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MONITORING OF REPTILES IN THE NETHERLANDS

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Abstract: The Dutch reptile-monitoring program started in 1993 in order to detect changes in populations of the seven reptile species present in The Netherlands. Six species are threatened and are on the national Red List. Reptiles are counted according to a standardised transect sampling method. A transect consists of a route of about 1750 meters, or an area of 2 - 2.5 hectare. It takes about two hours to visit a whole site, counting reptiles observed. Plots are visited seven times a year. Surveys are carried out by volunteers and employees of nature conservation societies. Results are checked for questionable data. Statistical analyses are conducted by Statistics Netherlands, using a loglinear Poisson regression TRIM. After five years of monitoring, conclusions can be drawn for *Lacerta agilis, Lacerta vivipara, Podarcis muralis, Natrix natrix,* and *Vipera berus.* There seems to be a positive trend for *Lacerta agilis* populations, and a negative one for *Vipera berus.* It is anticipated that information over an eight to ten years period is needed to ensure that trends observed are stable on the long term, and do not solely represent natural fluctuations. For *Coronella austriaca* and *Anguis fragilis* it is not possible to produce coherent datasets.

KEY WORDS: Conservation, monitoring, reptiles, Netherlands.

INTRODUCTION

Seven species of reptiles occur in the Netherlands (table 1). Except for *Lacerta vivipara*, all species are on the national Red List (Creemers, 1996). The presence of reptiles in the Netherlands is nowadays confined to nature reserves in heathlands and in dunes, except for some populations of *Natrix natrix*. Their habitat is strongly affected by the expansion of urban areas and infrastructure and intensification of agricultural land use, resulting in fragmentation.

The distribution of the reptile species in the densely populated Netherlands is well known. Although the reptiles nowadays are sparsely distributed, they can still be abundant locally. This allows individual animals to be counted. A pilot study to evaluate the reliability of reptile counting demonstrated that useful data are

Species	Red List category	Presence	Trend
Anguis fragilis	Vulnerable	rare	- 36 %
Lacerta vivipara	Safe/low risk	common	- 25 %
Lacerta agilis	Vulnerable	rare	- 41 %
Podarcis muralis	Critical	almost extinct	0 %
Coronella austriaca	Endangered	very rare	- 60 %
Natrix natrix	Vulnerable	rare	- 46 %
Vipera berus	Vulnerable	rare	- 49 %

Tab. 1: Red Data List of threatened reptiles in the Netherlands (after Creemers, 1996). The red list categories are according to the IUCN-system. The "trend" represents the decline in distribution area with regard to the first half of this century. The wall lizard (***Podarcis muralis***) can only be found on one location in the southern part of the Netherlands, where it still exists.

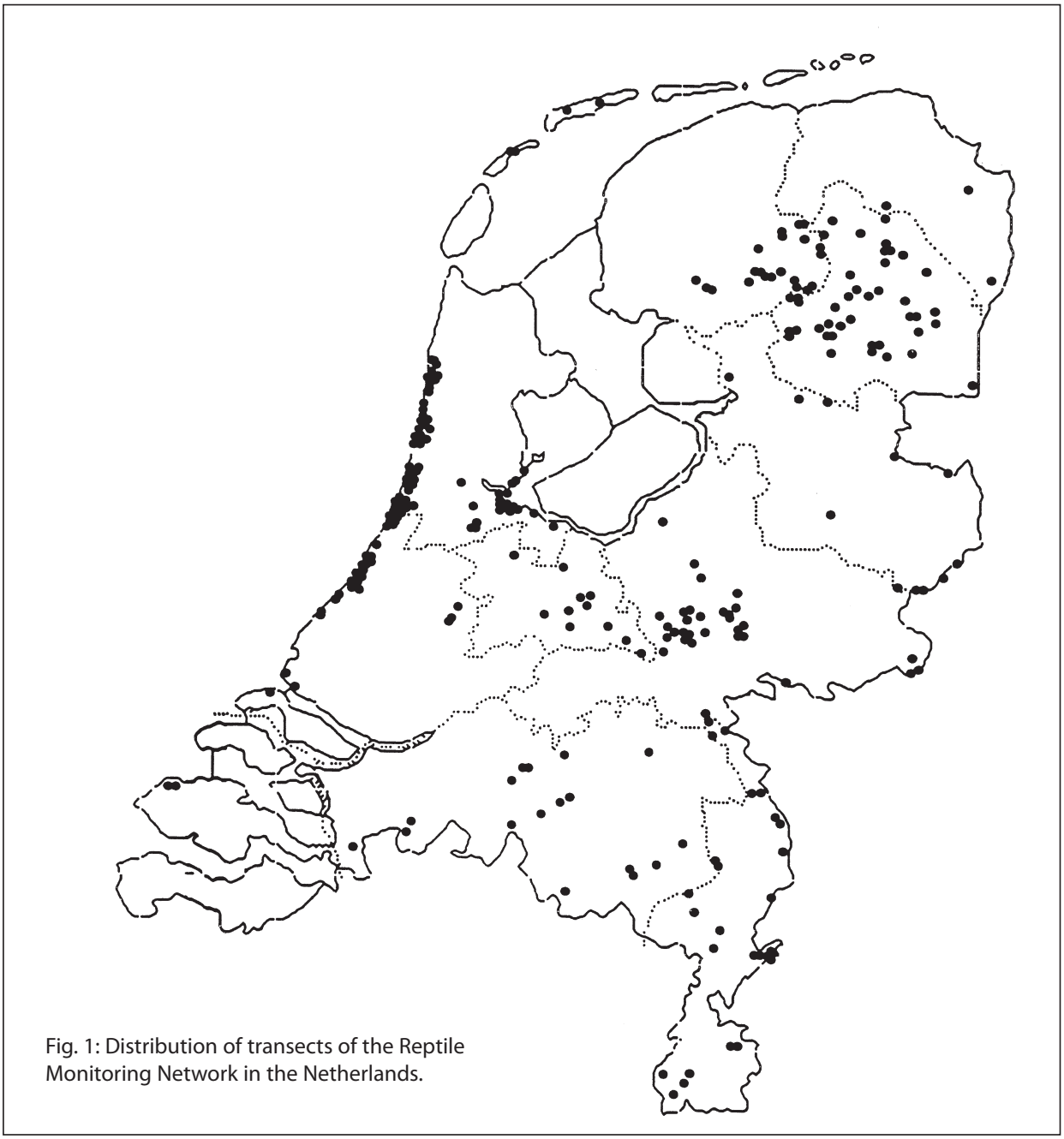

Fig. 1: Distribution of transects of the Reptile Monitoring Network in the Netherlands.

produced (Zuiderwijk and Smit, 1993).

The Dutch government has drawn up a National Nature Policy Plan (LNV, 1989) in order to develop sustainable nature preservation, restoration and improvement. The basis of this plan is development of a National Ecological Network. This Network should consist of core areas, nature development areas (i.e. for ecological improvement) and corridors (Stumpel, 1997). Being small terrestrial species in a fragmented habitat, reptiles are good indicators for monitoring such a network's effectiveness.

The above information provides three reasons why a Reptile Monitoring Network was desirable, and could be established in the Netherlands:

1. The endangered status of our indigenous reptile species.
2. Counting of individuals is possible and is a reliable method for conducting trend analysis.
3. The indicator value of reptiles for nature conservation and policy.

The Reptile Monitoring Network is designed as an "Early Warning Tool": It should provide information to detect if reptile populations are declining, before they become locally extinct. Thus, the aims of the Network are to detect changes in reptile populations and unravel their causes.

The Reptile Monitoring Network was set up in 1993 with financial support from the Dutch Government and the University of Amsterdam. Over a period of five years, the Reptile Monitoring Network has evolved into a nationwide network with over two hundred transects (fig 1).

Methods

Study area

Certain features of the Dutch landscape have resulted in a clear division between regions with and without reptiles. The southern, eastern and central part of Holland is largely made up of sandy soils, separated by river areas. The western part mainly consists of lowland peat and clay soils, bordered by coastal dunes. Most of the clay and lowland peat soils are below sea level, and reptiles are absent. Consequently the distributions of almost all Dutch reptiles are confined to the separated higher sandy soil and dune areas (fig 2). Some grass snake populations (*Natrix natrix*) occur in peat habitats (Zuiderwijk and Smit, 1991; Zuiderwijk *et al*, 1992).

Transect sampling

The method used for counting animals is transect sampling. A transect is defined as a fixed spatial unit in which an observer counts reptiles. Depending on whether it is a line transect or an area, the length is about 1750 m, and the area 2-2.5 ha. Some observers walk a line transect and search for reptiles in a band about 5 m wide; others comb the surface of an entire area. This results in an element of subjectivity in the monitoring, but accounts for the tendency for reptiles to aggregate in favourable areas. Bias was overcome since it was a procedure adopted for all site inspections. Usually, both methods are combined: walking a route and combing out small adjacent areas which look especially suitable for reptiles. As a rule, a transect is located in one type of landscape, to allow comparison with other transects. Physiognomie and vegetation characters of all transects are described in the field, allowing classification for future analyses.

Observation method

The surveys are conducted out by volunteers and employees of nature conservation societies. A manual is available for all volunteers to ensure standardisation of all data collected. The manual describes the methods used in detail. An important monitoring rule is that equal effort is taken during each visit, to allow comparison between visits and years.

On average, one survey will take about two

hours. The surveys need to take place during weather conditions favourable for reptiles, when they are basking outside their shelters. Advice about these conditions are described in the manual. The transect is surveyed seven times a year: four in spring and three in late summer. The advised periods for counting reptiles are: once in the second half of April, twice in May, once in June, twice in August and once in the first half of September. All sightings, and information about time, date and weather conditions, are recorded on a form. Again it is important that the same transect and method is used every time, year after year, in order to increase accuracy of statistical analyses.

Trend analysis

Trend analyses are conducted by Statistics Netherlands, the national Dutch bureau of statistics, using a loglinear Poisson regression TRIM. TRIM is a program developed for the analysis of data obtained from counts during animal population monitoring by volunteers. It allows for missing values to some extent (Pannekoek and van Strien, 1994). Spring and early summer surveys give the best results for statis-

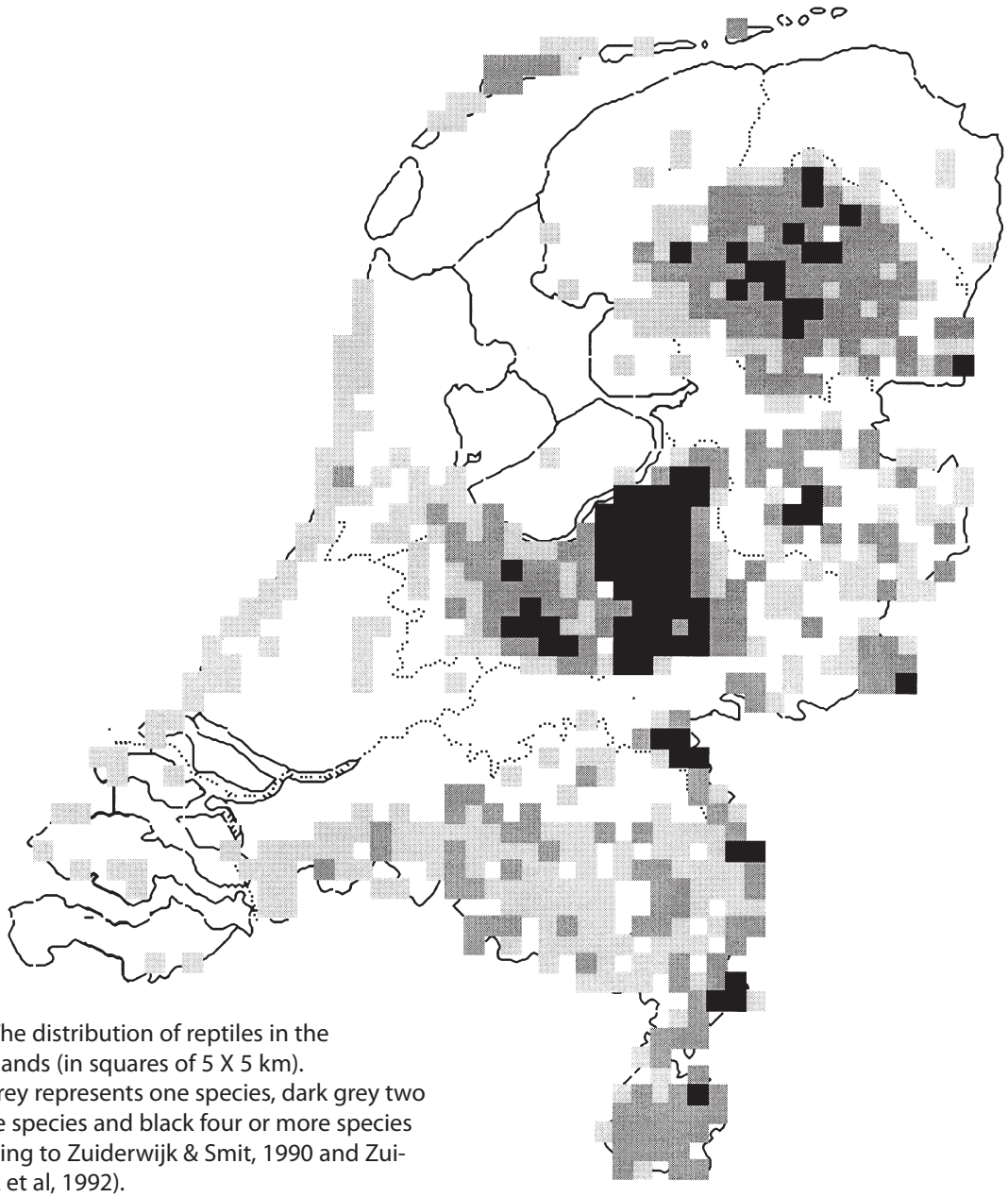

Fig. 2: The distribution of reptiles in the Netherlands (in squares of 5 X 5 km). Light grey represents one species, dark grey two to three species and black four or more species (according to Zuiderwijk & Smit, 1990 and Zuiderwijk et al, 1992).

tic analyses of the total numbers of adults counted, while the August and September surveys are mostly used for measuring reproductive success (juveniles).

Sustaining the network

The voluntary observers are organised in local groups whith a regional co-ordinator, who stimulates them and maintains contact, and also recruits new observers. The regional co-ordinators of the whole country meet once every year. To stimulate and inform the volunteers, a newsletter is produced three times a year, and excursions and lectures are organised. There is a close co-operation with staff of nature conservation management departments. This is valuable for both sides, in assisting with implementation of the monitoring-program, and in return recommendations and information about habitat management and reptile ecology are received.

Results

The monitoring of five out of seven species produced data sets that are useful for trend analysis. Species are *Lacerta vivipara*, *Lacerta agilis*, *Podarcis muralis*, *Natrix natrix* and *Vipera berus*. Transect sampling does not produce coherent data sets for *Anguis fragilis* and *Coronella austriaca*. This is due to their hidden way of life, resulting in large fluctuations of year to year sightings. The indices of juveniles of all species also show large fluctuations between years.

The following numbers give an idea of the magnitude of the data set at present, on which the trend analysis is based: in 1997, 221 persons counted 5747 reptiles of 198 locations during 1007 visits.

The nationwide indices have been determined for four of the indigenous reptile species (fig 3), a full data set is not yet available for the wall lizard (*Podarcis muralis*). Indices are standardised values representing an indexing of the mean number of sightings per field visit. In this indexing the first year of monitoring (1993) is always 100, and the following years relate to this first year. Indices are based on sightings of adult and subadult reptiles during springtime. These results are preliminary. Large-scale monitoring projects need a longer time span to make reliable inferences. However for the sand lizard (*Lacerta agilis*) and the adder (*Vipera berus*), there are already some results worthwhile taking a closer look at.

Sand lizard

The sand lizard in the Netherlands occurs in two different types of landscape: coastal dune areas and inland heath. The coastal dunes and the inland populations have been separated from each other by polders for several centuries. Within these two habitat types an ongoing process of habitat fragmentation is caused by human interference.

Summing up indices of the sand lizard for the whole country there is an increase in 1996, after a slight decrease from 1993 to 1995 (Fig 3a), which is significant (Wald-test, multiplicative slope 1.07, $p < 0.05$). When looking separately at the inland heath and the coastal dune populations (fig 4), both have a comparable index pattern. Detailed observations showed relative high numbers of juveniles in 1995 and subadult lizards in 1996.

Adder

The indices of the adder show a gradual decline in the period 1993 - 1997 (Fig 3d). This trend is significant (Wald-test, multiplicative slope 0,87, $p < 0.05$) for the northern part of their distribution range, where most adder transects are located. The decline seemed to

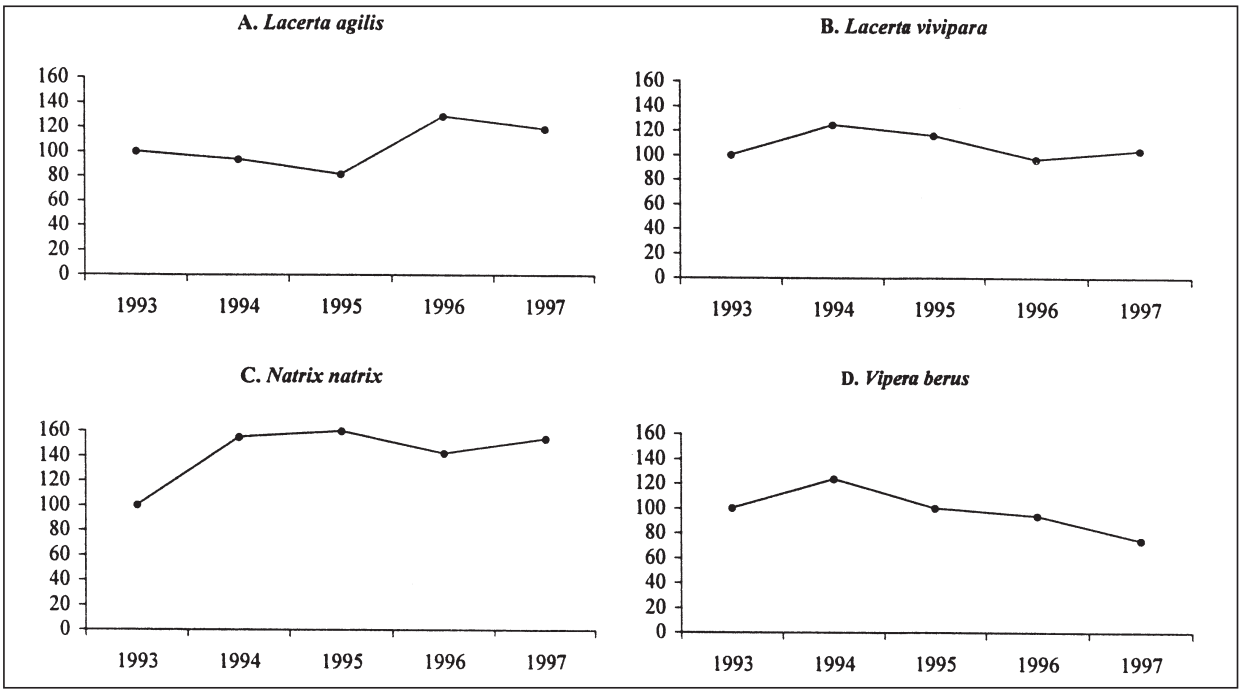

Fig. 3: Indices of reptiles in the Netherlands (1993 - 1997). Sample sizes are: ***Lacerta agilis*** = 125, ***Lacerta vivipara*** = 112, ***Natrix natrix*** = 48, ***Vipera berus*** = 60.

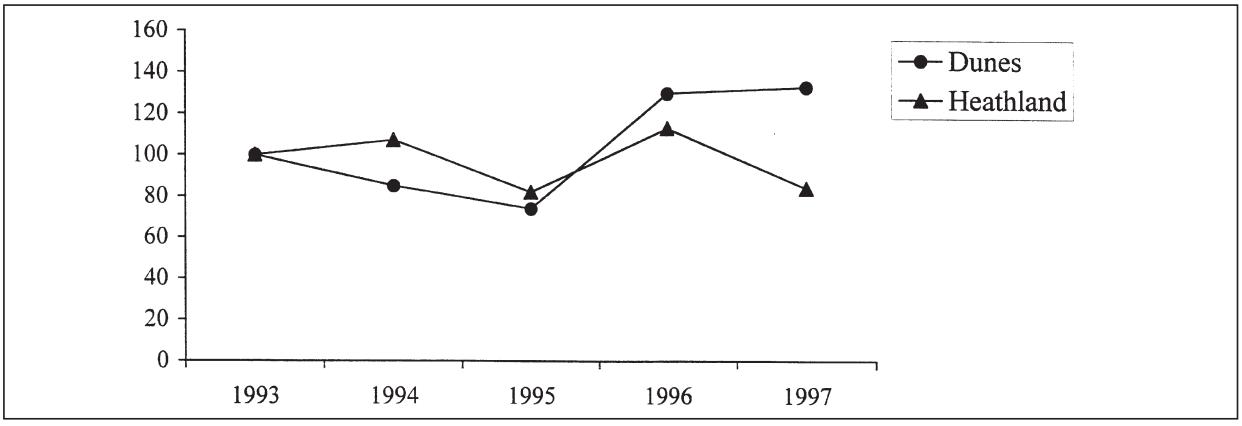

Fig. 4: Indices of the sand lizard, ***Lacerta agilis***. The indices of the populations in the dune area (n=86) are compared with those in inland heathlands (n=41).

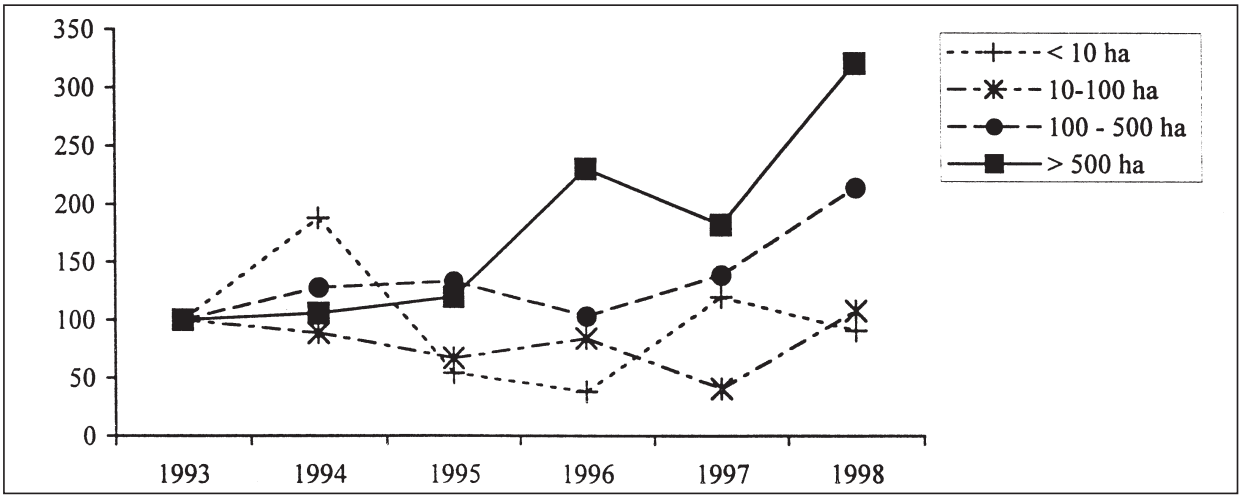

Fig. 5: Indices of the adder (***Vipera Berus***) from 1993 - 1998. The indices are drawn for groups of transects in areas of a different size (sample sizes are respectively 3, 6, 10, 7)

be more distinct in populations living in small areas (fig 5). Data for 1998 were available. Indices were classified, and four different area size groups recognised. In the small areas, <100 ha, populations are declining, while in larger areas an increase can even be observed. The trend difference between the different area size classes is significant (Wald-test 7.86, df=3, $p<0.05$).

Discussion and Conclusion

Different methods were tested for calculating the indices, i.e using the number of observed animals during the whole season, or those of spring and late summer seperately (juveniles included or excluded); using the maximum number of observed animals or the mean. Some of these analyses indicated a strong fluctuating curve. The curves of both the maximum and mean number of adult sightings in spring and early summer (15 March / 15 July), gave the most consistent results. Working with the mean number of observed animals was preferrable. Activity patterns of the reptiles allowed more reliable observations during springtime. During this season the animals had to leave their shelters more often for reproduction activity, and were more easily approachable. In late summer, activity patterns are more erratic.

The absence of large fluctuations in the index calculations indicates that transect sampling as used in the Reptile Monitoring Network, does produce useful data for trend analysis. The method works well for five of the seven Dutch reptile species. For the two more cryptic living species (*Anguis fragilis* and *Coronella austriaca*), transect sampling is not a suitable monitoring method.

The indices curve for the sand lizard followed the same pattern in both the coastal dunes and inland heathlands as the national indices, with an increase in 1996. This suggests that environmental condition plays an important role in the two separated populations, the two populations having evolved independently from each other. This condition is probably weather. Warm summers in two previous years resulted in high reproductive success, and thus a population increase. This was confirmed by the increased number of observed juveniles in 1995 and subadults in 1996.

The general decline in adder populations may be due to drying out of the adder's main habitat type, which is moist heath- and moorlands. Moreover, some nature management measures, like sod cutting and grazing, can have a negative impact on adder populations (Creemers, 1996). However, the results indicate that another phenomenon is also of importance in the adders' population dynamics. Comparison of data from populations derived from different area sizes reveals that populations in small areas of habitat are doing worse than populations from large areas. In general, smaller areas appeared to be more isolated. This suggests that isolation due to the ongoing process of habitat fragmentation seems to play a role in the declining population of the adder.

Although some of the trends observed can be explained by climatic influences, the case of the adder shows that in the long term, trends certainly can have a predictive value. The Reptile Monitoring Network does respond to the "early warning principle". However, a more prolonged period than the current five years of monitoring is necessary to analyse the results in more detail. About three more years are needed to be sure whether the observed trends are stable on the long term and do not solely represent natural fluctuations.

The Reptile Monitoring Network showed that working with such a large group of volunteers works out well, and results in a lot of data. Part of the success is due to the work

of the regional co-ordinators who keep in contact with the volunteers and stimulate them. Right before the start of the new season, the observers receive a newsletter with the results of the monitoring of the previous year. This quick feedback of their results is appreciated and stimulates them to continue with their monitoring activities.

There is a further by product of the Reptile Monitoring Network. Because many people are involved with reptiles watching, the knowledge they gain and concern for reptiles has led to numerous protection activities.

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