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Causes of deaths of *Lutra lutra* in the Czech Republic (Carnivora: Mustelidae)

Příčiny smrti vydry říční (*Lutra lutra*) v České republice (Carnivora: Mustelidae)

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Abstract. Causes of mortality of the Eurasian otter in the Czech Republic were studied by the analysis of found carcasses. Most of the carcasses were accidentally found in the environment. Altogether 316 cadavers were analysed from 1990 to 2011. A part of the analysed data was obtained from older databases and unified. Since 2008 a single database exists and standard protocols of collection and necropsy are followed. Most of the dead bodies were found along roads (75.6%), non-violent death accounted for 3.5% of individuals, 7.9% were intentionally killed by humans and the rest (13%) died for other reasons. Despite the fact that the results are biased by several methodological problems, clear trends were revealed. Otters die more frequently at the roads with higher traffic intensity. Males are more prone to traffic mortality. The proportion of otters dying at roads has been increasing during the last years, as well as the proportion of otters illegally killed by humans.

Key words. Mortality, autopsy, road casualties, illegal killing, risk factors.

INTRODUCTION

Determination of causes of mortality is one of the most important elements in evaluating risk factors for a population of the studied species. Such data, when collected in the long term using a consistent method, can also reveal developmental trends in these factors as well as developmental trends of a population. In case of endangered species, this type of information is important in order to propose management measures leading to their protection and future survival.

In the Czech Republic, the population of the Eurasian otter, *Lutra lutra* (Linnaeus, 1758), markedly decreased during the 19th and 20th centuries due to habitat degradation, over-hunting and water pollution (Baruš & Zejda 1981). A similar trend took place within the whole of Europe (e.g. MacDonald & Mason 1994). In the 1990s, the species' distribution in the Czech Republic appeared to be restricted to three isolated areas (Toman 1992). After the introduction of legislative protection, several management actions and general improvement of riverine habitats, the otter population has recovered and the species currently occupies most of its historical

range (Poledník et al. 2007). In the legislation of the Czech Republic, the otter is classified as a strongly endangered animal species (listed in the implementing regulation No. 395/1992 to the Act No. 114/1992 on Nature Conservation and Landscape Protection). Detailed species monitoring, including the collection and analyses of found dead individuals, is – among other measures – also a part of the Eurasian Otter Management Plan in the Czech Republic for the years 2009–2018.

Due to the fact that the otter is considered an endangered species all over Europe (it is protected by the European Union legislation as well), causes of its death based on analyses of found carcasses were also studied in other countries (e.g. Kruuk & Conroy 1991, Rosoux & Tournebize 1995, Kruuk 2006, Hauer et al. 2002, Lanszki et al. 2008, Madsen et al. 1999, Simpson 2007a).

MATERIAL AND METHODS

Sources of dead individuals

Dead individuals are the source of data for determining causes of otter deaths. They are in most cases accidentally found in the environment. Given that the otter is a relatively large animal (the probability of finding is thus higher), it is possible to organize collection with the help of wider public and to gain a rather large sample, sufficient to evaluate causes of death in general. A few additional cases come from dead animals that were radio-tracked, they are therefore not accidental findings.

Our data set was created by collecting carcasses, as well as joining together data from previous independent collections. Collection of dead otter individuals was partly started in the Czech Republic in the past. Since the 1990s, it was organized by the Fauna Protection Station at Pavlov (hereinafter SOF)

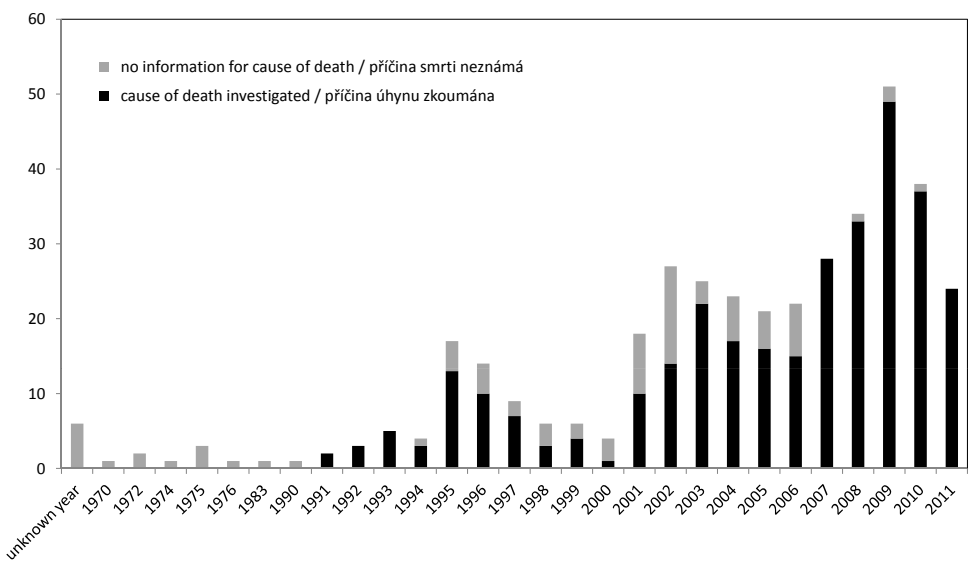

Fig. 1. Numbers of found carcasses of the Eurasian otter in the Czech Republic.
Obr. 1. Rozložení nalezených uhynulých jedinců vydry říční v průběhu let.

under the Agency for Nature Conservation and Landscape Protection of the Czech Republic (ANCLP) and by the Czech Otter Foundation Fund (ČNF). However, the collection was more or less local at that time, although the number of gathered carcasses reached 15–20 in some years (Fig. 1). Databases of these organizations were compared and integrated into one. Primary data collected by ANCLP till the year 2000 were unfortunately not available. At least summarized results of the data collected by ANCLP until 1995 are available in a publication by Toman (1995). Tissue samples or data from other institutions or persons (especially museums and taxidermists) owning one or more pieces from previous years were also gradually obtained. Since 2008, the collection has been unified and protocols for both collection and post-mortem analyses have been defined. Nature conservation agencies, administrations of protected areas, sanctuaries for handicapped animals, museums, taxidermists, the Bohemian-Moravian Hunting Union, the Bohemian Fishing Union, the Moravian Fishing Union and non-governmental organizations were informed of the need to collect dead otters. The data sample mentioned in Roche (2004) is included in the presented work.

Determining causes of death

The cause of death was primarily determined based on circumstances of a given finding. Since 2008, it has been also always confirmed (or proven false) by an autopsy report. Autopsy is done in a standard way according to the methodology recommended by the IUCN Otter Specialist Group (Simpson 2007b, 2011). Further specific analyses (gas chromatography for presence of poison, x-ray examination) are performed in case of suspicion or ambiguity. A small sample of randomly chosen carcasses was subjected to an x-ray examination for evaluation of non-lethal injuries from shooting.

Methodology of autopsy

The carcasses were frozen before necropsy was performed. A detailed examination of body surface is done for each animal. Body weight, body length (from snout to anus) and tail length (from anus to tip of tail) are taken in each individual. The entire carcass is then soaked in water and the following areas are examined with the help of a toothbrush: snout, surroundings of mouth and head, front and back feet and surroundings of reproductive organs and anus; the rest of the body is examined only briefly. Attention is focused on searching for puncture marks/holes in skin, which can be caused by mutual fights among otters or by shooting. The carcass is then skinned and contusions and bruises all over the body are searched for. Flayed skin is checked from inside to see if it contains pellet marks. Testes are inspected in males and tissue of mammary gland in females. Bones are also checked in all individuals and their fractures are noted. All organs of abdominal and thoracic cavities are macroscopically controlled, one by one. Condition of each animal (1–4) is subjectively estimated based on the amount of subcutaneous fat near the base of the tail. Teeth are checked as well.

Condition index is calculated from values of the animal's weight and length, according to Kruuk (2006): $K=W/5.02L^{2.33}$ for females and $K=W/5.87L^{2.39}$ for males (K – condition index, W – weight in kg, L – body length in m).

Constants of the index are defined based on the sample of normal healthy individuals from the Shetland Islands. Values around 1.0 mean average healthy animal; malnourished individuals have values from under 1 to appx. 0.5; well nourished individuals can, on the other hand, reach values of 1.4 or more. The condition index can be calculated only when the body is compact without open injuries and extensive fractures of bones. List of causes of death is given in Table 1.

Data samples

The current data set includes 316 samples from the years 1990–2011, for which the cause of death has been determined (Table 1). In another 81 recordings of dead otters from previous years, no data are available regarding the cause of death. Out of the entire data set, 259 samples come from earlier collections,

Table 1. Causes of death of found dead Eurasian otters in the Czech Republic
Tab. 1. Příčiny smrti u nalezených uhynulých jedinců vydry říční v České republice

cause of death / příčina úhynu	1990–2000	2001–2005	2006–2011	total / úhrnem
traffic collision / dopravní nehoda	29	63	146	238
– collision with a vehicle / srážka s automobilem	28	63	144	235
– collision with a train / srážka s vlakem	1	0	2	3
intentionally violent death / násilná smrt	2	2	22	26
– poisoning / otrava	0	0	15	15
– shooting / zastřelení	1	0	2	3
– beating / zakousnutí	0	1	2	3
– iron trap / odchyt do želez	0	1	3	4
– another killing / jiné zabití	1	0	0	1
non-violent death / nenásilná smrt	6	5	1	12
– disease / onemocnění	0	2	0	2
– bad condition / špatná kondice	2	2	0	4
– old age / sešlost věkem	1	1	1	3
– other / jiná	1	0	0	1
– predation / predace	1	0	0	1
– bites by another otter / pokusání jinou vydrou	1	0	0	1
other (intentionality unclear) / jiná	14	9	17	40
– abandoned cub / opuštěné mládě	0	3	10	13
– bites by a dog / pokousání psem	3	1	1	5
– bites by unknown animal / pokousání jiným zvířetem	1	0	0	1
– unknown / neznámá	10	5	6	21
total / úhrnem	51	79	186	316

138 individuals were recorded already according to the standard methodology (findings from the years 2008–2011).

For further analyses, the data set is divided into three time periods (1990–2000: N=51, 2001–2005: N=79, 2006–2011: N=186) and also into sex groups (males N= 169, females N=97).

The found dead otters come from the entire Czech Republic, from all areas of their occurrence (Fig. 2). A relatively large portion of individuals come from the South-Bohemian Basin and from the Bohemian-Moravian Highlands – from areas with the highest population densities. Given the methodology of collection and previous distribution of otters in the Czech Republic, samples from earlier years come only from these two areas.

For 20 randomly chosen carcasses an x-ray examination was performed. The condition index was calculated in 56 cases (only cases processed by the standard methodology). Radio-tracking studies provided data on the cause of death for five animals from the vicinity of the Dačice town and one animal from the Třeboňsko Protected Landscape Area.

Road analyses

All carcasses collected along roads were further sorted using GIS tools. Depending on the position of each carcass with regard to the nearest aquatic environment, each individual was classified into one of the following categories:

(1) near watercourse – the carcass was found within 20 m from a crossing between a watercourse and a road;
(2) dam of a water body – the carcass was found on a dam of a fishpond or another water body, with a road running on the top of it;
(3) no water body or stream – the carcass was found more than 20 m away from aquatic environment.

In addition, the class of the road where the particular individual was found, was identified. In order to compare the numbers of individuals killed on roads of different classes, the following data on overall lengths of roads of different classes in the Czech Republic were used: highways 1,156 km, 1st class roads 5,832 km, 2nd class roads 14,635 km, 3rd class roads 34,129 km (Anonymous 2011).

RESULTS

Within the whole data set of found carcasses (N=316), the cause of death was traffic collision in 75.6% of cases, 3.5 % of individuals died in a natural non-violent way, 7.9% experienced intentionally violent death, and 13% died as a result of an "unclear" cause which could not be identified whether it was intentional or unintentional human-based or natural (Table 1). Traffic collisions were – with the exception of three cases of deaths on railways – constituted of deaths on roads. Concerning diseases, only canine distemper was proven in one case. Several ways of deliberate killing were confirmed during the years: shooting, iron traps, beating and poisoning. Carbofuran was used in all documented cases of poisoning. All cases in the category "unclear" were individuals found in the countryside (far away from road network), in good condition and without any pathological findings or traumas.

Collision with a vehicle is the most common cause of death in the found individuals. Probability of collision with a car depends on traffic intensity. Otters died most often on the 1st class roads (45.1% of individuals that died on roads), followed by 2nd class roads (22.8%),

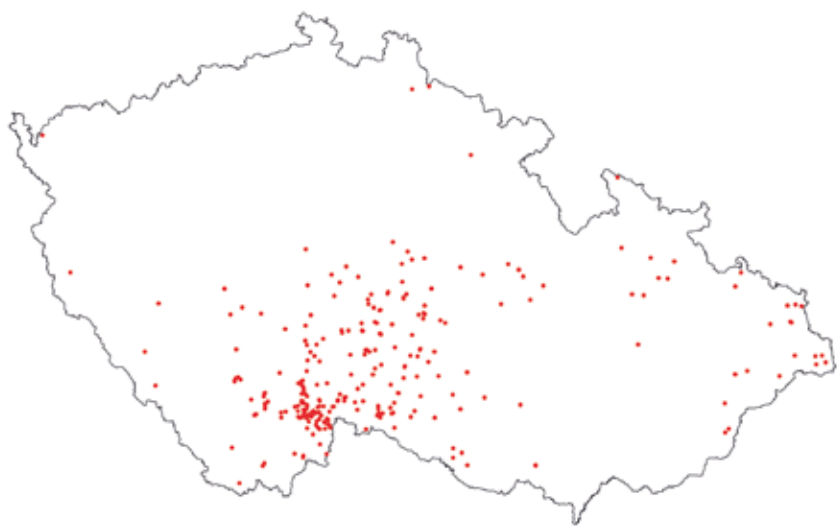

Fig. 2. Location of found carcasses of the Eurasian otter in the Czech Republic.
Obr. 2. Lokalizace nalezených uhynulých jedinců vydry říční v České republice.

3rd class roads (17.3%) and local communications (8.6%). The remaining 6.2% of individuals that died on roads were found on highways. Recalculated to the amount of different-class communications in the entire Czech Republic, it gives one found otter per 79 km of highways, one otter per 55 km of 1st class roads, one otter per 273 km of 2nd class roads and one otter per 839 km of 3rd class roads.

Dead otters on roads were found in 30.4% of cases in close proximity to watercourse, in 25.5% of cases at a dam of a reservoir (pond) and in 44.1% of cases there was no water body or stream near the place of finding.

The proportion of deaths on roads in the period 1990–2000 was lower (57%) than in the two following periods (80% and 78%, respectively). The number of otters that died naturally got gradually lower, declining over the time periods from 16% to 1%. During the last five years, natural death (old age) was established as the cause of death only in one individual. Intentional violent death, on the other hand, increased from 2% to 12% (Table 1).

Proportions of causes of death differ between males and females. Males are more prone to dying on roads (82% of recorded male deaths) than females (69% of recorded female deaths) (N=266; Chi-square 5.52; p=0.0188). Total numbers of found individuals that died as a result of traffic collision are: 138 males and 67 females. In cases of deaths resulting from other causes than traffic, the total numbers of found males and females are balanced (31 males, 30 females during the entire monitored period).

No pellets were found in any of 20 randomly selected controls by x-ray.

Data on causes of death coming from radio-tracked individuals brought the following results: collision with a car (1 individual), disease (1) and deliberate violent death (4).

The condition index ranged 0.642–1.557; mean 1.087±0.027; median 1.109 (N=56). The condition index in animals hit by a vehicle fluctuated from low to high values. Other causes of death, on the other hand, are associated with condition. Below-average values were found in cubs classified in the category "abandoned cubs", as well as in individuals that died as a result of other animals' bites – either another otter or a dog. One male in bad condition was beaten to death in a trout fish farm (K=0.845). All poisoned individuals were in a good condition (K: 1.105–1.322).

DISCUSSION

Methodology

While interpreting the results, it is very important to look at the data and results with regard to possible methodological distortions. The fact that the probability of finding dead otter individuals is strongly dependent on the cause of death constitutes a significant flaw of the method of determining causes of death in the found dead individuals. The gained data sample is then not a random sample of the population. Especially in the case of road kills the probability of finding is much higher than in case of other causes of death. Animals lying on the roads are quite visible and there are many potential "finders" in this "environment". Findings of animals that died for example of old age or due to disease are, on the other hand, very rare. One radio-tracked male followed during the years 2001 and 2002 died after a longer ongoing disease. He was found curled up under a bush in very dense vegetation on non-cultivated land. He would not have been found without a functional transmitter. Roughly estimated, the probability of finding in different causes of death can differ as much as 40 times (Poledníková et al. 2010a). A slight distortion could have also been caused by disunited means of collection and performances of

analyses (subjective evaluations of causes of death, especially in cases from previous years, when autopsies were not carried out).

Distribution of causes of death in radio-tracked individuals is very different from that in the data set of found individuals. Minimum distortion can be assumed in the sample of radio-tracked animals, because this data set is not dependent on the cause of death. Unfortunately, the sample is very small (5 individuals). However, this sample indicates that some causes of death could be much more significant than we expected.

Number of carcasses recovered per year

The number of detected otters has been increasing over years, in the last few years it is around 35 individuals per year. This increase in found animals is caused by several factors.

One distinct factor influencing the number of collected individuals is detectability. That is, how many dead individuals are found and then also reported and submitted to cooperating persons. Detectability is given by:

(a) Probability of finding dead individuals by the public – this is likely to be generally the same over time, we do not think that there were noticeable changes in the past.

(b) Probability of finding dead individuals by the staff of organizations that manage the databases – this did change during the years depending on the importance of collection. For example, according to Roche (2004), the increase in findings in 1994–1995 is caused by considerably higher time spent in the field by workers of ČNF.

(c) Reporting/submitting the carcasses to cooperating persons, so that these cases can be included into the presented sample. This is influenced by public awareness of the collection and also by willingness of the public to cooperate. Increase in findings in 2009 is due to this reason, because at the beginning of the research project supported by the Ministry of the Environment, the collection was intensively presented in several ways to possibly interested groups of people.

Another significant factor influencing the number of found/reported otters is the cause of death and its proportion in the reasons of death. The number of individuals that died on roads has been increasing over years. Considering the fact that probability of finding a carcass on roads is much higher than at other places, the average detectability gets higher and therefore influences the number of samples in the data set.

The last important factor is then an overall increase of otter population in the last two decades. Since 1992, distribution of otters in the Czech Republic (as documented in three country-wide mappings) changed from 28% of the occupied territory at the beginning of dead otters' collection, to 75% of the country occupied in 2006 (last distribution mapping), with corresponding increases in abundance (Toman 1992, Kučerová et al. 2001, Poledník et al. 2007). That means that there also is an increase in absolute numbers of dead otters per year. The reason for the decrease of the number of collected carcasses in the last two years is a delay in carcass collection and analysis.

Causes of death in general

Causes of otters' deaths can be either "natural" or caused by humans – intentionally or unintentionally. Diseases, old age, or starving are classified among natural deaths. It is, however, very difficult to distinguish between these categories without detailed analyses. Road kills are caused unintentionally by humans. But there also is a group of cases where it is not clear if they were caused by humans intentionally or unintentionally, e.g. killing by dogs or findings

of abandoned cubs. Intentional killing by humans is then the third main category of causes of otter deaths in the Czech Republic.

Roadkills

The proportion of otters killed on roads in the neighbouring countries, e.g. in Hungary (Lanski et al. 2007) and some federal states in Germany (Hauer et al. 2002), is comparable to our data. Increasing traffic intensity is therefore a relatively strong risk factor that can significantly influence the currently positive trend of the entire population of the otter in Central Europe.

Although the relative proportion of causes of death is strongly skewed towards road kills due to a higher probability of finding, it is clear that traffic is a significant factor influencing otter mortality in the Czech Republic. The reason for the increasing absolute number of road kills is partly in methodological errors (see above – increasing intensity of collection, increasing population). However, there also was an increase in the relative proportion of road kills over years as compared to other causes of death (from 57% to 78%). Toman (1995) also states a "lower" proportion of road kills for the period 1990–1995. Traffic volume has been growing significantly in the Czech Republic in the last years (Anonymous 2011). In addition, greater probability of a road kill on roads of higher classes was detected, that means on roads with greater traffic. The increase in relative proportion over years together with growing traffic and greater mortality on roads of higher classes shows that the increase of individuals killed on roads is also given by higher mortality (not only by methodological errors in data collection), meaning that mortality on roads increases with growing traffic. The influence of traffic intensity on mortality of the otter has been proven in other studies (e.g. Philcox et al. 1999). According to known predictions, the trend of increasing traffic in the Czech Republic will continue (Bartoš et al. 2010). From that, it can be inferred that otter mortality on roads will also keep increasing and will therefore influence growth rate of the Czech population more significantly.

The otter is a semi-aquatic animal species that makes use of all types of both stagnant and running waters and most often stays in or close to water while moving within its home range. It may therefore seem that otters are not so strongly influenced by road network in the countryside, as they can use bridges and underpasses for safe passage. Crossing of a communication with a water body sometimes creates a barrier and otters have to overcome it by crossing the communication. However, passing under bridges or across a road is influenced by many factors, especially whether it is at all physically possible to pass under the bridge. The influence of these factors was studied mainly in Germany (e.g. Jancke & Giere 2010). It must be said that while wandering around the countryside, otters use the terrestrial environment as well. It could be because of barriers on streams or just in order to shorten the route from one pond to another. Findings of dead otters on roads far away from water were frequent in our study (44.1%). Analyses of dead otters from north Germany, from an area of lakes where otters cross dry land between lakes (a comparable environment to the pond areas of the Czech Republic), bring similar results (Jancke & Giere 2010).

Illegal hunting

Despite the low number of intentionally hunted individuals found, we believe that intentional hunting is one of the main causes of death in the Czech Republic and it is an important factor influencing otter mortality and the growth of the otter population. Detectability of illegally killed individuals is probably very low. Data from radio-tracking support the suspicion that

the illegal killing can be common. Unfortunately, it is complicated to document and then even prove such cases, exactly for the reason of illegality. We have heard about tens of illegally killed otters and about several other methods used to kill them which are not mentioned here. However when there was no clear evidence either from a dead body or documented pictures, we did not include the case in the database/dataset. Therefore it is important to look at the results with respect to this bias.

Considering that the otter is currently protected by both the European Union (Council Directive No. 92/43/EEC, Appendices II and IV) and national legislation (listed as a strongly endangered animal species according to nature conservation legislation, and as a year-round protected game species according to the Game Management Act No. 449/2001), hunting is an illegal activity. In compliance with the Game Management Act, it is considered as poaching.

One reason for illegal hunting can partly be a habit from the past, when the otter used to be a game species (was hunted for skin, meat and as a pest species). Nowadays, the main reason for hunting is lowering damage caused by otters on fish stocks. Illegal killing occurs in the entire territory of the Czech Republic – most frequently in areas with long-term occurrence of otters, but also in areas where recolonization of otters has taken place only recently. Individual findings come from the following regions: Jihočeský, Vysočina, Pardubický, Moravskoslezský, Plzeňský, Olomoucký. Negative attitude of fishermen towards otters is also shown in social surveys (e.g. Moravcová 2002, Culková 2007, Poledníková et al., in press). In order to mitigate this conflict, two basic strategies have been used by nature conservation organisations so far: education and a financial measure in the form of the Act No. 115/2000 on compensation for damages caused by selected specially protected animals. Based on this act, fishermen farming on ponds have the right to claim compensations for damages caused by otters. Taken into account that cases of illegal killing have been documented in the last years (e.g. 7× in 2009, 1× in 2010, 2× in 2011), it is obvious that the conflict between otter protection and economic interests of fish-farming subjects is not yet solved or lowered. Therefore, the conflict and illegal hunting are still considered as a strong risk factor for otter population in the Czech Republic.

Several means of poaching have been documented: shooting (shotgun, rifle, small-bore rifle), using iron traps (leg-hold traps), beating to death and poisoning. Carbofuran was used in all cases of poisoning. Six different cases of poisoning by carbofuran have been discovered since 2006 with a total number of 14 killed individuals. The condition index of all measured individuals was above one, they were therefore not animals suffering from starvation. This is a surprising finding, because when fish-eating predators are targeted by the poisoning, a bait in form of a poisoned dead fish is typically used. Otters are said to consume carcasses only exceptionally. Details about the individual cases of poisoning from the Czech Republic are summarized in Poledníková et al. (2010b). Illegal hunting is reported also from Germany, Hungary or Austria – from traditional pond areas (Gutleb et al. 1995, Hauer et al. 2002, Lanszki et al. 2008), but also from Denmark or England (Madsen et al. 1999, Kruuk 2006).

Other causes of death

Within the category of non-violent causes of death, very few diseases have been documented so far in the Czech Republic. Canine distemper was identified in one case. Toman (1995) reported invagination of the small intestine as the cause of death in one case. The proportion of diseases in the entire sample is very likely to be strongly underestimated (low probability of finding – see above, and not determining the disease due to insufficient analysis of the carcass).

Madsen et al. (1999), Hauer et al. (2002), Kruuk (2006), Simpson (2007a) report many diseases, e.g. distemper, pneumonia and other bacterial diseases, liver abnormalities or tumours. They also report many other abnormalities that were, however, not determined as the direct cause of death. In general, very little is known about diseases of Eurasian otters, especially about their prevalence or influence on mortality. In a study from Germany (Hauer et al. 2002), a difference in the proportion of causes of death among age groups was detected. More cubs and old animals died due to diseases.

The category "abandoned cubs" includes cubs estimated to be under one year of age that were either found dead or died soon after being found. Cubs that were found alive and then survived in captivity (in sanctuaries for handicapped wild animals or in the SOF at Pavlov) are not included in the presented data set. These individuals are usually malnourished (the condition index in the measured individuals was always below one). Otter cubs are accompanied by their mother approximately until they are one year old (Kruuk 2006), after that the family breaks up. There can be two reasons for abandoning cubs: the mother dies (any cause of death is possible) or the mother abandons her cubs intentionally. Leaving one or more cubs intentionally by the mother has been observed on the Shetland Islands (Kruuk 2006).

In several cases, animals with very serious bites, which caused their death, were reported (in one case infection of the wound was the cause of death). In five cases the victim was bitten by a dog, in one case by another otter. Except for one adult female and one adult male, all these cases concerned cubs. The condition index was lower than one in all measured individuals. With the exception of one case (subsequent infection), all the bites were fresh, therefore bad condition was not the consequence of the bites but rather their cause – a starving animal can behave in a non-standard way and can come closer to human settlements with dogs. Intraspecific aggression was relatively frequently (38%) documented in England (Simpson 2007a) – either as the cause of death or as old wounds. This factor has not had a greater influence on otter population in the Czech Republic so far. Toman (1995) reported one case of a bitten cub. One cub is also classified as bitten by an adult otter in the presented data set. Old wounds from intraspecific fights were found very rarely in the Czech Republic (scars on paws were found in six carcasses from 38 examined, however the reason for scars is unclear, could be either a result of intraspecific aggression or from the environment).

Predation as a cause of death comes into consideration only for cubs, because adult otters do not have natural predators in the Czech Republic. Cubs can be predated by an eagle-owl or by a fox. Two cases (4%) were reported by Toman (1995), one old case is included in the presented data set.

Gastrointestinal changes connected to long-term starvation have been reported quite often (8%) from the Shetland Islands (Kruuk 2006). Although many individuals with the condition index below average are documented, long-term starvation due to the lack of food was identified as the cause of death in none of the cases. Toman (1995) reported this cause of death for four individuals (7%).

Other causes of death, so far not proven in the Czech Republic, have been reported from other countries. Drowning in fishnets is documented in Germany and as a very significant – even though decreasing – factor in Denmark (Madsen et al. 1999, Hauer et al. 2002). Fishnets that could potentially be dangerous for otters are not used in the Czech Republic. Kruuk (2006) also reported oil poisoning. This cause of death can affect Eurasian otter populations living on sea coasts (oil spills) and is reported as an important factor for the Canadian river otter, *Lontra canadensis* (Schreber, 1777), and the sea otter, *Enhydra lutris* (Linnaeus, 1758) (Kruuk 2006).

However, poisoning by other substances might also occur inland in case of spills on rivers. Such case has not been documented from the Czech Republic.

Sex differences

Proportion of the particular causes of death differs between sexes. There have been twice as many males found killed on the roads than females. Therefore, males are considerably more prone to this cause of death. It is likely caused by the fact that males have larger home ranges than females (Poledník 2005) and so their movements through the landscape are probably greater. Also, a bigger dispersion distance after leaving the mother is assumed in subadult males. When comparing proportion of the two genders in all other causes of death, the ratio comes out balanced 1:1. Therefore, methodological problems are definitely the reason for unbalanced overall sample as far as gender is concerned. It is, however, not safe to state that the real gender ratio is balanced, the collected data are not yet sufficient to make such a statement.

CONCLUSIONS

Based on the presented analysis, several conclusions and important findings should be pointed out. With respect to the expected increase of traffic intensity, mortality of otters on roads seems to be a critical factor for the future trend of otter population in the Czech Republic. Therefore it is necessary to further monitor the road casualties and, in places with repeated records of dead otters, measures ensuring save passing of the road by otters should be installed.

Another important risk factor is illegal killing of otters by fish farmers. The present measures to reconcile this conflict are not sufficient. The situation currently poses a significant risk to otter population in the Czech Republic, but it also increases negative attitude of landowners to nature protection and intensifies social tension in the society in general.

Data on non-violent deaths are very scarce, therefore continuing the collection and analyses of otter carcasses is recommended in order to get better knowledge regarding otter diseases.

SOUHRN

Na základě sběru a analýz nalezených uhynulých jedinců vydry říční (*Lutra lutra*) byly sledovány příčiny smrti vyder v České republice. Uhynulí jedinci byli ve velké většině případů náhodně nacházeni v prostředí. Kadávery byly/jsou nacházeny širokou veřejností a systémem hlášení a svozu se materiál sbírá a analyzuje jednotně pro celou republiku. Příčina smrti je primárně určena na základě okolností nálezu a od roku 2008 vždy také potvrzena (či vyvrácena) pitevním nálezem. Pitvy jsou prováděny standardním způsobem podle doporučené metodiky IUCN Otter Specialist Group. Současný soubor obsahuje 316 vzorků z let 1990 až 2011. Z uvedeného souboru pochází 259 vzorků z dřívějších sběrů, jedinců zaznamenaných již dle standardní metodiky je 138. Z celkového vzorku dat nalezených jedinců se u 75,6 % jednalo o kolize s dopravními prostředky, 3,5 % jedinců uhynulo přirozenou nenásilnou smrtí, 7,9 % úmyslnou násilnou smrtí a 13 % jedinců uhynulo na základě jiné příčiny smrti, která se nedala jednoznačně označit jako násilná či nenásilná. Relativní poměry jednotlivých kategorií jsou silně zkreslené metodickými problémy. V případě kolizí s dopravními prostředky se až na tři případy (úhyn na železniční trati) jednalo o úhyny na silnici. Vydry častěji hynou na silnicích s vyšším autoprovozem (zejména silnice 1. tříd a dálnice). Samci jsou náchylnější na úmrtí na silnicích. K nemocem je velmi málo údajů. Prozatím byla z možných nemocí prokázána v ČR pouze psinka (v jednom případě). Z možných způsobů úmyslného zabití bylo v průběhu let prokázáno střílení, železa, ubití a trávení. Ve všech případech trávení se jednalo o jed karbofuran. Často jsou nacházena opuštěná mláďata. Mládě může být matkou opuštěno předčasně úmyslně nebo může být opuštěno z důvodu úmrtí matky. Přirození predátoři dospělých jedinců vyder v ČR nejsou. Dochází však

k úmrtí vlivem soubojů s domácími psy. Mláďata mohou být predována pravděpodobně výrem či liškou, prokázáno je však jen několik málo případů. V průběhu let narůstá podíl úhynů na silnicích a také narůstá podíl vyder nelegálně zabitých.

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