories where the species was recorded at least one times after 1990 (either it is the first record in that area or it a reconfirmation of the presence of the species); white arrow – record based on misidentification; orange arrow – first record (actual northern limit of the species distribution in Dobrogea); white circles – administrative territories where the records are probably based on misidentification; orange circle – area where the records are surely based on misidentification (confusion with *Podarcis taurica*).

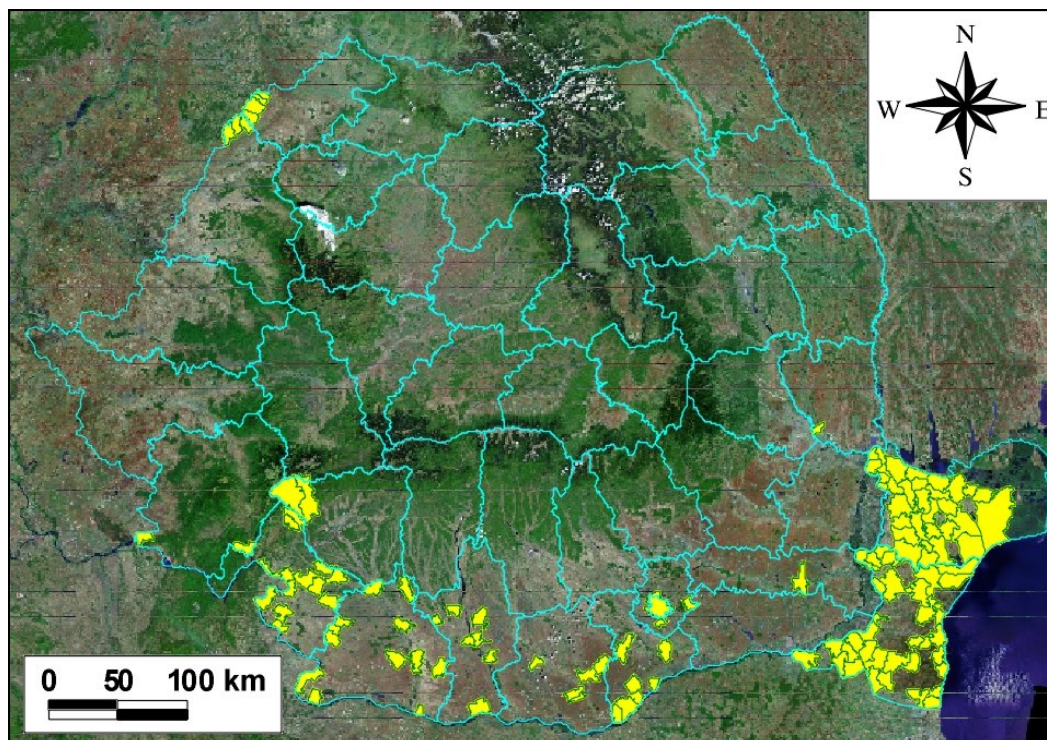


Fig. 13. Administrative territories from Romania where there was at least one record on Balkan Wall Lizards (*Podarcis taurica*) up to the year 2007.

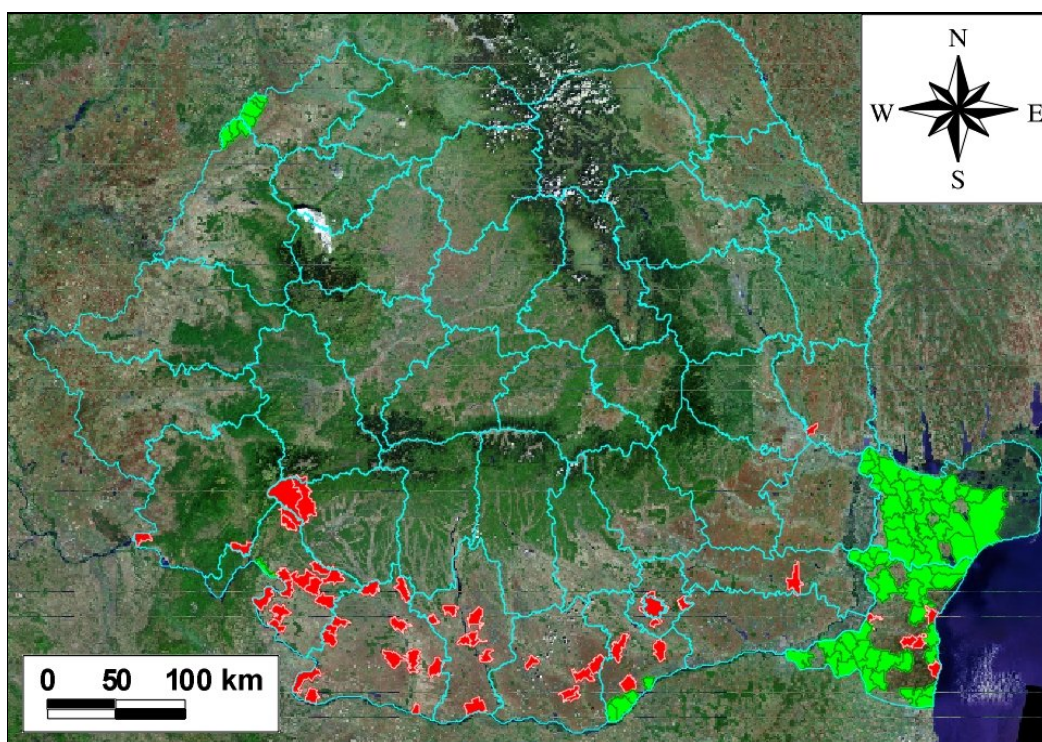


Fig. 14. Administrative territories from Romania where there was at least one record on Balkan Wall Lizards (*Podarcis taurica*) before 1990, respectively after 1990.

Note. With red there are highlighted the administrative territories where the species was recorded at least one times, but only before 1990; with green there are highlighted the administrative territories where the species was recorded at least one times after 1990 (either it is the first record in that area or it a reconfirmation of the presence of the species).

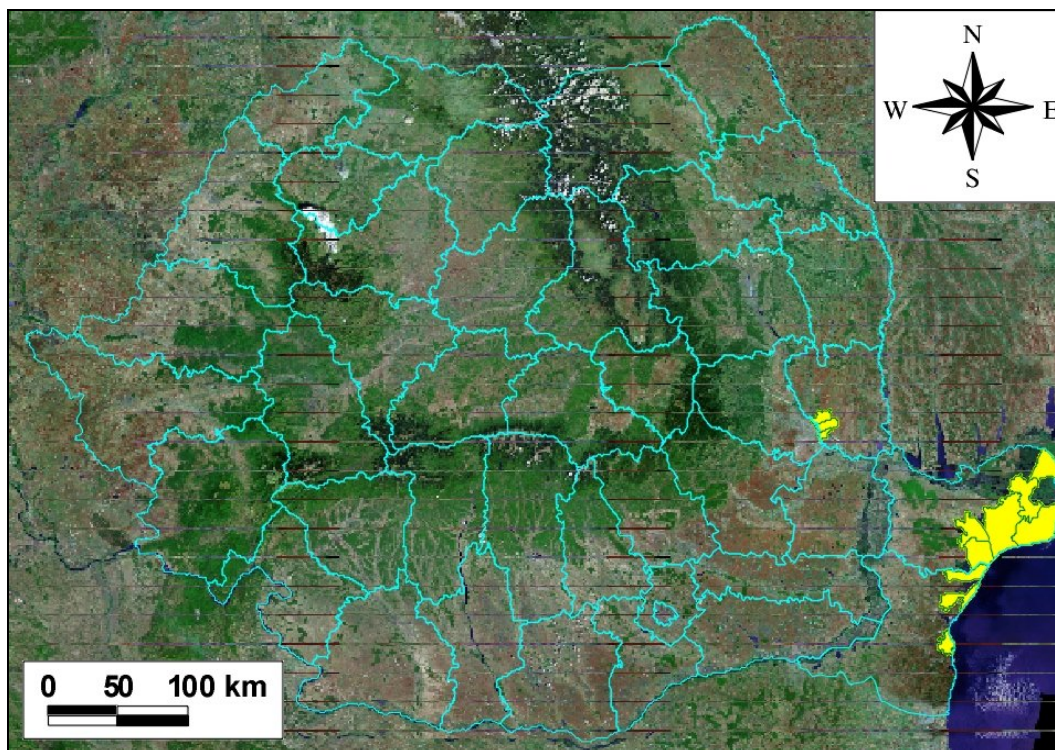


Fig. 15. Administrative territories from Romania where there was at least one record on Steppe Runners (*Eremias arguta*) up to the year 2007.

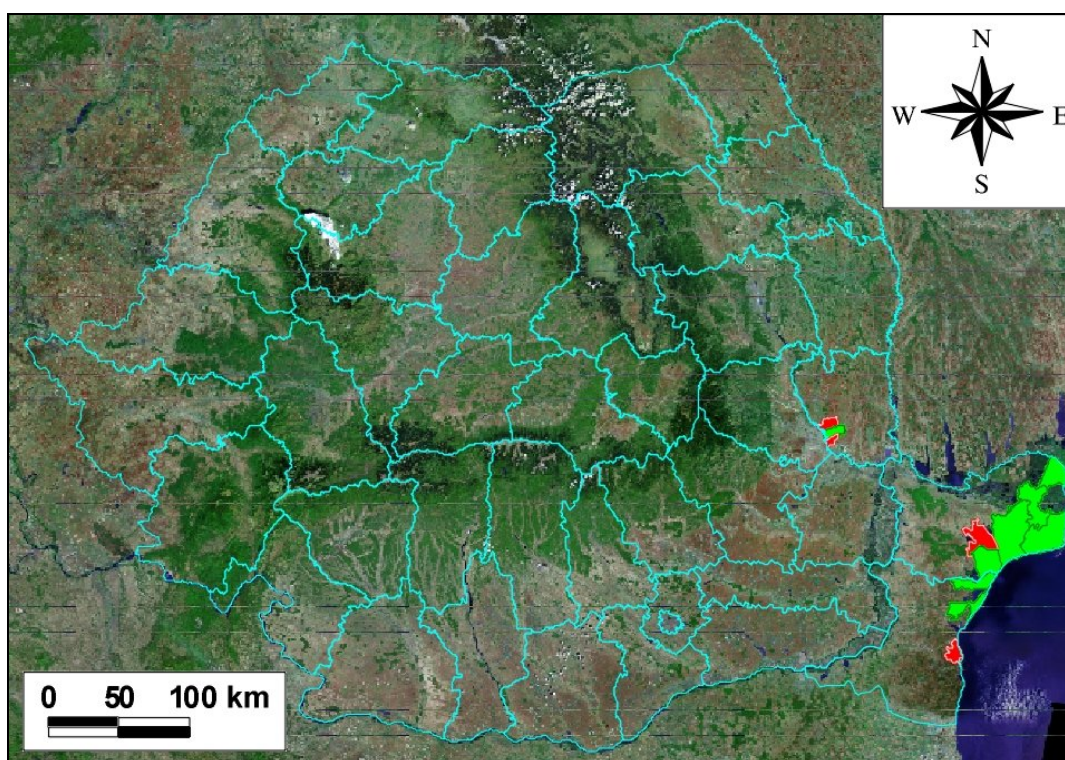


Fig. 16. Administrative territories from Romania where there was at least one record on Steppe Runners (*Eremias arguta*) before 1990, respectively after 1990.

Note. With red there are highlighted the administrative territories where the species was recorded at least one times, but only before 1990; with green there are highlighted the administrative territories where the species was recorded at least one times after 1990 (either it is the first record in that area or it a reconfirmation of the presence of the species).



Fig. 17. Adult specimen of Wall Lizard (*Podarcis muralis*) from the population discovered in May 17th, 2007 at Canaralele Hârșovei (Constanța county, Romania).

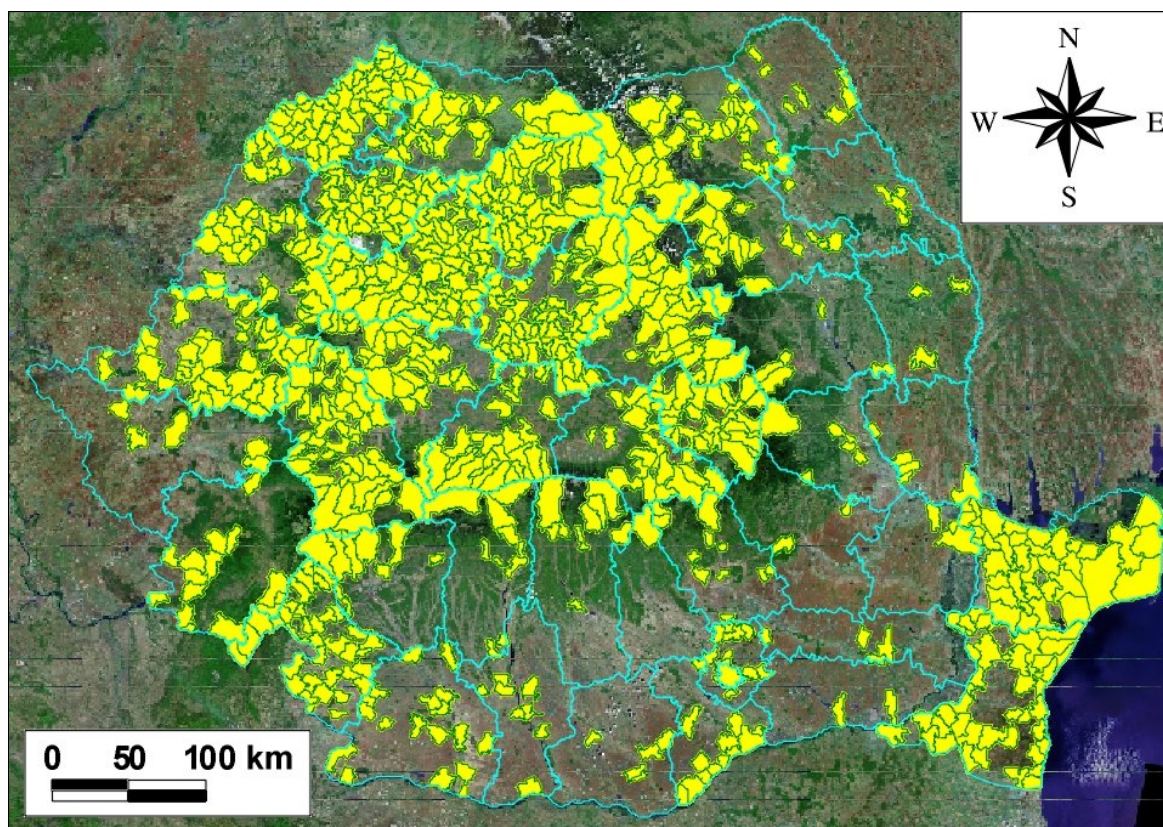


Fig. 18. Administrative territories from Romania where there was at least one record on at least one species belonging to Lacertidae family, up to the year 2007.