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Field research into reptiles is acquiring an established form

Common European viper (Vipera berus) warming itself in the sun

In all zoological disciplines it can be seen that efforts are continuously being made to devise and establish standardised methods of conducting research – i.e. monitoring, which can be used to repeatedly observe species variety within a studied area, along with the density of individual populations. Monitoring must be performed in such a way that it does not influence natural processes and yet can be repeated many times, allowing the comparison of changes over the course of time.

While standardised methods became established in botany in the nineteen-thirties (Braun-Blanquet 1932) and continue to be used today (e.g. Ewald 2003), they are taking much longer to gain a foothold in zoology. The reasons for this are obvious: animals are mobile and extremely morphologically heterogeneous. The very different lifestyles of aquatic, soil-dwelling and terrestrial organisms prevent the use of identical methods when studying them. It is clear that under these circumstances it is necessary to develop many highly diverse methods. In the case of terrestrial animals, innovators in the entomology field began applying standardization with regard to sweeping, pitfall traps and light traps. Later, other methods were added to the list of those available, such as adhesive traps, intercept traps, Malaise traps, collar traps and yellow pan traps (e.g. Novák 1969). The situation has evolved in a more complex manner in vertebrate zoology, particularly in the case of land vertebrates. When studying terrestrial vertebrate fauna one needs to deal with the extremely varied biology of the individual groups involved: birds, bats, ungulates, amphibians and others. From the beginning it was clear that the use of one single unified system of methods was out of the question.

With vertebrates it is possible to divide up the approaches to gaining information in the field into four areas: network mapping, capture, indirect observation methods and direct observation methods.

Grid mapping

Grid (or quadrat) mapping involves the recording of species occurrence via the presence/absence system within a wide area divided up into smaller parts. In principle it is possible to use this method for all taxonomic groups; its efficiency is, however, dependent on the number of observers. It should also be mentioned that this is a semi-quantitative, macroscale method (working at the scale of tens of km^2). In central Europe it is common to use map fields with trapezoids; each individual field measures 10 minutes of longitude×6 minutes of latitude. In the case of the Czech Republic such a field measures approximately 11.2×12.0 km (Buchar 1982). For Europe, square fields are used with sides of up to 50 km in length (Gasc et al. 1997).

Capture

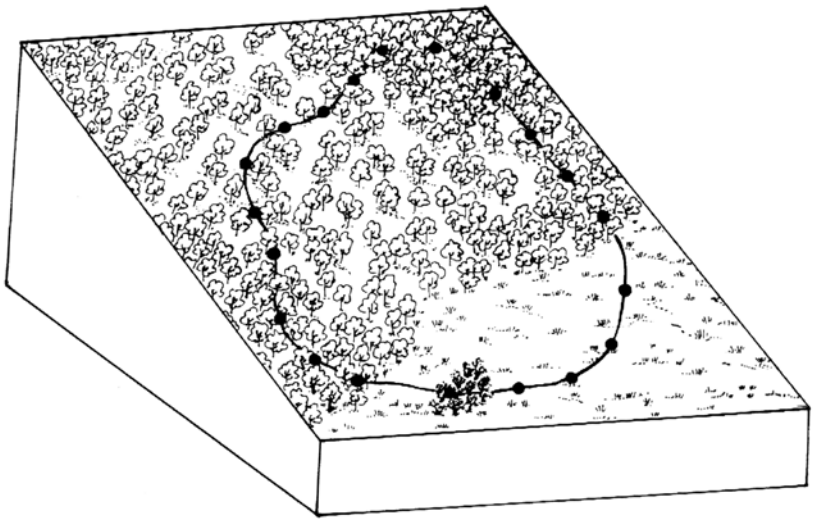
This primarily refers to the catching of birds and mammals. When the methods involved are standardised it is possible to gain good quantitative results that can be statistically evaluated. Some success has been had when using it with small mammals (e.g. Pelikán 1975). During the capture of birds in nets in combination with ringing, use is made of e.g. the CES (Constant Effort Site) and RAS (Recapture of Adults for Survival) methods. Today, the CMR (capture-mark-recapture) method is becoming popular; this involves the capture of mammals using restraining traps. The use of such traps has the advantage of lowering the impact of research on the studied population (Wilson et al. 1996).

Direct observation methods

Alongside audiovisual methods, such as camera traps and sound recordings, line transects and point transects are also used in direct observation.

The line transect method enables relatively reliable monitoring of the population size of individual species on the basis of records of the number of heard or seen individuals (Janda et Řepa 1986). The observer records all species determined visually and acoustically while moving along a course of certain length through terrain. This method, which is highly suitable e.g. when comparing the relative abundance of bird species at different locations, is fairly simple and not too time consuming. It can be used to survey large areas and practically all year round, though it isn't all that precise given that the width of the transect and the walking speed of the observer can only be estimated. The oldest method of observing lizards for which documentation exists was devised by Andruško (1936, in Novikov 1953), who recommended counting individuals along a line around which finds would be recorded to a width of three metres.

Point transects basically involve the collection of qualitative and quantitative data, which always takes place at previously determined locations (points) for a certain period of time. For example, the observer selects points approximately 300 m from each other and remains at each point for five minutes, recording all species heard and seen. While moving from one point to another no species are recorded. The most significant point count method is IPA (Indice Ponctuelle d'Abondance = index of abundance), which is based on visual and acoustic observation and the recording of all birds at individual points along a transect over a period of 20 minutes. This is best performed in the early morning, when birds are at their most active. It is used for songbirds, piciformes and pigeons, i.e. for birds which declare their nesting territory acoustically.



Schematic representation of a point transect. The points are located in such a way that they represent the basic biotopes proportionally (thin forest, dense forest, meadow, etc.) ***Drawing: Šárka Mikátová***

Indirect observation methods

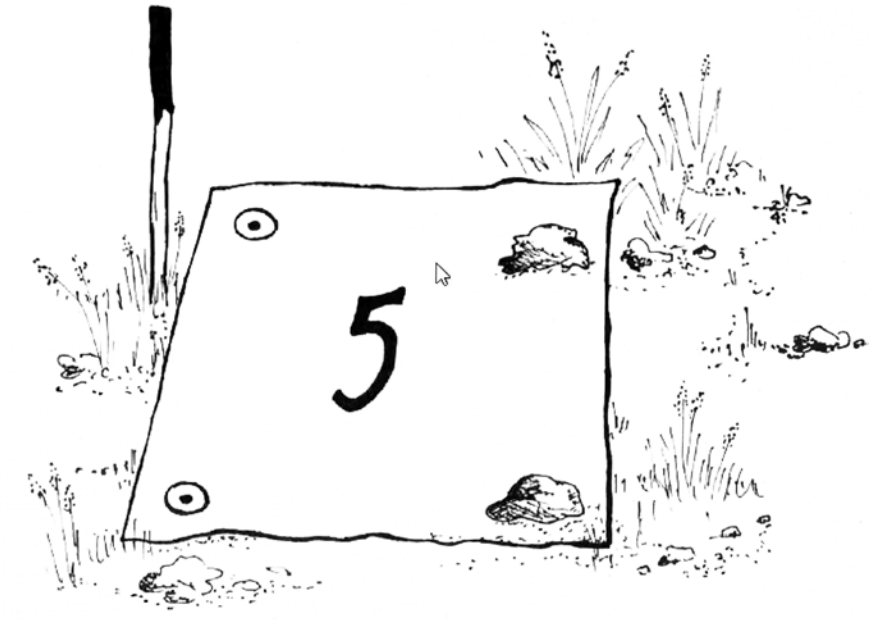
Indirect observation methods discover the presence of organisms from the various products or traces of their activities. These methods are based on the recording of excrement, sheds and other products, and the monitoring of abundance on the basis of animal tracks and trails. Another method involves the recording of signs of habitation (counting of browsed or gnawed items). It is very useful in the case of e.g. beavers (e.g. Vlašín 1992).

Methods of observing reptiles

One group of vertebrates for which to date – aside from network mapping – there is no suitable and widely-used standardised observation method, is that of reptiles. There are many reasons for this. An ethological-ecological difference exists between reptiles that walk using legs and reptiles that have to crawl. Lizards walk, while snakes and slow worms crawl. Tortoises walk in a different manner – with a little exaggeration their gait could be described as 'silly walking'. A great obstacle in the path to standardised methods is the fact that the activity of reptiles is very dependent on the weather, and not just during monitoring but also in the previous days and hours. Low, but also very high temperatures may cause mainly snakes (but also lizards) to seek places to shelter, and to avoid activity. Birds, for example, will sing even after temperatures have dropped significantly, bats fly even during light rain, and amphibians continue mating even during unfavourable temperatures, while reptiles reduce their activity at temperatures below 15 ˚C to such an extent that the chance of observing them at a given locality decreases to zero. An error caused by this factor may then completely destroy the usefulness of data gained for the purpose of long-term monitoring.

The basic method for the monitoring of reptiles has always been and still is direct observation. The observer walks through the landscape and tries to find as many species and individuals as possible. This method also involves what is known as 'looking under hiding places', which takes into consideration the characteristic tendency of all reptiles to use small random hiding places to rest or possibly to warm themselves. Looking under hiding places is used in the British method of reptile observation (e.g. Gent and Gibson 1998), which suggests the use of artificial hiding places. Zoologists create such shelters at locations which are not randomly selected but are rather chosen with regard to the highest expected probability of finding animals. When monitoring takes place, the individual hiding places are visited and the reptiles found under them, on them and along the route between the hiding places are recorded. The method recommends at least seven visits per year for basic research and up to twenty for detailed research. It isn't, however, focused on the determination of population density in various places but is instead designed to discover the largest possible number of species in the area. The zoologist thus avoids places with a low probability of reptile occurrence. We consider this to be the biggest flaw in this method as the occurrence of reptiles can be overrated, creating some kind of artefact. On top of this, the method doesn't enable comparison between various surfaces.

Guilfoyle (2010) attempted the standardization of methods. He suggested monitoring reptiles either in such a way that an area is examined during a period whose length is pre-defined, similarly as in the CES method (time-limited surveys), or by monitoring animals in permanent standardized areas (area-limited surveys). For time-limited surveys, Guilfoyle proposes a standard time of thirty minutes. He recommends what he calls active research, i.e. turning over stones, wood, fallen leaves and other objects at a certain location. The trouble with this method is that when the amount of findings (connected with a high number of records) is large, the time spent actually walking is shortened. In area limited surveys, the size of an area may vary from 1×1 m up to 50×50 m. The process of actively searching for animals (e.g. turning over wood and stones) must be standardized and repeated while taking inventory. When using standard area sizes, the density of population can be calculated and these data can be used for long-term monitoring at various locations and during varying weather and seasonal conditions. A variant is the use of a transect of a standard length. However, all authors work with natural hiding places only.



Schematic representation of one of the points of the transect. A 1x1 m foil, attached with nails (200 mm long) on the left and stones on the right, with a colour-coded pole (height 1 m). ***Drawing: Šárka Mikátová***

A shallow layer of substrate placed under the foil provides a suitable hiding place for snakes

A smooth snake (Coronella austriaca) under an opened 'decoy' foil

A transect point fitted with a 'decoy' foil and a marker pole (Podyjí National Park)

While surveying the Aesculapian snake in the Podyjí National Park and also in the Bílé Karpaty Protected Landscape Area, we included the installation of artificial hiding places as an inseparable part of our research. From practical reasons, we decided to use squares fabricated from different materials with the dimensions 1×1 m. A person can handle an object of this size easily, and at the same time its surface will provide a sufficient hiding place even for large Aesculapian snake specimens. In the initial stages of the research we concentrated on various types of material and examined various types of such artificial hiding places non-systematically. While we cannot claim that our observations in this matter provide any empirical proof of anything, we can still divide the hiding places into suitable, less suitable and unsuitable. The suitable ones include squares of pond foil, studded film and gurt (stiff conveyor belts made from rubberized textile used in the mining and quarrying of raw materials – the material is 1cm thick or more). Less suitable are, for example, tarpaulin, corrugated iron and Jekor carpet (non-woven carpet with a usual thickness of 3 mm). The following materials can be considered unsuitable: thin transparent plastic foil, wood, textiles (material for window blinds), garden foil and reed mats. These unsuitable materials either fail to provide suitable hiding places for reptiles or decompose quickly in the field. From the suitable materials we chose the one which brought the best results in terms of easy installation – pond foil. It proved advantageous on a long-term basis to attach it at two corners by nails and weigh it down with stones at the other two corners. Our procedure during the survey was to proceed in a standard way: on passing the foil squares we recorded all the reptiles we saw both outside the foils and on them. When we arrived at a foil square, we removed both stones carefully and lifted the sheet quickly. We either just spotted and recorded the reptiles or caught them in our hands for further research. Based on experience gained in the period between 2000 and 2014 we have developed the following methodology.

The point transect method for the monitoring of reptiles

This is a type of limited area survey method. When surveying a certain territory (a reserve, research area, object subject to biological evaluation, etc.), a 1 km long transect needs to be delimited and 20 points fixed along its track. For larger territories (over 10 ha), more lines of this kind need to be placed. One 'decoy' foil is placed at each point as an artificial hiding place (see below). The examined territory needs to be divided into basic habitats and their proportional representation must be estimated (e.g. meadow 20 %, dense forest 15 %, thin forest 60 %, shrubbery 5 %). Furthermore, a line needs to be drawn through the territory in such a way that it intersects all the basic habitats, and a proportionally corresponding number of points needs to be placed within each habitat (i.e. for example 20 % = four foils, 15 % = three foils, etc.). It is obvious that the transect thus won't lead along a line but rather will follow a curve which may also have round or elliptical characteristics. The points don't have to be spaced out evenly, but the smallest distance between them should be 20 m and the greatest 200 m.

A 'decoy' foil square with the dimensions 1×1 m is to be placed at each permanent point, attached at two of its corners with 200 mm long nails with a wide underlay and weighed down with stones at the remaining two corners. 0.6 mm thick pond foil made of black polyethylene is to be used as the material. It is advisable to put crushed bark and wood chips, small stones and similar items under the foil so that it doesn't lie directly on the surface – there are small crevices between it and the surface of the earth. Each point on the transect must be marked with a 1m high stick inserted into the terrain, with the upper end coloured brightly so that it is easy to find during the peak period of vegetation. A period of at least one month should elapse between the installation of the transect with the foils and the first monitoring session as reptiles only start using such hiding places when they remain in the landscape for an extended period of time. The optimum time for the installation of the line is in the autumn, and the launch of the survey should then occur in the spring.

During the monitoring, the researcher should go around the foils in a standard way (always along the same track) and record all reptiles spotted during the walk outside the foils as well as on them. When reaching a foil, he or she removes both stones carefully and lifts up the sheet quickly. The reptiles are recorded either only visually (eventually photographically) or are caught in the researcher's hands for further investigation (in this case, the direct observation method is thus being combined with the capture method). During each walk, a record is made of what the weather was like, and the air temperature at the beginning and end of the monitoring session also needs to be recorded.

For fauna research it is sufficient that the line transect is checked six times, and this should be done at optimum times. For quantitative research, twelve visits must be carried out per season, which lasts from April to September, with two checks per month regardless of the current weather.

Discussion

We tested this method at three different locations (classified according to Culek 2005): the Třebechovice bioregion (1.10), Hercynian sub-province (Plachta); the Bílé Karpaty bioregion (3.6), West Carpathian sub-province (Vlárský průsmyk); and the Jevišovice bioregion (1.23), Hercynian sub-province (Podyjí National Park). The method was tested intensively in the Podyjí National Park. We erected six transects with 24 points on each of them at a total of six localities. We also created 144 'decoy' foil shelters (96 foils were placed in 2011, after which more were added to meet the target state). These transects were monitored each season in the years from 2011 to 2014.

The foils are of varying importance to reptiles in the local landscape. They bring a new structure to the biotope which is different from the surrounding environment and which creates new hiding places. These are significant additions within relatively homogeneous environments (e.g. meadows), but thanks to the specific properties of the foils, reptiles also use them in very rugged and diverse environments such as e.g. sunny slopes with rock outcrops. It is obvious that monitoring reptiles under foils can also be an artefact to a certain degree. With regards to the generally low mobility of reptiles we assume that if a snake is recorded regularly under a foil in a certain place, it has certainly also frequented the foil (or its close vicinity) even before.

Reptiles generally perceive the spaces under the foils as places which are suitable for warming themselves while remaining hidden and free from the danger of predation. On other occasions the foils also enable reptiles to shelter from the rain. With regard to the fact that foils are often also used by small terricolous (soil) mammals, the space under the foils can also be used as a place for hunting. Mainly in the early spring period, lizards hunt insects which fly onto the surface of the foils (Vlašín et Mikátová 2007).

The Aesculapian snake (Zamenis longissimus) also loves vineyards (Podyjí National Park)

The foils are used by all terrestrial Central European reptile species but they are of essential importance in the monitoring of snakes and slow worms. Lizards can be also be observed almost equally well when walking along a line transect due to their high movement activity. In the case of the slow worm, 90 to 95% of found animals were discovered under foils and only 5–10 % of finds were the result of walking along transects. In the case of snakes, 81 to 93% of recorded individuals were found under foils. The share of snakes spotted outside the foils also varied during the season. The highest percentage of snakes found on the transect outside the foils (almost 20 %) was during the spring period when the activity of snakes is highest because, for example, they are migrating from their wintering places to their seasonal locations, they start exhibiting various forms of epigamic behaviour (connected with reproduction), etc. The foils were used by snakes in all age categories. In the Podyjí region, all four kinds of slow worm which appear in this locality *(Natrix natrix, Natrix tessellata, Coronella austriaca, Zamenis longissimus)* were observed under one foil. In the Plachta area in East Bohemia, the common European viper *(Vipera berus)*, grass snake *(Natrix natrix)* and slow worm *(Anguis fragilis)* were all observed under one foil. It is clear from these results that the use of foils in reptile research (mainly snakes and slow worms) is a basic method for discovering the species spectrum in a certain area as well as the possible evaluation of the characteristics of a given population.

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