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A long-term analysis of the age structure of otters (*Lutra lutra*) from eastern Germany

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Abstract

The objective of this study was to examine if the increasing number of road-killed otters in eastern Germany affects the age structure of the population over a period of 40 years. A sample of 1 027 otter carcasses from eastern Germany that were collected mainly as roadkills (69%) between 1957 and 1998 was used to reveal possible long-term changes in age and sex composition across regions. Age determination was based on the analysis of cementum annuli of canines. The frequency of juveniles (age class I) amounted to 22%. This is considerably underestimated when compared with living populations. The greatest proportion of otters is represented by middle age class IV (52%) with a maximum age of 15 years. Contrary to the even sex ratio found in living otters from the study range, the present data revealed a significantly higher proportion of males (58%), especially in lower age classes (age class I: 66%, age class II: 71%). Concerning the question on possible effects of increasing numbers of road-killed otters on the population structure, there is no indication of effects on the age structure over the study period. Moreover, there is no time-related difference or significant region-specific deviation between age compositions of the otter samples of seven different regions. These results apply equally for both sexes. There is currently no evidence that an increased mortality affected the age structure of otters from eastern Germany.

Key words: *Lutra lutra*, age structure, road mortality, eastern Germany

Introduction

The otter, *Lutra lutra* (L., 1758), was once widespread throughout Europe and Asia. Today, its European range is strongly fragmented (Foster-Turley et al. 1990; Macdonald 1995). In eastern parts of Europe, however, dense populations still exist and eastern Germany constitutes one of the most important refuges in central Europe. There, viable populations exist from north to south in the provinces of Mecklenburg-Vorpommern, Brandenburg, and Saxony, with the river Elbe as the western border of the more or less continuous distribution.

In spite of many investigations on the conservation biology of otters, there are still few data available on age and population structure. Heggberget (1984), Kruuk and Conroy (1991), Sidorovich (1991), Madsen (1996), and Ansorge et al. (1997) reported on the age composition of otters, based on carcasses that were mostly shot by hunters or killed by traffic. However, there have been only very few attempts to check for possible long-term changes in the population structure, particularly with respect to causes of mortality (e. g. Kruuk et al. 1997).

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Even though hunting, habitat destruction, and pollution caused decline or regional extinction of otters in central Europe, a recent increase of otters is now being noticed in many regions of Europe. This is, however, paralleled by increased numbers of road casualties (Madsen 1996; Philcox et al. 1999). Numbers of road casualties among otters have especially increased in eastern Germany, as a result of increased traffic and road density after the political changes in Germany (Hauer and Heidecke 1999; Körbel 1994; Zinke 1991). Here, we study whether the increasing number of dead otters, that are mainly killed by road traffic, have an effect on the age structure in various regions of eastern Germany over a period of the past 40 years.

Material and methods

Otter samples, periods of collection, and study regions

A total of 1027 dead otters was collected during 1957–1998 in eastern Germany. According to the necropsies of all carcasses, the main cause of death was road casualties (69%). Carcass collections were initially sporadic but intensified since 1985. For this analysis the material was separated into the following five irregular time periods, to achieve sufficient period-specific sample sizes and to take into account historically and ecologically relevant changes in the study regions: before 1988, 1988–1990, 1991–1993, 1994–1996, 1997–1998. Furthermore, the otter material was assigned to the following seven regions (Fig. 1):

1 – Baltic coast – this approximately 25 km wide stripe of coastal land along the seaboard of the Baltic Sea in eastern Germany includes sandy beaches, shallow bays, and large areas of undisturbed habitat but also has a high road density
2 a – Mecklenburg – a region south of the Baltic coast with few human settlements and large undisturbed habitats with lakes and rivers
2 b – Lake district and Tableland of Mecklenburg/Brandenburg – similar to region 2 a but with many lakes
3 – Oder-Neiße-region – middle part of the German border to Poland; characterized by the rivers Neiße and Oder; with undisturbed habitats and low road density
4 – Lower Lusatia and Brandenburg heath and lakeland – with lower number of ponds, but many settlements and high road density
5 a – Upper Lusatia – most southeastern part of Germany; extensive pond district with many fish farms
5 b – Elbe-Elster-region – delta between the rivers Elbe and Schwarze Elster with intensive agricultural areas; high road density but also a network of ditches

Age determination

After skull preparation a canine or adjacent tooth was extracted. The age in years was determined for each individual by counting the incremental cementum lines of canines produced by low speed sawing of longitudinal root sections (Driscoll et al. 1985; Ansorge 1995). In addition, otters within their first year of life could be distinguished from older ones by various criteria of the skull development, such as obliteration of sutures, development of the postorbital constriction, and the sagittal crest, as well as bone deposition around canine alveoles (Heggberget 1984; Stubbe 1969; van Bree et al. 1966).

Years of age of single otters was grouped into the following age classes (AC), mainly based on reproductive aspects, in order to get a better overview in the following analyses:

Age classes (AC)

I: juveniles (within their first year); II: subadults (within their second year); III: younger adults (within their third year); IV: grown adults, middle age (4.–9. year); V: seniors (over 9 years)

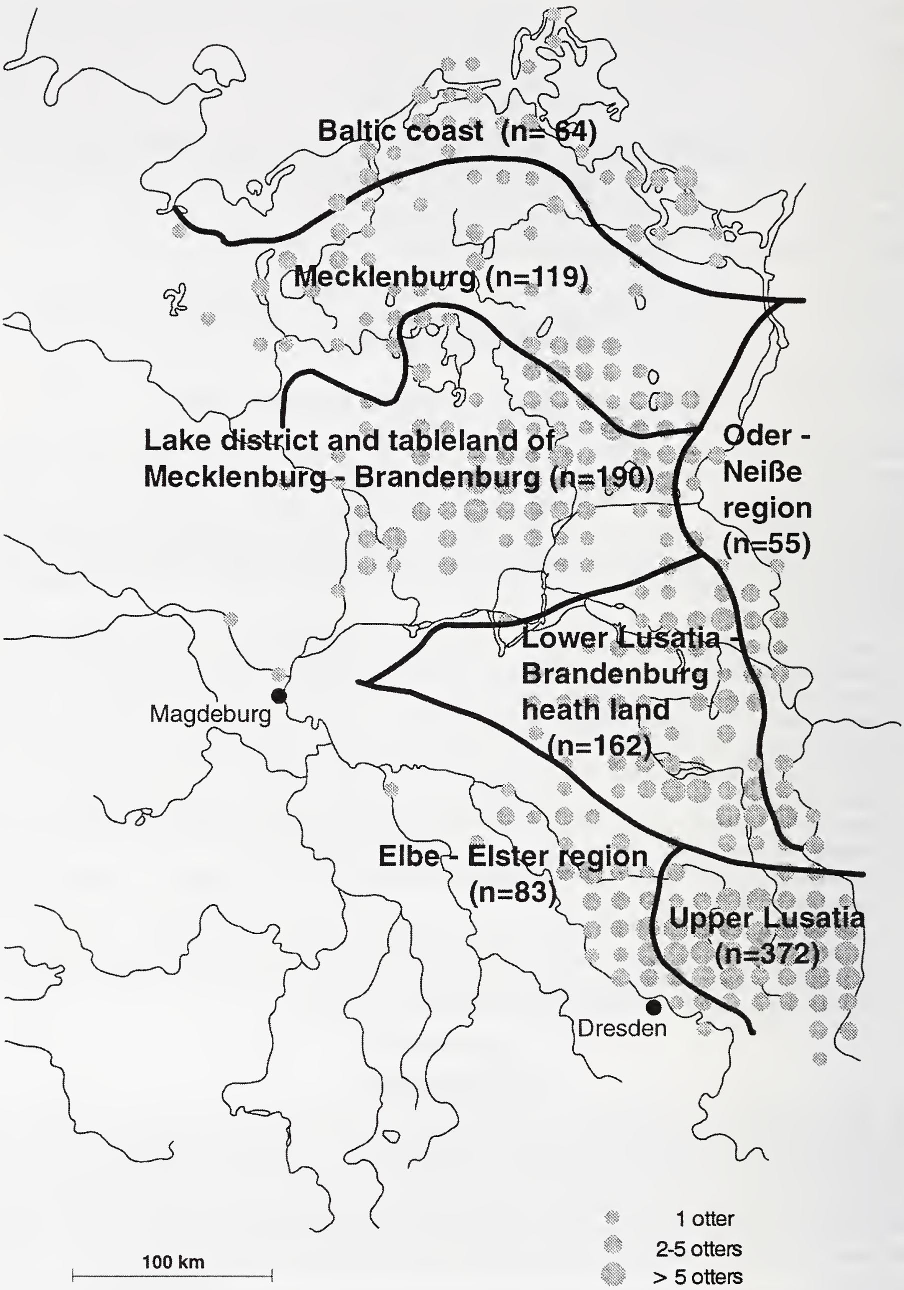

Fig. 1. Map of the sample area including number of investigated otter carcasses studied per topographic grid (grid side length is approximately 11.5 km).

Statistics

Pairwise chi^2 tests were used to check for differences in age class (AC) compositions between regions and for successive periods of time (5×2 contingency tables, respectively, see also Bodkin et al. 2000). Trends in different frequencies of juveniles over the study period were tested by Spearman-Rank-Correlation-Coefficient. These tests were carried out for combined sex samples and separately for each sex, and significance decisions were based on the Sequential Bonferroni procedure with a nominal $\alpha = 0.05$ to account for multiple and partly dependent tests (Rice 1989).

Results and discussion

Sample structure

The age composition and the sex ratio of the total sample material are illustrated in figure 2. The age pyramid appears relatively stretched because of the small proportion of juveniles and lower age classes and the long life span. Juveniles account for only 22%, while otters in their 2nd (AC II) and 3rd year (AC III) of life are represented with 11%, respectively 10% of the total sample. Otters of age class IV make up a considerable part (52%) of the sample. Only eight percent of the otters are older than nine years, but otters in our study could reach a rather old age, even exceeding 15 years. In contrast to the age structure of females, males show a nearly continuous development with successive decline of year proportions to the top of the age pyramid. Females show reduced frequencies in years 2 and 4.

The sex ratio of the total otter sample from eastern Germany is male-biased with 58% (1.4:1). Males predominate especially in age class I (66%) and age class II (71%).

Above 6 years the sex ratio of 1.2 males (55%) to 1 female is more balanced; and animals older than 9 years have a mean sex proportion of 1.4:1 (58%).

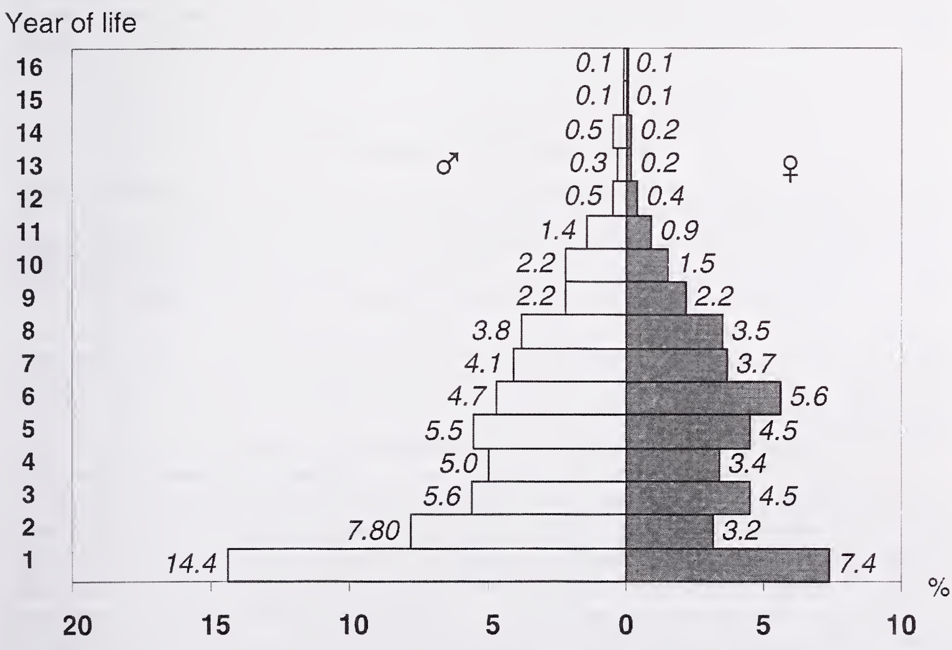

Fig. 2. Sample structure of otters (n = 1 027) from eastern Germany, data from 1957–1998 combined.

Despite the frequent use of carcass samples for assessing age and population structures, it has to be emphasized that such samples probably do not reflect the true structure of living populations (GOSSOW 1976). Hence, in interpreting and discussing such data caution is necessary.

Population structure of mustelids based on collection of carcasses is frequently characterized by a male-biased sex ratio (BUSKIRK and LINDSTEDT 1989; VAN BREE 1968). The reason for this could be the larger territorial size and the higher activity level of males of mustelids in general (GOETHE 1964) and therefore an increased exposure to road traffic for male otters (HEGGBERGET 1991; PHILCOX et al. 1999). UTHLEB et al. (1992) hypothesized that increased activity, particularly of young males in connection with searching for a free territory, could increase their risk of mortality. Also, it was assumed that male cubs were more active and curious than female cubs, and thus more endangered. The presently found low number of juveniles, in particular of female juveniles in our sample (Fig. 2) might result from these facts. In contrast to the presently studied carcass sample, females predominate in living otter population as shown by the model of ANSORGE et al. (1997). The low numbers of 2 and 4 year-old females in our study are probably due to stochastic effects.

The age composition of the total otter sample shows a remarkable small proportion of younger age classes (juveniles and subadults) when compared to a population model of otters and reproduction data (ANSORGE et al. 1997). Even though the presently found small fraction of juveniles and subadults is comparable to findings in otter populations from Norway, Scotland, Byelorussia, and France (HEGGBERGET 1984; KRUUK and CONROY 1991; SIDOROVICH 1991; ROSOUX and TOURNEBIZE 1995), it is an underestimation of the real proportion of these age classes within the free-living population. A very high proportion of cubs die non-violent causes, and they are less likely to be found than otters that were killed by road traffic or other violent causes (KRUUK and CONROY 1991). For one study area ANSORGE et al. (1997) developed a model to estimate the real population structure based on the age structure of otter carcasses as well as the analysis of reproduction signs (placental scars, embryo and corpora lutea counts), and field records of cubs per female. According to this model juveniles made up 50% of the living population as opposed to only 24% in the corresponding carcass sample.

Age structure related to time periods

The pairwise comparisons of successive time periods did not reveal any significant differences und thus, changes in the age structure of the eastern German otters.

To exclude the possible influence of different causes of mortality in these tests, a further analysis of changes in age structure over time was carried out using road-killed otters only (Fig. 3). But this approach did not fundamentally change the results.

When possible changes in frequencies of juveniles were analysed, using a Spearman-Rank-Correlation over the time periods there was no significant decline in the proportion of juvenile otters (age class I) after use of the Bonferroni procedure ($\alpha = 0{,}00192$, $p = 0{,}037$; $R = -0{,}9$).

None of the samples show sex-specific differences in age composition.

As in most other central European regions, otters declined continuously before 1988 in eastern Germany and reached their minimum distribution area. However, since the late 1980s a general re-colonisation of regions of former distribution is being noticed (HAUER and HEIDECKE 1999). This range expansion is reflected by the period 1988–1990. From 1990 onward a drastic increase in traffic-mortality of otters has been recorded. This is caused by an enormous intensification of traffic and growth of the road net work (HAUER and HEIDECKE 1999; KÖRBEL 1994). More recent time periods are characterized by an almost constant high level of road mortality. Both re-colonisation of regions and

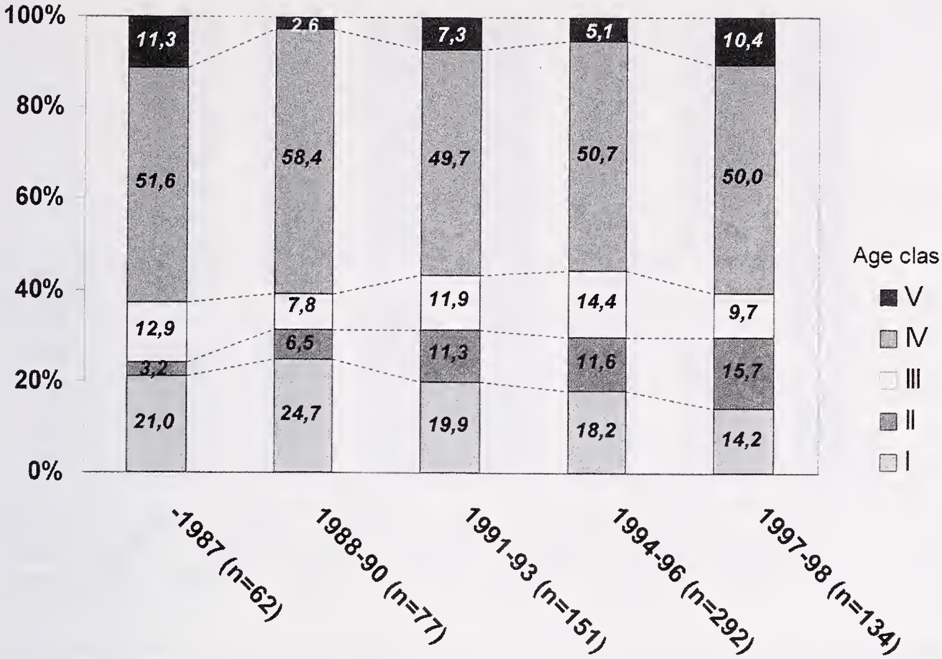

Fig. 3. Age composition of otters related to time periods – traffic-killed only. For age categories, see material and methods.

the increasing traffic mortality were also noticed in other European countries (Philcox et al. 1999). But this increase in road mortality obviously did not alter the age composition of eastern German otters in general.

The slight and not significant trend towards lower juvenile frequencies in the eastern German otters due to road casualties over the last 40 years possibly results from the generally noticed increase of otter populations. In contrast, Kruuk et al. (1997) found a decline of mean age in Scottish otters based on an increasing proportion of immature otters amongst road-kills, and interpreted this as resulting from increased population densities. This contrasting interpretation could be explained, if we assume that the decreasing trend of juveniles in eastern Germany might suggest a more developed population with a higher density than the Scottish populations that might just have begun to build up.

Comparison of the age structure across regions

The age class compositions of the otters killed by road traffic did not differ significantly across the seven regions of eastern Germany (see Fig. 4). This result is the same regarding otters of all causes of mortality.

However, the proportions of age classes III and IV show slight, non-significant deviations for example between region 3 (Oder-Neiße) and region 2 a (Mecklenburg), but the amount of both age classes III and IV achieves 60–70% for each of the regions with the exception of region 4. The lowest proportions of juveniles exist in the regions of the Baltic coast (1) and Oder-Neiße (3) (Fig. 4).

The regional deviations in the proportion of juveniles might result from a lower risk of road mortality for juveniles from undisturbed habitats in the Baltic coast region (1)

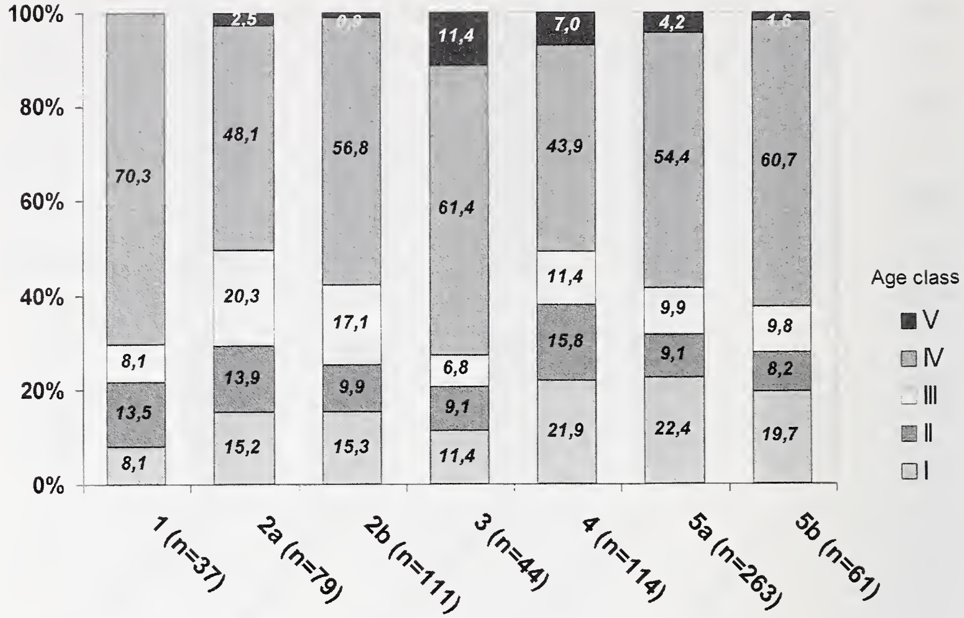

Fig. 4. Age composition of otters in the seven regions of eastern Germany – traffic-killed otters only. (1 – Baltic coast; 2 a – Mecklenburg; 2 b – Lake district and tableland of Mecklenburg/Brandenburg; 3 – Oder-Neiße-region; 4 – Lower Lusatia and Brandenburg heath- and lakeland); 5 a – Upper Lusatia; 5 b – Elbe-Elster-Region)

and the Oder-Neiße-region (3) and correspondingly high proportions of middle-aged otters (AC IV). A higher risk of road mortality would explain the higher proportion of juveniles and subadults in regions with higher road density (4, 5 a) and lower proportions of animals between 3 and 16 years of age (AC III–V). However, all these results do not show significant differences.

Obviously, neither different habitat conditions, nor different levels of disturbances or risks of mortality in the diverse regions do have a significant influence on the age structure of the otter sample.

Population genetic analyses of the otter from eastern Germany did not reveal any strong subdivisions or general isolation among the populations from the regions presently studied (ANSORGE and STUBBE 1995; EFFENBERGER and SUCHENTRUNK 1999; CASSENS et al. 2000). This suggests some exchange of individuals among the various regions; and this could result in only minor differences in the age structure across large geographic distances.

As we could conclude no significant differences in age structure between several regions in eastern Germany were registrated. The age composition of the otter sample from eastern Germany does not show any indication of increasing mortality since the last 40 years. This is a sign for a long-time stable otter population in eastern Germany.

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Zusammenfassung

Langzeitstudie zur Altersstruktur von Fischottern (Lutra lutra) in Ostdeutschland

Es wurden insgesamt 1 027 Totfunde von Fischottern aus dem östlichen Deutschland aus den Jahren 1957 bis 1998 untersucht und mittels der jährlichen Wachstumslinien im Zahnzement altersbestimmt. Die Haupttodesursache war der Straßenverkehr mit 69%. Ziel war die Charakterisierung der Alters- und Geschlechterstruktur sowie die Untersuchung zeitlicher und regionaler Unterschiede in der Altersstruktur der untersuchten Stichprobe.

Das Geschlechterverhältnis ist deutlich zugunsten der Männchen verschoben (58%), was sich besonders in den unteren Altersklassen (AC I: 66%, AC II: 71%) bemerkbar macht. Als Höchstalter von wildlebenden Fischottern in Ostdeutschland sind 15 Jahre nachgewiesen. Im Vergleich zu freilebenden Populationen ist der Anteil juveniler Tiere in der Untersuchung deutlich unterrepräsentiert (AC I: 22%), den höchsten Anteil stellen Fischotter der mittleren Altersklassen (AC IV: 52%). Das Fehlen deutlicher Änderungen in der Altersstruktur während der letzten 40 Jahre läßt trotz der stark zugenommenen Verkehrsmortalität auf einen großflächig und langzeitig stabilen Bestand in diesem Raum schließen.

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