Management Plan of the Eurasian Beaver in the Czech Republic

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SUMMARY OF THE MANAGEMENT PLAN

The Management Plan of the Eurasian Beaver in the Czech Republic is based on the need to deal with the issue of conservation of this specific species in the context of agricultural use of the landscape by humans. The Eurasian Beaver is currently returning to its entire original habitat and the Czech Republic is no exception. Beaver numbers in our country have been rising for over three decades and their activities frequently come into conflict with use of landscape elements from the aspect of farming, forestry and water management. This results in damages and restriction of agricultural use of land affected by beavers. This is why it is essential to seek solutions that will ensure the possibility of co-existence of conservation of the beaver and agricultural activities the landscape.

It is assumed that the Management Plan will be effective for 10 – 15 years, but individual measures will be examined and evaluated on the basis of set criteria during its progress and if they are not efficient enough, they will be reviewed.

In the field of nature conservation, the Czech legislation is closely linked to the European legal framework and potential changes to the beaver's conservation status (which are frequently proposed) are consequently a complicated and long-term issue; such changes are not considered in this material. The Management Plan consequently proposes management of the Eurasian Beaver population in the Czech Republic while respecting the existing legislative situation, and potential changes in this area, which must be dealt with on the level of the EU, are therefore outside its scope (in the event of legislative changes, the Management Plan will naturally need to be updated).

The Eurasian Beaver is listed on the red IUCN list as a species of least concern (LC). However, according to European Council Regulation 92/43/EEA, the Eurasian Beaver is a protected specifies listed in Appendix II and IV. The Bern Convention on the Conservation of European Wildlife and Natural Habitats also mentions this species in Appendix III. In the Czech Republic the Eurasian Beaver is listed as an especially protected animal in the "critically endangered" category according to Implementary Decree No. 395/1992 Sb. to Act No. 114/1992 Sb. on nature and landscape conservation.

The analytical section of the submitted Management Plan gives basic information about the history, development and current numbers of the beaver population in our country, information about its biological and ecological requirements and an analysis of existing measures implemented for conservation of this species. The Eurasian Beaver was a widespread species in our country in the past, which was present practically everywhere. The massive decrease in numbers began to occur at the turn of the 15th and 16th centuries. The beaver was exterminated in our country for the first time in the middle of the 18th century and for the second time, following previous successful reintroduction on the Schwarzenburg estates, in 1876. The main reasons for extermination are considered to be excessive hunting by humans for meat and fur and also persecution of beavers as a result of their activities. Beavers felling trees, constructing dams and digging dens caused problems in relation to their co-habitation with humans (e.g. as a threat to the stability of developed pond systems). Another cause of the reduction in beaver numbers today is the impermeability of the landscape along watercourses or loss of food sources due to human agricultural activities. In spite of the abovementioned risk factors, beaver numbers in our country have increased continuously since the nineteen seventies and we have a population of 2,500 – 3,000 individuals today. The main source populations are in South Moravia in the area around the confluence of the Morava and Dyje rivers, in the central area of the Morava River and in the Litovelské Pomoraví Protected Landscape Area and also in West Bohemia in the Bohemian Forest Protected Landscape Area and in the Berounka River catchment area or on the lower section of the Elbe between Střekov and Hřensko. As well as these areas, the beaver is also penetrating further into the interior along watercourses and is gradually inhabiting its original habitat.

The second section of the Conversation Programme formulates the goals, the essence of which is conservation of the Eurasian Beaver in our nature. The goal is to assure the viability of populations in individual main catchment areas of the Elbe, Danube and Odra rivers, while simultaneously maintaining the social-economic sustainability of the beaver in the Czech Republic. On the basis of historic experience it may be difficult to maintain stable populations of this species without assuring the sustainability and social acceptance of the existence of the beaver. Realisation of the following measures in particular is crucial to achieving the goals of the Management Plan:

- assurance of administrative and legislative tools for improving the social-economic sustainability of the presence of beavers and prevention of damages,
- assurance of provision of information to the public, particularly economic subjects affected by the beaver's activities in the landscape,
- monitoring development and dispersal of the Eurasian Beaver population in the Czech Republic, applied research.

The third part of the document contains a list of measures leading (within a horizon of the following 10 – 15 years) to fulfilment of the set goals. The key pillar of all the measures is differentiation of protection of the Eurasian Beaver. Three zones dividing the Czech Republic depending on the approach to conservation of this species are defined for the purpose of realisation of the Management Plan. This means that the requirements for use of the landscape and the requirements for nature conservation, consisting of protection of Natura 2000 system sites and maintenance of a favourable condition of the species as a whole in compliance with Directive 92/43/EEA, will be met. *Zone A* is subsequently defined, which chiefly includes Special Areas of Conservation (SAC) designated for conservation of the beaver in which conservation of this species should be a priority. *Zone C* is also defined, encompassing areas with a potential for origin of major nationwide economic damages, i.e. the area of the South Bohemian pond basins with an appropriate protective zone. This is where conditions preventing origin of beaver populations should be created. The last type of area is *zone B* (other areas in the Czech Republic), where the permanent presence of beaver populations with simultaneous application of measures to prevent and minimise beaver damages is assumed.

The actual consequence of differentiated protection of the beaver should be increased flexibility when dealing with problems related to the presence of this species in the landscape and reduction of requirements (within the terms of specific legislative possibilities) for protection in the majority of the Czech Republic (*zone B*). The current intensity of protection of the beaver population will only be maintained in a very small part of the Czech Republic (*zone A*). On the contrary, it will be essential to prevent beaver settlement in the designated area (*zone C*). Settlement in this area would have enormous potential for origin of serious damages and there is consequently a high risk here of major reduction of the species' acceptability to the public.

In the field of care of the Eurasian Beaver's biotope, it is proposed that permeability of the landscape (particularly watercourses) and protection of especially valuable areas originating as a result of its activities (chiefly with regard to aspects other than actual conservation of the beaver) be assured. Actual conservation of the species consists of the aforementioned differentiation of protection of the species in the individual zones and also prevention and compensation of damages originating as a result of beaver activities in the landscape. Monitoring the species in our country and monitoring the development of existing populations will remain an important source of information. At the same time, the existing knowledge of the species and its requirements should be supplemented by applied research focusing on monitoring the impact of the Eurasian Beaver on the landscape and ecosystems in Central Europe (including water management aspects, etc.). Work with the public, particularly with interest groups whose activities the Eurasian Beaver may come into conflict with (including provision of information and materials for dealing with conflict situations, prevention of damages, etc.) should be absolutely essential. The issue of a unified concept of execution of state administration in relation to beaver conservation and development and improvement of technical measures leading to moderation of the impact of its activities on the landscape is also dealt with within the terms of the Management Plan.

The Management Plan does not mean any significant increase in the economic or administrative burden (apart from the need to assure its actual fulfilment). By means of a complex approach (enabling a more flexible approach to dealing with damages, elimination of beaver populations in the highest-risk localities, optimisation of existing economic instruments and assurance of information) its goal is to reduce the social-economic impact of the presence of the Eurasian Beaver, with the understanding that the existence of viable populations of the species will be assured in the Czech Republic. The proposed administrative measures should make the situation clearer from the aspect of execution of state administration and simplify the procedure from the aspect of the affected subjects. Measures in the field of economic tools should mainly focus on optimising existing measures for dealing with damages. However, the total financial demands of economic instruments will also naturally grow, along with the increasing size of the population and the rising awareness of the public about the options for use of economic instruments. It is now proposed that funds for supporting minor measures within the terms of prevention, minimisation or rectification of damages, also be supplemented. The Management Plan primarily regulates and unifies the executed activities (e.g. monitoring is now performed as a basis for reporting according to Directive 92/43/EEA) in the field of collection and provision of information. Executing information materials for the public and affected subjects (Manual of measures, etc.) and applied research, which is essential for further progress in assuring the co-existence of various interests in the landscape, can be considered newly generated expenses in this field.

The Eurasian Beaver is, without a doubt, a species that historically belonged and continues to belong to the fauna of this country. However, the requirements and demands of other users of the landscape must also be taken into consideration and a suitable form of coexistence of the beaver with humans must be found. This species has been exterminated in this country twice in the past, it will now have a third chance and it is up to us to ensure that history is not repeated again.

1 Initial information

1.1 Taxonomy

The Castoridae family is one of seven main braches of the Rodentia order, whereas this family is phylogenetically classified as "mouse-related" (HUCHON *et al*., 2002). However this group, with two recent species, is systematically classified in the suborder Castorimorpha (WILSON & REEDER, 2005).

The *Castoridae* family originated in the later tertiary period, when it separated from the *Paramyidae* family (late Oligocene). This group had representatives in North America, where *Agnocastor* lived, and also in Europe– the *Stenofiber* family. From the evolutionary aspect these more primitive predecessors were burrowing forms and only evolved in later times to adapt to the aquatic environment. The *Castor* family is known to have been present from the Pliocene (ROČEK, 2002). Giant forms of the *Castoroides* family dating from the Pleistocene have also been documented (ROČEK, 2002).

The entire branch is currently represented by two members of the *Castor* family (MACDONALD & BARRETT, 1993): the Eurasian Beaver *C. fiber* (Linneaus, 1758) and the North American Beaver *C. canadensis* (Kuhl, 1820). Interspecific hybridisation between the species *C. canadensis* (2n = 40) and *C. fiber* (2n = 48) is generally not presumed for now, due to the fairly great difference between karyotypes (HALLEY & ROSELL, 2002). The *Castor* species lives in the Holarctic realm; the habitat of the *C. fiber* species is the Palaearctic realm, however, *C. canadensis* was originally transferred from the Nearctic realm to the Palaearctic realm and the Neotropical realm (HALLEY & ROSELL, 2002). During the nineteen sixties and seventies individuals of this non-indigenous species were released in Poland, Austria and in France. According to all available information (MOUTOU, 1997; SIEBER *et al.*, 1999) however, the North American Beaver has reputedly been exterminated in the continental part of Europe (apart from Finland and Russian Karelia) (MOUTOU, 1997; SIEBER *et al.*, 1999).

The marked similarity between members of the *Castor* family (biological and ecological) leads to the results of research of the relative species being assumed in many works, if similar information is not available. This will also be the case in the text below, with regard to the fact that research of the North American Beaver has been in progress for longer and there is a greater number of sources of information about this species.

The taxonomic classification of the *Castor fiber* species into subspecies is currently under discussion. We can give only a basic summary of this issue here. The works by GABRYS & WAZNA (2003), NIETHAMER & KRANP (2004) and also VOREL & NOVÁKOVÁ (2008) discuss the systematics and taxonomy in detail.

Six forms of the Eurasian Beaver have been described (MACDONALD & BARRETT, 1995; BABIK *et al*. 2005). Most of this differentiation followed the water catchment areas of individual major Euro-Asian rivers. The original population of the beaver subspecies *C. f. albicus* has survived in the Saxony-Anhalt Region on the Elbe River. The nominate, untouched population of the subspecies *C. f. fiber* has survived in South Norway. And the subspecies *C. f. galliae* is successfully dispersing again at the mouth of the Rhone River in France.

The East European subspecies *C. f. vistulanus* (other synonyms: *belarusicus, belorussicus, orientoeuropaeus* and *osteuropaeus*) has survived in the European part of the former USSR in the area around Voronezh in Belorussia and in Northeast Poland. Two subspecies of disjunct populations in the far east are defined spatially close to each other: *C. f. birulai* is present at the borders of Russia and Mongolia and members of *C. f. tuvinicus* form a local population in the catchment areas of the rivers Tuva and Jenisej. And finally, the last used term *C. f. pohlei* is used to identify a small isolated population in the Ural region (HALLEY & ROSELL, 2003).

The work by GABRYSE & WAZNE (2003) discusses taxonomic and classification inaccuracies. However, it is important that definition of all acknowledged subspecies is based simply on surviving relict and regionally defined populations.

The taxonomic situation in the Czech Republic is a reflection of many incidents of reintroduction executed in Central Europe during the second half of the 20th century. This resulted in a large number of source populations of various subspecies in our country, which are merging in places. Chapter 1.3.8 “Genetic variability and structure of the population” discusses this issue in more detail.

1.2 Distribution of the species

1.2.1 Range of the species

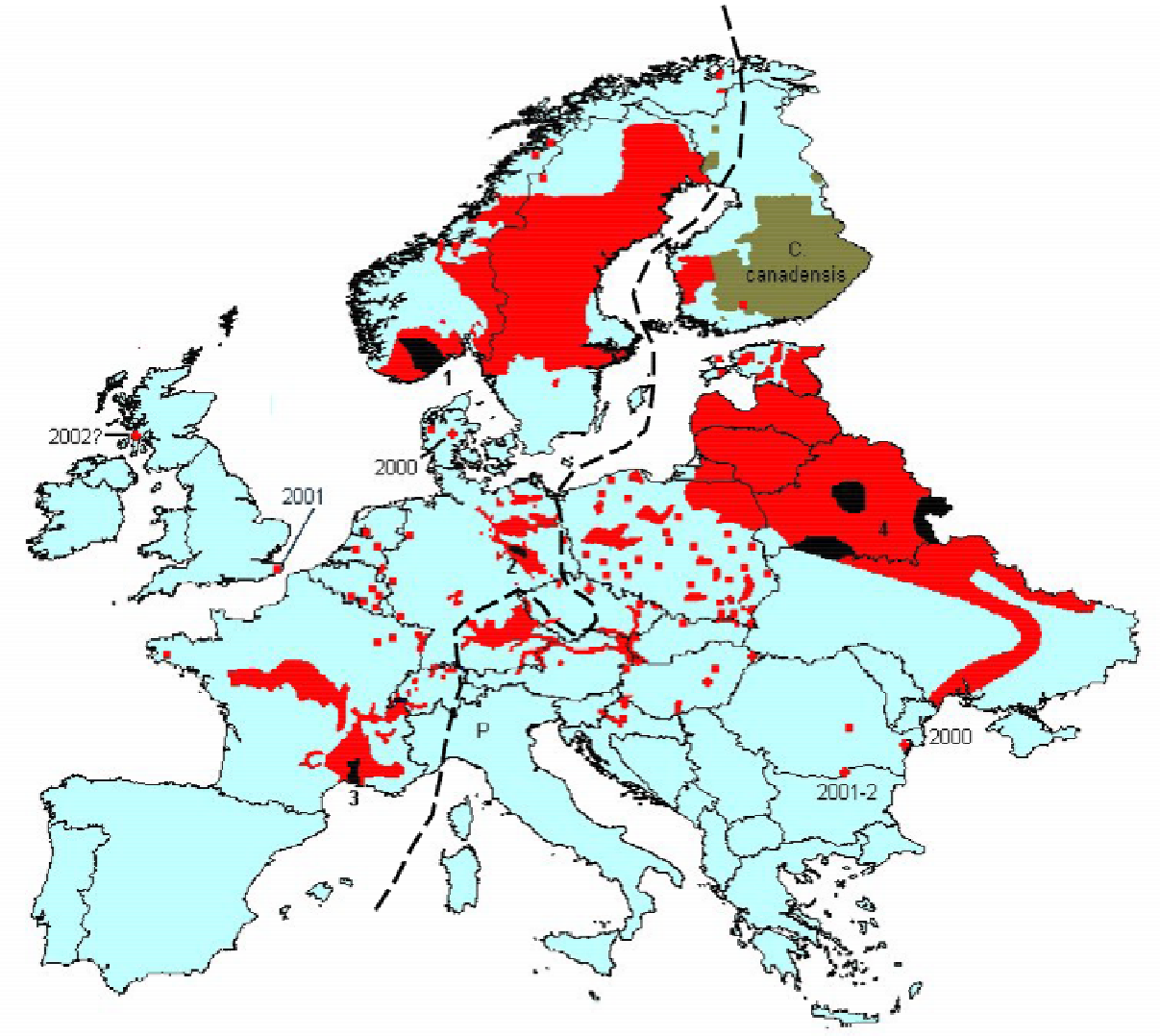
The *Castor* genus was originally present in Eurasia from the northern edge of the tree line to the southern edge of the deciduous forest in the temperate zone and in places as far as the sub-tropics (Rhone). This genus was also present in the steppe areas of East Europe and Central Asia, basically the entire region of the temperate and subarctic zone of the Palearctic realm. Today fragments of *Castor fiber* populations are present in parts of this original habitat. In recent times *C. canadensis* has been transferred to the Palearctic realm (see above) and the Neotropical realm (Argentina) from its original Nearctic realm.

The habitat of the Eurasian Beaver today is markedly disjunct (see pic. 1), however, the settled areas are quickly becoming connected. An area starting in East Poland, continuing through the Baltic states, Belorussia, Russia and Finland and ending in the Central areas of Siberia (HALLEY & ROSELL, 2002) is continuously inhabited. A second large, but isolated population inhabits Scandinavia and includes a large part of Norway and Sweden. One of the largest and most important populations in continental Europe inhabits the area around the Elbe River. It reaches from North Bohemia nearly all the way to Hamburg, whereas it also covers a large number of tributaries in Saxony and Saxony-Anhalt (HEIDECKE *et al*., 2003). Another extensive population in Central Europe covers nearly all of Bavaria, continues along the Danube through Austria to Slovakia to Hungary, and the settled area ends in Romania (HALLEY et al. 2012). An important promontory of the habitat of this sub-population reaches through the lowland passages of South Slovakia, upstream on the Morava River, to the north to our country. The rest of Europe, particularly the east, central and west parts, are inhabited by smaller disintegrated populations, which are quickly merging however.

1.2.2 Changes to numbers in Europe

The Eurasian Beaver population continues to grow in Europe. The current range continues to increase throughout the original historic habitat. The population can be considered stabilised and the species present throughout the continental part of Europe, in East Europe and Russia and also in Scandinavia (see pic. 1). The beaver surge has reached the Balkan states (Romania, Croatia), the beaver has also been reintroduced to the British Isles and reintroduction is being considered on the Apennine and Pyrenean peninsulas.

Changes can be seen between existing and newly originating population in the non-structural population parameters. While population density does not change much – in saturated populations the density ranges from 0.1 to 0.5 territories per km (HEIDECKE, 1984; NOLET & ROSELL, 1994; NOLET & BAVECO, 1996; SIDOROVICH *et al*., 1996; FUSTEC *et al*., 2001; HERR & ROSELL, 2004; CAMPBELL *et al*., 2005), abundance in territories varies. The number of individuals in territories is significantly lower in areas settled over a longer period (over 50 years): for example in former East Germany – 3.3 ex./ter. (HEIDECKE *et al*, 2003), South Norway– 3.3 ex./ter. (ROSELL & PARKER, 1995), Northeast Poland – 3.7 ex./ter. (ZUROWSKI, 1984).

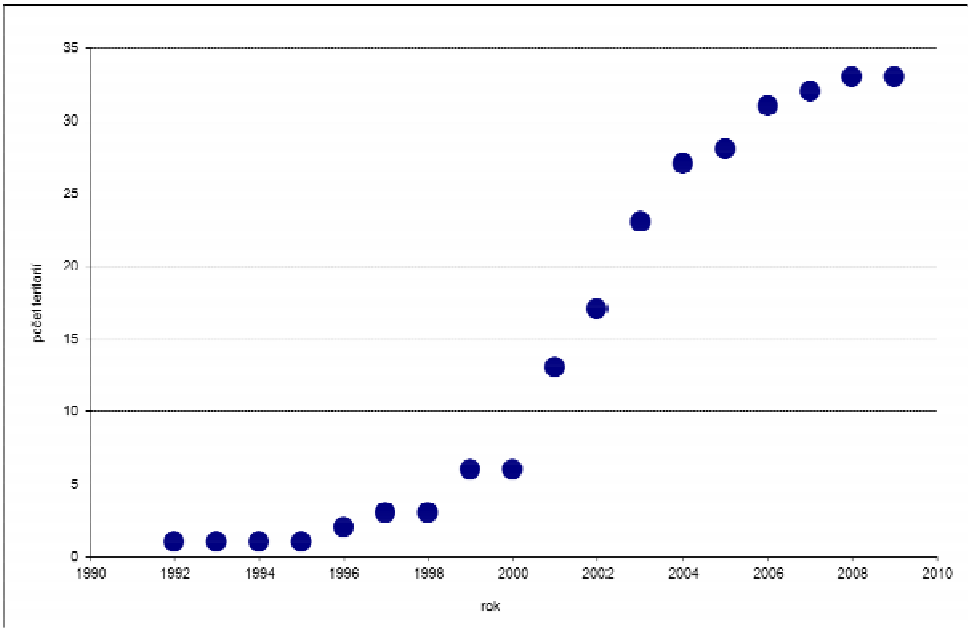


Picture 1: Map of distribution of the *Castor* family in Europe
The red areas show distribution of the Eurasian Beaver population at the turn of the 20th and 21st centuries. Settlement is either continuous (Scandinavia, Baltic states, Ukraine and Belorussia) or possibly as individually isolated populations (particularly France, Germany, Poland, Czech Republic, Slovakia, Austria and Hungary). The black areas show the oldest and never exterminated historic remainders of populations of the Eurasian Beaver in Europe. The numbers express four key European refugia, which became the source for the Pan-European reintroduction programme following the Second World War: 1. *C. f. fiber*, 2. *C. f. albicus*, 3. *C. f. galliae*, 4. *C. f. vistulanus*. The brown areas show distribution of the North American Beaver *C. canadensis*. The interrupted line shows interface between the West and East forms of the Eurasian Beaver.
Source: modified, HALLEY & ROSELL, 2003; DURKA *et al*., 2005; www.bibermanagement.de

The fertility of individuals in younger populations is not yet modified by negative feedback, which is why abundance within the territory achieves higher values: for example Lithuania – 4.0 ex./ter. (PALIONENE, 1975), or Belorussia – 4.4 ex./ter. (GOLODUSHKO, 1975 *in* MACDONALD & BARRET, 1993). A much higher number was registered in the Czech Republic also, where the populations are approx. 20–30 years old – 5.4 ex./ter. (VOREL *et al*., 2010a).

The populations in a great part of the current habitat of the Eurasian Beaver are in the situation following initial re-colonisation or on the level of expansive dispersal. Only 1,200 individuals survived in several refugia at the turn of the 19th and 20th centuries (NOLET & ROSELL, 1998).

The status of endangered European species helped the Beaver undergo a rapid renaissance in its distribution and its further conservation on the continent was so successful that it was estimated that the population numbered 430,00 individuals in 1997 (NOLET & ROSELL, 1998).



Picture 2: **An example of development of settlement of the population following initial colonisation of the area – population on the Elbe (VOREL *et al.* 2010b)**

According to the last published estimate, the minimum number throughout Eurasia was approx. 1,040,000 ex in 2012. (HALLEY *et al*., 2012).

Change in the number of the Eurasian Beaver population can generally be described using a classic logistics development model. Following initial colonisation of the territory (even in cases of reintroduction) by a few individuals, the initial very gradual phase of development quickly changes into very rapid growth of the population within the horizon of approx. 10 – 15 years (HARTMAN, 1994). This is initially gradual, but subsequently transforms into an expansive phase (HARTMAN, 1995). The aforementioned duration of the individual phases is very dependant on environmental parameters, so cannot therefore be generalised (BARTÁK et al., 2013).

Current development in Central Europe will remain in the growth phase until all the potential sites have been filled. However, the regional growth curve has clear development, during density ceases to grow after capacity has been filled, which is clear on the example of development of settlement of the Elbe River (see pic. 2).

After settlement has been initiated the low-density population expands into the surrounding and distant area. After all the ideal sites have been occupied the population begins to increase in density by settling unoccupied localities within the area instead of expanding outside the territory. (VOREL *et al*., 2010a).

Today the Eurasian Beaver population is no longer at acute risk of extermination in Central Europe. The population in most settled regions is biologically stable. Any threat and potentially repeated risk of degradation is more likely to consist of inappropriately timed and too rapid regulation and therefore arises only from configuration of correct management of the population.

However, the Eurasian Beaver's successful distribution throughout continental Europe is the result of several external and internal factors:

- low topical and trophic demands, which are very easily satisfied in a cultural and intensively farmed landscape (SCHWAB & SCHMIDBAUER, 2003; VALACHOVIČ & GÍMEŠ, 2003; MARINGER & SLOTTA-BACHMAYER, 2006; VOREL *et al*., 2010a),
- legislative conservation of the species (see chapter 1.6 Conservation status),
- there are de facto no competitors or predators in the inhabited biotope (VOREL, 2005),

- high vigilance supported by a number of specific ethological adaptations (WILSSON, 1971),
- high reproduction potential (MÜLLER – SCHWARZE & SUN, 2003; CAMPBELL *et al*., 2005),
- strong territoriality, without the tendency to reduce the size of territory (NOLET & ROSELL, 1994; MÜLLER – SCHWARZE & SCHULTE, 1999).

The aforementioned factors are crucial for the entire modern distribution of the beavers, they are applied in full to the territory of the Czech Republic and it can therefore further increase in population numbers and density can be assumed.

1.2.3 Historic presence in the Czech Republic

During the Holocene history (Neolithic age – high mediaeval age) the beaver was always present in archaeological findings (KYSELÝ, 2005). Findings of this species are more abundant in the Neolithic age, the Roman period and the early medieval age, while findings of evidence of the presence of the species are much lower in the high mediaeval age. According to Holocene findings the species was more abundant in Moravia than in Bohemia, but it was present throughout both areas (KYSELÝ, 2005).

In them medieval age the beaver was a normal part of our fauna. At the beginning of the second millennium it was present throughout practically the entire Czech lands. But at the turn of the 15th and 16th centuries its numbers began to fall rapidly. The cause of this decrease in numbers was intensive hunting for meat and fur. Hunting of the beaver increased particularly in relation to development of the pond industry, because this species poses a threat to the stability of newly established ponds. The period when the beaver disappeared completely from Czech and Moravian nature falls into the 17th and 18th centuries.

HOŠEK (1978) gives data about the last wild individuals found and shot in our territory. On the Elbe in Děčín 1722, Kolín 1645; on the Orlice in Opočno 1718; on the Doubravka in Žehušice 1643; on the Ohře in Ostrov nad Ohří 1666. The beaver lived on the Jizera River until the middle of the 17th century. The Třeboň region remained the area with the greatest numbers of beavers caught in the 17th and 18th centuries. It is estimated that the beaver was exterminated on the Nežárka and Lužnice rivers around 1750 at the latest. Most beavers along the Morava River and its tributaries disappeared at the end of the seventeenth century, the last known beaver to have been caught here was from Grygov u Olomouce in 1730. These were probably the last wild beavers of the autochthonous population in the Czech and Moravian lands.

Successful attempts were made to reintroduce the beaver on the Schwarzenberg estates in the 18th and 19Th centuries and the beaver also began to be bred artificially in so-called “bobrovny" (beaver-facilities”) (ČENĚK, 2011). Beavers that had been reintroduced or had escaped from beaver-facilities bred quickly and subsequently dispersed into the surrounding area. Due to concerns that dams would be disturbed, an order to exterminate the beaver was issued again in the Třeboň region in 1833 and all individuals were killed. This happened in 1871 on the Nová řeka River and in 1876 on the Nežárka River. This is also the last document of the presence of the beaver in the wild within the territory of what is today the Czech Republic (ZÍBRT, 1929; HOŠEK, 1978).

1.2.4 Recent distribution in the Czech Republic

The Eurasian Beaver is currently present in five more or less isolated areas of the Czech Republic. The map in pic. 3 shows the numbers of beavers at the end of 2011, which is discussed in detail below.

The North Bohemian population is the result of spontaneous dispersal of the species from the area of former East Germany (originally from Saxony-Anhalt, through Saxony to our country), this concerns a

population of the Eurasian Beaver from the Elbe refugium. The Elbe River is the highway for this dispersal of the beaver; settlement of the flood plain itself has been registered by Děčín since 1992.

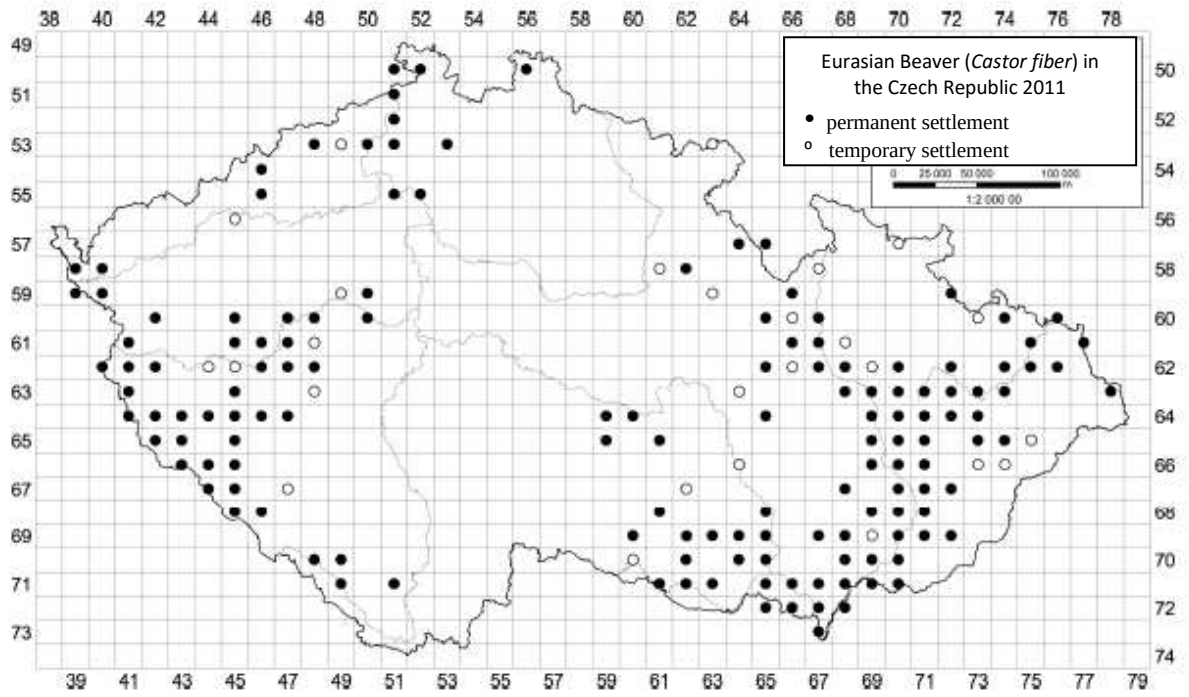
Dispersal of the beaver above Střekov weir – where the population has settled between Roudnice nad Labem and Mělník - was confirmed for the first time in 2010. Pioneer individuals (or families) have also settled in the Šluknov promontory and on the Ploučnice and Bílina rivers.

An extensive population in West Bohemia is the result of a reintroduction of the beaver in Bavaria in the second half of the 20th century. Settlements on the tributaries of the upper section of the Ohře River (up to Sokolov) are sporadic, but clearly evident. The Mže River in the area surrounding Tachov is settled more sporadically. Intensive settlements can be found on two other tributaries of the Berounka River – on the Radbuza River and the Úhlava River. The settlement on the Berounka River can also be called a permanent settlement that has lasted for several years, at least on the upper section of the river. The first stable territories are also evident in Šumava and in the Pošumavi Region – on the Křemelná, Vltava and Blanice rivers. The West Bohemian population also includes a settlement past the main European Danube-Elbe watershed. This concerns an area with the highest population density – the central part of the Bohemian Forest (Přimda Forest), the southern part in the area surrounding the Všeruby pass and the water catchment area of the Řežná River in Šumava.

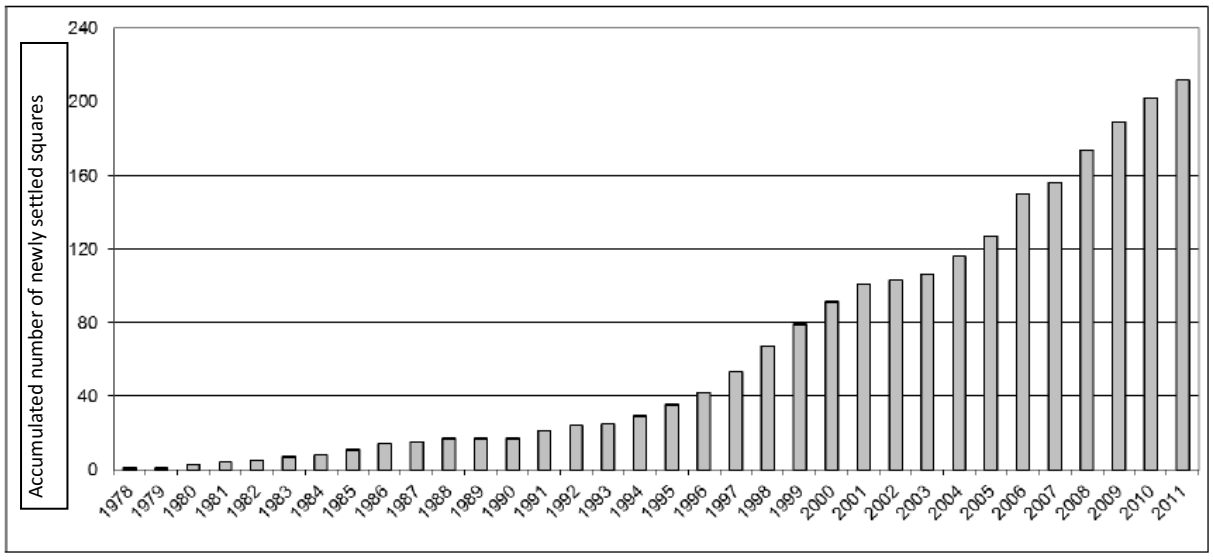
The most extensive settlement in the Czech Republic includes the catchment area of the Morava River. The local population originated as a result of immigration of individuals and their offspring, which were originally reintroduced in Austria. This settlement includes a high population density in the area of the confluence of the Morava and Dyje Rivers, and also around the Nový Mlýn reservoirs and their main feed rivers– the Dyje, Svratka and Jihlava rivers. On the Dyje River the beaver population has settled the Dyje river up to the Podyjí National Park, the Svratka River has been settled up to Brno (the area surrounding Veverská Bítyška), the Jihlava is settled more sporadically up to the area it springs from in Vysočina and in the Jihlava Region. The entire flood plain area of the Morava River has been settled from Hodonín upstream to nearly Kralický Sněžník, including more extensive flood plain areas in the Litovel Pomoraví region, the Zástudáńčí region and by Strážnícka Morava.

In the northern part of the Morava catchment area, tributaries on both sides have also been settled, for example the Moravská Sázava river, the Třebůvka, Oskava etc. The settlement in Hané reaches up to the border mountain areas; there is extensive settlement on the Bečva and Dřevnice rivers, the Olšava and Velička rivers.

The Eurasian Beaver is currently spreading from the Orlické Mountains, where the presence of this species has been registered from at least 2000. This is again the result of reintroduction of beavers, this time in Southwest Poland. In 2010 and 2011 reports of dispersal of the beaver downstream along the Orlice were registered. And, on the contrary, in 2011 settlement of the Divoká Orlice River was no longer confirmed and there are no beavers there at this time.



Picture 3: **Map of the Eurasian Beaver population in the Czech republic at the end of 2011 (source: VOREL *et al*., 2012)**



Picture 4: Depiction of development of the population in the Czech Republic – total numbers of beavers in newly settled squares (KFME network)

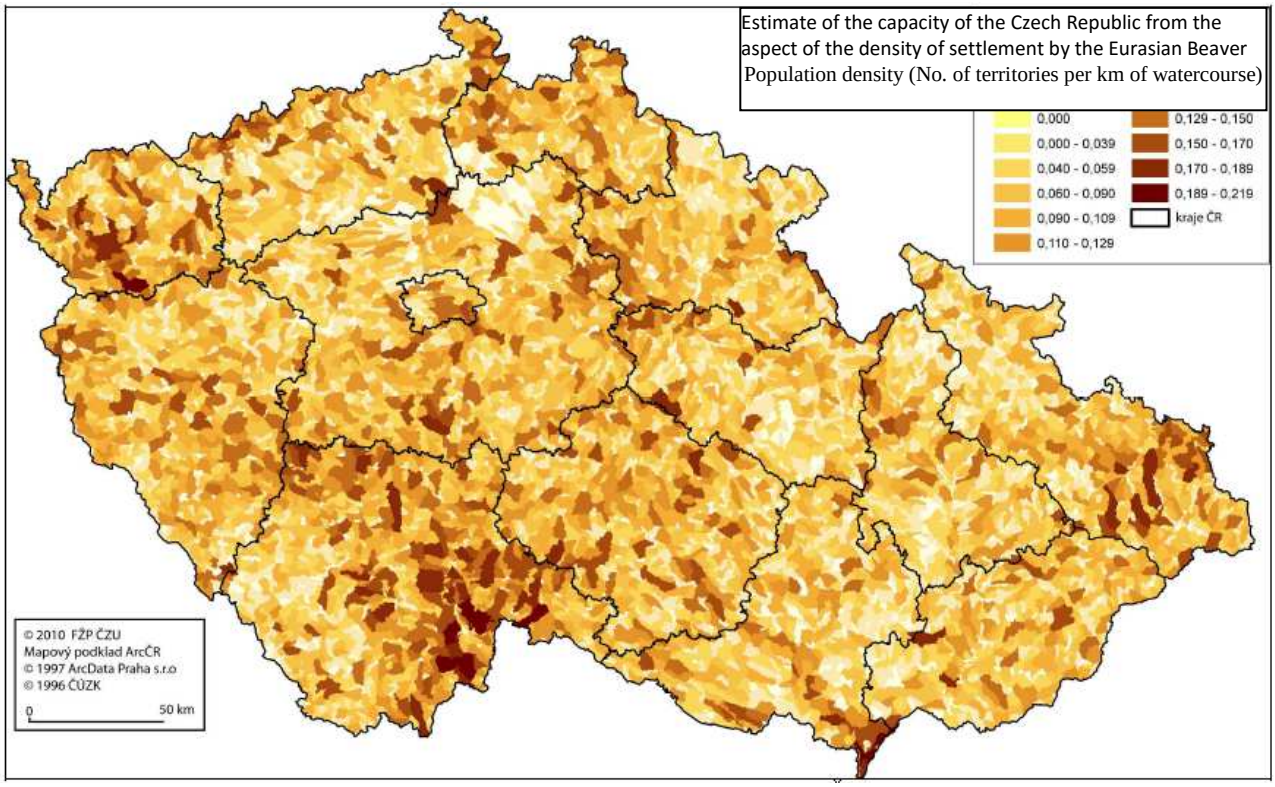
The last major settlement is located in Silesia, where beavers migrated from Poland. The first areas of settlement here are the Olše and Stonávka rivers. There has been a stable population in the local subsidence sites since the beginning of 2000. The Opava River is settled from its confluence with the Odra River to Krnov. The Odra River has been settled along its entire length in our country (including Ostrava for example) and the regionally densest settlement is located in the Poodří Protected Landscape Area. As well as the aforementioned migration from Poland, the local beavers also originate from reintroduction in the middle of the nineteen nineties, when they were introduced into the Libavá Military Training Ground.

Detailed information about present-day distribution of the beaver in the Czech Republic is given in works by ŠAFÁŘ (2002), ANDĚRA & ČERVENÝ (2004), ANDĚRA (2011) and VOREL *et al*. (2012), an analysis of the speed of dispersal of the beaver was published by BARTÁK *et al*. (2013).

1.2.5 Trends in expansion and numbers in the Czech Republic

The Eurasian Beaver continues to disperse throughout Europe (HALLEY & ROSELL, 2002; HALLEY *et al*., 2012). In the Czech Republic population numbers were estimated at 2,500 – 3,000 at the end of 2010 (VOREL, 2012). The rise in numbers from zero in 1977 (when the beaver first appeared in the Czech Republic) can be seen in the graph in pic. 4. Further growth and expansion of the population will depend on the number and extent of unsettled areas. The beaver's migration and colonisation capabilities will ensure continuous growth in the number of individuals over the next approx. 5 – 10 years.

Regular monitoring of the largest and oldest parts of the settlement in the Czech Republic (Elbe River, West Bohemia, the flood plains of the Dyje and Morava rivers, the Chropyňsko region and Litovel region) currently registers the presence of approx. 1,500 – 1,800 individuals (VOREL *et al*., 2008; and see annex 1), whereas there are no rapid changes to numbers in the aforementioned monitored areas. However this always concerns population parameters monitored in areas that have been settled over a long period; no monitoring of developing populations is currently taking place, information is not collected systematically and published regularly (see links to references at the end of the preceding chapter). However, the development of two localities has been documented from their initial settlement until the present day (population in the Bohemian Forest and on the Elbe, see pic. 2 for the second mentioned population). It is clear from development of settlement of these populations that the phase of initiation lasts for approx. 5 – 10 years, this is followed by a rapid rise in numbers up to the maximum capacity of the area. After the highest possible capacity is attained, these numbers are then maintained in subsequent years. The results acquired from two localities in the Czech Republic (the Elbe and the Bohemian Forest) comply with the evidence of other authors (HARTMAN, 1994; FRYXELL, 2001).



Picture 5: Map of potential density of the Eurasian Beaver population in the Czech Republic (VOREL *et al*., 2010a); the used facets with expressed density are hydrological areas generated by the DIBAVOD project (in brief this concerns parts of the catchment area of watercourses), the purpose of this analysis was to estimate the theoretical biological capacity of the maximum number of beaver territories per kilometre of watercourse (or length of banks by bodies of water) in each facet.

However, the capacity of the Czech Republic has certainly not been exhausted. Numbers will continue to grow steeply in regions that have not been affected by beavers at all, or where settlement is in its initial phase. A high potential for a numerous population can be expected in the Polabí area and in the

lower Poohří area, on the Ploučnice River. The entre Bohemian-Moravian highlands also provide very good conditions for development of beaver settlements. The large Bohemian pond basins – Třeboň, České Budejovice and Blatensko (see the map in pic. 5) can also provide the beaver with absolutely unique conditions.

The estimate of the net biological capacity of the Czech Republic for the Eurasian Beaver is based on current results of regular monitoring and on predictive models. The theoretical size of the population in the Czech Republic is estimated at approx. 17 to 20 thousand individuals (for more details see VOREL *et al*., 2010a). However, the resulting size of the population after the entire Czech Republic has been filled to capacity will be lower. The size of the population will most probably be restricted as a result of the need to reflect the risk of origin of serious damages and other factors; it can therefore be expected that the size of the population will be approx. half the aforementioned maximum number. The feasible capacity will be significantly reduced by full realisation of measures mentioned in this Management Plan, full-scale regulation of the species to the abovementioned maximum capacity is not proposed during this phase.

1.3 Species biology and ecology

1.3.1 Environmental requirements

The Eurasian Beaver is a mammal linked explicitly to the aquatic environment. However, the water is a medium. not a source of existence for the beaver. It is capable of inhabiting practically all ecosystems, in which there are open bodies of water (whether these are standing or free flowing). During phylogenetic development of this taxon, it developed a large number of morphological, anatomical and etiological adaptations, which enable it to successfully inhabit the aforementioned ecosystems.

Beavers are consequently capable of inhabiting a significantly broad range of biotopes: watercourses – from major rivers such as the Elbe and Danube, to small streams in the foothills and bodies of water: natural lakes and pools, man-made sand quarries, ponds and reservoirs. The beaver is also easily capable of reaching sites that are isolated from the river network. For example karst lakes and artificial bodies of water, or the watersheds of watercourses (ČERVENÝ *et al*., 2000; VOREL, 2003; VOREL *et al*., 2010a). The beaver also finds it no problem to settle reclaimed land (VALACHOVIČ, 1998; ULEVICIUS, 1999). Synanthropic colonies have also been observed in urbanised Central European landscapes (PACHINGER & HULIK, 1999; MATRKOVÁ, 2004).

As well as an aquatic environment, the second determinant for settlement of sites by the beaver in Central European is the presence of vegetation on the banks of a character of soft or hard riparian forest (VOREL *et al*., 2010a; VOREL *et al*., 2012). An important characteristic of the optimum biotope is growth of willows, poplars or both tree species at the same time (VOREL *et al*., 2010a). According to HEIDECKE (1989), the site, density and distribution of forest growth is also of importance, as well as the composition of the riparian vegetation. According to him it is very infrequent that sites are not settled due to insufficient food sources. Beavers resettle to another site usually due to the fact that the range of food is qualitatively better, not because it was insufficient at the original site. As well as sources of food, the importance of the biotope also consists of provision of vegetation coverage or shelter at the time the water level is higher (FUSTEC *et al*., 2001; FUSTEC *et al*., 2003). Biotopes with a low or zero range of suitable tree species are usually refused by beavers. However, in areas with a high population density some sub-optimal localities of the aforementioned type are also settled (JOHN & KOSTKAN, 2005).

The quality of the water is currently not a limiting factor in the Czech Republic (VOREL, 2001). For example, watercourses springing in intensively utilised areas from the aspect of agriculture and forestry in the South Moravian flood plains of the rivers Dyje and Morava, are also settled in the Czech Republic for example (VOREL *et al*., 2008). Beavers also inhabit anthropically heavily affected areas such as the developed areas of towns and industrially encumbered flood plains – for example the Elbe in the section of Ústí nad Labem and Hřensko (VOREL *et al*., 2008).

1.3.2 Reproduction and life strategy

The beaver is a predominantly monogamous mammal (CAMPBELL *et al.*, 2005) with a monoestrous cycle. It copulates mainly at the end of January and the beginning of February, and is gravid for 105 – 109 days. It gives birth to an average of 2 – 5 precocious young – average 2.7 (WILSSON, 1971; DOBOSZYNSKA & ZUROWSKI, 1983; DZIECIOLOWSKI, 1996; CAMPBELL *et al*., 2005). The kits are suckled for three months (WILSSON, 1971), but begin to accept vegetable matter during lactation (DZIECIOLOWSKI, 1996), mainly herbaceous plants and thin twigs with leaves (WILSSON, 1971). The young beavers leave the den accompanied by their parents at 4 – 6 weeks of age (DZIECIOLOWSKI, 1996). Their ontogenetic development is marked at the time they leave the den. The young beavers are only capable of swimming on the surface for the first 6 weeks, but later develop the ability to dive.

According to OGNĚV (1947), the weight of newly born kits is 380–620g, at one year of age the beavers weigh on average 9.9 kg (7.0–15.0), two-year old beavers weigh on average 13.9 kg (11.0–16.0) and three-year old beavers weigh on average 16.3 kg (14.0–19.0). They reach sexual maturity at 2 – 3 years and growth is finished in their fourth year. This is also related to how long the parents care for their young, they remain in the family for 1 – 3 years and their parents then force them out of the territory. A beaver settlement has a stable hierarchical structure, with the parents at the top, and usually two or even three generations of offspring in the territory. There may be up to 15 or more animals in one family depending on the number of generations.

In our conditions we have registered from 1 to 10 individuals in one territory (VOREL *et al*., 2010a). The average number was determined as 5.5 individuals (VOREL *et al*., 2010a). Beavers can reproduce until they are 16 years of age, but their main reproductive period is between their 4th and 10th year (DZIECIOLOWSKI, 1996). Beavers live a maximum of around 20 years, but some captive individuals may even reach 50 years of age (BREHM 1963 *in* DZIECIOLOWSKI, 1996). Animals living in the wild usually live to between 10 and 12 years (MÜLLER-SCHWARZE & SUN, 2003)

1.3.3 Territoriality

As well as an actively defended territory, the beavers also use a larger area – the home range. This is an area that the beaver is very well acquainted with and regularly visits, but does not actively defend On the contrary, its territory (part of its home range) is defended against intruders by a recognizable type of behaviour, aggressive stances or fighting within the terms of intraspecific competition (BEGON *et al*., 2006). In a fully saturated area, the home ranges may be reduced in size down to the area of the territory. The size of the territory must fulfil the condition that this area is capable of sustaining the inhabitants in the long-term (HARTMAN, 1994; NOLET & ROSELL, 1994; FRYXELL, 2001; FUSTEC *et al*., 2003; CAMPBELL *et al*., 2005).

According to various authors the home range ranges in size from a 1.3 to 4.9 km (average 2.7 km) length of a watercourse (NOLET & ROSELL, 1994; MÜLLER-SCHWARZE & SUN, 2003; CAMPBELL *et al*., 2005; VOREL *et al*., 2007).

In our conditions the length of a home range is most frequently between one to two kilometres – average 1.7 km (VOREL *et al*., 2008). The size of the territory (the length of settled banks within the territory) is mainly dependant on the corresponding biotope, which is characterised by the quantity of available food sources. The size of the territory grows with the falling quantity of food sources available (FUSTEC *et al*., 2001). No link between the number of individuals in a social unit and the length of the territory was proven (CAMPBELL *et al*., 2005). There is also marked seasonal variability in territoriality, when the section of banks defended in the cold months may be just half the size of the section defended in summer. The fact that beavers lose great amounts of heat, and subsequently energy, during the winter months when active outside their den, also plays a significant role (NOLET & ROSELL, 1994). Adjoining territories overlap minimally and there is also no difference between males and females defending their territory (HERR & ROSELL, 2004).

Beavers communicate with each other using chemical signals contained in their anal gland secretions. This secretion is applied to a mound of mud, vegetation or other mounded material (ROSELL *et al*., 1998). This scent marking is used to mark a beaver's territory and also as a warning signal for individuals from other colonies who intend to penetrate a foreign territory (MÜLLER-SCHWARZE & HECKMAN, 1980). There is probably no difference in the function of between a scent marking deposited on a mound of mud or sprayed on a tree trunk (ROSELL & NOLET, 1997). The reason for placing the malodourous secretions on an elevated mound is evidently to increase the effect of the scent, which subsequently spreads over a greater distance.

Placement of chemical information on the highest available point also guarantees that fluctuation of the water level during the day and potential waves do not wash the marking away (MÜLLER-SCHWARZE & SUN, 2003).

The function of territorial scent markings is dynamic definition of the borders of a territory. The spatial variability of the scent markings expresses the current requirements for defence of the territory (ALEKSIUK, 1968; ROSELL *et al.*, 1998). The number of scent marks does not correlate with the size of the territory or the number of individuals (ROSELL & NOLET, 1997). The only correlation that appears is some dependence of the number of scent markings and the distance to the closest adjacent territory; the smaller the distance between adjacent territories the more scent markings there are and vice versa (MÜLLER-SCHWARZE & HECKMAN, 1980). Experiments with artificial scent markings have proven that beavers respond differently to the scent markings of their neighbours (less aggressively) than to the territorial behaviour of unknown intruders – Dear enemy phenomenon (ROSELL & BJØRKØYLI, 2002).

Territoriality is therefore a crucial expression of inter-species behaviour by beavers (WILSSON, 1971). It is expressed most strongly in spring, and less frequently throughout the rest of the year. Females with young are more active in defence of the territory than males, but only in the area surrounding the den. Males develop defensive behaviour fully after they have mated for the first time (WILSSON, 1971).

1.3.4 Food ecology

The Eurasian Beaver is an exclusive herbivore. Its food mainly consists of woody plants, water plants and herbaceous plants growing on the banks (HEIDECKE, 1989). Consumption of these three types of vegetation has significant seasonal variability (KROJEROVÁ *et al*., 2010). In the winter period (non-vegetative season) beavers are strongly dependant on the woody component of their food. The source of this food is bark, bast and thin woody twigs from the woody plants growing on the banks. In spring and during the vegetative season submersed plants and underground bulbs (knotweed, Jerusalem artichokes, etc.) play a significant role as food sources. There is also a third source in the summer months, which is herbaceous plants growing in the area surrounding watercourses. All three components are not consumed strictly separately, however, each food type is significant during different seasons (KROJEROVÁ *et al*., 2010).

The consumption of woody plants is mainly covered by the genera *Salix* spp., *Populus* spp. and other species growing in softwood and hardwood riparian forest (SVENDSEN, 1980; HEIDECKE, 1989; KOSTKAN, 2000; VLACHOVÁ, 2001; JOHN, 2001; FUSTEC *et al*., 2001). The preference of *Populus* corresponds to the results of research of the metabolism of the North American Beaver. The authors DOUCET & FRYXELL (1993) found that the ability to digest the wood of Aspen (*Populus tremula*) is 2.3-2.7 faster than the ability to digest the Alder (*Alnus* spp.) and other types of wood. Conversely, the spectrum of herbaceous species is very broad. DZIECIOLOWSKI (1996) states that the beaver consumes nearly all types of herbaceous plants growing on the banks and in the water (including the crops on farmed land in areas surrounding watercourses and bodies of water).

Beavers probably also require a mixed composition of food, which can be explained by the need for specific nutrients and trace elements, which are only contained in some species. Another reason for seeking out unusual sources of food – e.g. conifers – may be elimination of consumption of harmful substances from one type of woody plant (NOLET *et al*., 1994). This is also probably linked very closely to spring gnawing of the bark of coniferous trees, which beavers do not otherwise fell or use. This theory is also supported by PANOV (1990), who gives the case of mass felling of pine trees in Ukraine. He believes that the reason for this is consumption is the beavers' vitamin deficiency in the autumn and spring months when they do not have sufficient herbaceous plant food. The bark and needles contain a large amount of vitamins (A, C, E). There are also records of sporadic felling of conifers in our territory (SYROVÁTKOVÁ, 1998; VLACHOVÁ, 2001; HOŘENÍ, 2005; VOREL *et al*., 2008, 2009), however, this is a very marginal phenomenon.

There are currently 86 types of woody plant and 149 types of herbaceous plant described, which serve as key food sources for the Eurasian Beaver. However, this selection is narrowed down to 35 key plants, whereas the greatest species variety in food sources occurs at the end of September and the beginning of October (HEIDECKE, 1989). Consumption of plants depends on several factors. On the season, the water level in the locality, the quality and quantity of food sources, their availability and lastly the ability of plants to regenerate is also important (HEIDECKE, 1989).

Preparation for overwintering takes several forms in the beaver: creation of fat stores, winter storage sites and gnawed tree trunks. Preparation for overwintering (with creation of stores) is one of the most demanding phases of the year. It is accompanied by the highest beaver activity; individuals are more physically active throughout the entire territory (VOREL *et al*., 2010a).

Winter stores are generally created in the water near the entrance to the den and most frequently consist of branches of woody plants or herbaceous plants. Food sources prepared in this manner are gradually collected during the winter and consumed. Beavers fell large trees in autumn and in winter until the surface of the water freezes, otherwise they use their stores. When the temperature falls below -6 °C beavers usually only leave their dens if their stores have been exhausted (MÜLLER-SCHWARZE & SUN, 2003). In spring they quickly convert their diet to summer foods, however, this transition is physically quite demanding. But the autumn transition in food consumption habit from herbaceous plants to woody plants rich in cellulose is much more demanding (WILSSON, 1971).

The other form of stores is felled and unprocessed larger tree trunks (HEIDECKE, 1989). Preferred stump diameters of felled woody plant trunks range between 1 and 12 cm, but felled trees may have a diameter of 1 m and more (VOREL *et al*., 2008; VOREL *et al*., 2009).

The quantity and quality of food may also correspond with the quantitative characteristics of the population. The length of the territory is proportionately dependent on the length of growth of the preferred woody plants (FUSTEC *et al*., 2001). According to these authors the long-term stability of the territory requires at least a 1.8 km length of *Salix* spp. growth.

The composition of woody plant species in the locality also probably influences the number of individuals within the territory. HAY (1959) describes families of North American Beavers of various sizes depending on the presence of specific tree species in their territory. Territories in areas rich in Aspens (*Populus tremuloides*) have an average number of 7.8 individuals, while territories with willow growth have an average of less than 5.1 individuals. On the contrary, some authors do not agree with the fact that the length and quality of the settlement is related to the quality of the key source of good (CAMPBELL *et al*., 2005).

The food pressure on growth is closely linked to the intensity of settlement. This particularly concerns the trophic base, which seems to be the most important factor influencing the existence of beavers (HARTMAN, 2003). Food activity may reduce the local offer of consumed plants so that the consumption of preferred woody plants is faster than their regeneration (FRYXELL, 2001). This effect causes fluctuation in the settlement over the long-term horizon. There may be a theoretical risk of rapid reduction of the territory with carrying capacity in which a population can continue to successfully expand in most long-term settled localities (HARTMAN, 1995; FRYXELL 2001; HARTMAN, 2003). However, this has not been duly monitored and demonstrated in Central Europe. A much more frequent reason for the beaver's disappearing food base is not the beaver itself, but humans (management of growth on the river banks by watercourse administrators, forestry activity, local residents).

1.3.5 Dispersal

Beavers may disperse several times a year, most individuals disperse (beavers generally do not migrate in the true sense of the word) only once in their lives (primary dispersal). Young beavers disperse for the first time when they have to leave their native territory. Another form of dispersal (in this case quite random) is forced subsequent journeys. Individuals are either forced out of their territory as a result of competitive battles, or if their territory has been reduced or destroyed.

Adolescents leave their families and disperse up to tens of kilometres away. A significant number (74%) of individuals move downstream when leaving their families. The dispersal distance changes according to various authors, but a significant number (88%) of individuals generally endeavour to initially colonise the adjacent locality– within 5 km (NOLET & ROSELL, 1994; SUN *et al*., 2000; MÜLLER-SCHWARZE & SUN, 2003). If a settlement is not created in the adjacent area, the dispersal distance ranges between 3.2 km to 37.2 kilometres – the average is 8.8 km (FUSTEC *et al*., 2001). One-year old dispersing beavers form 14% of the total number, dispersal most frequently occurs at the age of two years (64%, the last age category (three-year old adolescents and older) forms 21% (SUN *et al*., 2000). Secondary, i.e. forced dispersal, may occur in subsequent years following primary dispersal. In most cases this will concern loss of the original territory (reduction of the site, competition among individuals, seeking better resources) or due to the search for a partner (SUN *et al*., 2000).

Beavers usually disperse along watercourses, but beavers may exceptionally also move along dry land or cross the border of a watershed (HARTMAN, 1995; ČERVENÝ *et al*., 2000; VOREL, 2003b). Beavers are mainly forced to cross a watershed by increasing population pressure from the initial population. This then forces beavers to make a high-risk crossing over dry land (HARTMAN, 1994). The permeability of the landscape for the Eurasian Beaver is defined by the permeability of the watercourses and the network of water routes connecting bodies of water and also the permeability of watersheds between individual water catchment areas, regardless of the hydrologic system.

The most frequent and most natural dispersal path for the beaver is along natural watercourses. However, natural (waterfalls) or artificial (dams, weirs) obstacles occur on these. Their permeability may therefore be limited, in some cases they are only permeable in one direction (downstream) and some may be practically impassable (e.g. the Střekov Dam in Ústí nad Labem).

After receiving an impulse for dispersal (usually being forced out of their native territory by their parents), the adolescent individuals begin to seek new, uninhabited potentially inhabitable territories (NOLET & ROSELL, 1994; NOLET & BAVECO, 1996; SUN *et al*., 2000; FRYXELL, 2001). The moment they fail to find a place suitable for settlement within the entire catchment area or within an area enclosed by obstacles, the sub-adult beavers are forced to move to another catchment area across the watershed. Cases when a dispersing animal moves to another catchment area across uplands have also been registered in this country (ČERVENÝ *et al*., 2000). Cases when beavers cross many hundreds of metres and even kilometres between sources of water or disperse to isolated bodies of water within the catchment area have also been described.

In these cases we frequently encounter lone individuals past the obstacle, who usually do not establish a permanent territory and range throughout a large area. If they are not found by a partner they leave the locality or gradually die as a result of unfavourable conditions. These individuals do not establish a system of day shelters; they are frequently the victims of an encounter with vehicles or become an easy target for predators (ČERVENÝ *et al*., 2000; ŠAFÁŘ, 2002).

1.3.6 Physical activity

Beavers are active practically exclusively at dusk and at night. They are mostly active at night overlapping into the morning hours, particularly in the summer months (SHARPE & ROSELL, 2003). According to these authors there are also no differences between individuals of various sex in their activity at night and the length and type of activity also does not differ during the period of care of year-old kits. SHARPE & ROSELL (2003) consequently believe that both parents care for their young equally. From the aspect of the beaver's seasonal activities, they do not hibernate in winter nor do they slow their metabolic processes in any manner (MACDONALD & BARRETT, 1993). However, in the colder months they may decrease their temperature to 34–35 ^{O}C (BAKER & HILL, 2003).

1.3.7 Roles in the ecosystem

As well as its natural place in the ecosystem the Eurasian Beaver also has another important role. The beaver's position in the natural environment is unusual with regard to the beaver's ability to actively change the settled area. There are not many other organisms that have such a profound effect on their surroundings and these species are usually called "key–stone species" (JONES *et al*., 1994). Specific interactions with other environmental components are some of the strongest effects mammals have on the ecosystem and the landscape (ROSELL *et al.*, 2005).

One of the beaver's most important activities is construction of dams, construction of shelters and felling of trees. Thanks to these activities, the beaver is capable of positively and negatively affecting creation of topographical relief and significantly changing the character and structure of ecosystems. This issue is discussed in detail in chapter 1.4.

In the Czech Republic the beaver only has natural predators when young and kits may be attacked by larger predators, for example the Fox (*Vulpes vulpes*) (DZIECIOLOWSKI, 1996). The authors ROSELL & HOVDE (1998) actually believe that the beaver may be potentially preyed upon by the Martin (*Martes* spp.). Newborn kits may also theoretically be preyed upon by the smaller predators, such as the Mink (*Neovison vison*). However, adults are physically strong enough that they have few natural enemies. Generally known predators of the beaver are the Wolf (*Canis lupus*), the Bear (*Ursus arctos*), Lynx (*Lynx lynx*) and Wolverine (*Gulo gulo*) (BAKER & HILL, 2003; MÜLLER-SCHWARZE & SUN, 2003). These authors even state that the beaver is the most frequent prey of the wolf in areas inhabited by both species during the vegetative season (it forms 34.8% of the wolf's food source); the wolf is therefore the beaver's dominant predator. On the contrary, HARTMAN (2003) states that in spite of the fact that predatory pressure by wolves on the beaver has been growing in Sweden during the last 20 years, its impact on population numbers is not significant. The authors RINPLE & BESCHTA (2004) actually go so far in interpretation of the relationship between the wolf and beaver that, according to them, the consequence of selective pressure may result in these large predators causing a change in species composition, density and coverage of growth (predation cascade).

No attacks by predators have been described in the Czech Republic as yet (VOREL, 2012, unpublished data). The aforementioned large predatory species do not create stable populations at the existing sites of beaver settlements (the lynx in South-West Bohemia and the wolf and bear in the Beskyd mountains). However, there is data available (although unconfirmed) of wolf and bear predation on the beaver from Central Europe (East Slovakia autumn 2011).

According to HARTMAN (2003) and BUSHER & LYONS (1999) a more important factor is food-based competition between large herbivores, which beavers may compete against for food sources to a specific degree. The relationship between deer and trees felled by beavers is well known. In North America the White-tailed Deer (*Odocoileus virginianus*) may prevent regeneration of softwoods through excessive grazing of "beaver meadows" in the area surrounding watercourses, thereby reducing the food base.

The beaver's range of food may similarly be limited by intensive grazing of the shoots of regenerating trees by the European Moose (*Alces alces*) (HARTMAN, 2003). This trophic competitive relationship may restrict the quantity of available food in a location with the final result of preventing further development of the population (BUSHER & LYONS, 1999; HARTMAN, 2003). No similar interaction in our conditions has been described as yet. In the winter period we have only registered Red Deer (*Cervus elaphus*) or Fallow Deer (*Capreolus capreolus*) grazing on trees felled by beavers.

There is probably no competition with other species of mammal in Europe, unless we consider the North American Beaver (*Castor Canadensis*), which is not indigenous to Eurasia. This close relative may be a competitive species competing for food sources and, just as importantly, for space.

The North American Beaver may force the existing Eurasian Beaver population out of its habitat due to its greater reproductive efforts. DANILOV (in ERMALA & LAHTI, 1997) points out the different population dynamics of both species. According to these authors a Eurasian Beaver female (reaching sexual maturity in her third year) would have an average of 1.9 kits in a litter. It was found that the North American Beaver had an average of 3.3 kits per litter and the females reached sexual maturity as early as 1.5 – 2 year of age. The aforementioned mechanism can be demonstrated on a situation in Finland (ERMALA & LAHTI, 1997). Between1935–1937 both species of beaver were introduced here at a ratio of 19:7 (*C. fiber* vs. *C. canadensis*). According to estimates of the size of the population of the genus *Castor,* the population numbered 9,000–10,000 individuals in 1995. 10 % of these individuals were *C. fiber* and the remainder *C. canadensis*. According to HALLEY & ROSELL (2002) there were 15,000 individuals consisting of an unknown ratio of both species in the specific area in 2002.

Commensalism probably concerns the Muskrat (*Ondatra zibethicus*), which sometimes inhabits the dams and occupied lodges and dens. There may be a very unclear relationship between the beaver and the Coypu (*Myocastor coypus*), which has been dispersing through the riparian forests along the Elbe and Morava rivers over the last two decades. It is also assumed that the Eurasian Otter (*Lutra lutra*) also uses abandoned beaver dens, as stated by KOSTKAN (2000) or VOREL (2001).

1.3.8 Genetic variability and structure of the population

Chapter 1.1 defines the still valid subspecies of the Eurasian Beaver. However, their previous isolation and current position is the result of intensive persecution of the species throughout its range, not the result of evolutionary processes. Strict conservation has simply managed to preserve the remainders of populations, which where then defined as separate sub-species. Their long-term isolation (until the recent past) could theoretically lead to light genetic diversification. Some genetic diversity can also theoretically be expected (LAVROV, 1981), however, any differences will probably be minimal.

To what degree the defined subspecies actually differ is currently the focus of several on-going research projects. There are some morphometric differences in some sub-populations, for example. *C. f. albicus* has different cranial characteristics compared to other subspecies (LAVROV, 1981; LAVROV, 1983; HEIDECKE *et al*., 2003). DZIECIOLOWSKI (1996) mentions differences in body dimensions and weights of individuals in the Elbe population compared to the members of other forms. LAVROV (1983) also states that the metristic differences between the nominate *C. f. fiber* and the *C. f. albicus* forms are so great, that it would actually be possible to declare the Elbe population a separate species – [*Castor albicus*]. He bases his theory on the differences in cranial parameters, where he describes 17 differences between *C. f. fiber* and *C. f. albicus* in relation to 28 cranial characteristic. For comparison he states that the same criterion in two species

C. fiber and *C. canadensis* shows 21 differences in 28 cranial characteristics. However, a large number of authors (newly for example DUCROZ *et al.*, 2005; DURKA *et al.*, 2005; BABIK *et al.*, 2005) do not consider these reasons significant. The reason for these marked differences could be the different environmental impact of individual sites rather than the marked difference of an entire population (ZIMA *et al.*, 2005). It is more probable that the population gene pool was reduced as a result of a very strong bottleneck effect, which all the Eurasian Beaver populations underwent (BABIK *et al.*, 2005). With regard to the differences between the individual aforementioned subspecies (which are still not doubted and not reclassified, see DUCROZ *et al*., 2005), differences on the level of two so-called evolutionary significant units (ESU) have been found to date: the west for *C. f. fiber*, *C. f. albicus*, *C. f. galliae* and the east, which incudes *C. f. vistulanus*, *C. f. birulai*, *C. f. tuvinicus* and *C. f. pohlei* (DURKA *et al*., 2005; BABIK *et al*., 2005). However, this concerns polymorphism on a very low level, which has no practical meaning for conservation of the species.

The situation in relation to the Central European population is very varied. According to the results of an analysis of mitochondrial DNA, it is clear that beavers from the German Elbe refugium inhabit North Bohemia. The offspring of beavers introduced in the Belorussian area and the population in Norway live in South Moravia. Beavers mostly of French origin inhabit West Bohemia. Central Moravia has been settled by the offspring of beavers from the Belorussia area, and the population in North Moravia and Silesia probably originated in North East Europe (VOREL *et al.*, 2010a).

The question remains: whether we should actually concern ourselves with intra-species classification at all. According to the information given above about the taxonomy of the species, it is not possible to work with simply defined subspecies of the European Beaver. Their use probably also has no biological purpose. Furthermore it is not possible to define the limits of individual subspecies, particularly because our largest populations in South Moravia and West Bohemia have merged.

Accordingly we do not discuss separation into individual subspecies any further in the Management Plan.

1.3.9 Hybridisation

According to all available sources, interspecific hybridisation of two species from the *Castor* genus is not very probable. Artificial laboratory experiments, which hybridised these two species, took place in Poland and Russia during the nineteen thirties. However the experiments were not successful, because the kits were always stillborn (ZUROWSKI, 1983). The reason for this is most probably the great difference in the number of chromosomes between the species *Castor fiber* (2n=48) and *Castor canadensis* (2n=40) (HEIDECKE, 1987; WARD *et al*., 1991).

The North American Beaver is originally from North America. Its habitat was expanded by Eurasia as a result of reintroduction during the nineteen thirties (see pic. 1). As a result, this species is now present in large populations in Finland and in the adjoining Russian Karelia district, as well as in the Amur catchment area and in the Kamchatka (PARKER *et al*., 2012).

Unfortunately, as well as this very large population on the Finnish-Russian borders, this non-indigenous close relative was also illegally, or legally but by mistake, released in Poland, Austria and in France in the nineteen sixties and seventies. According to all available data it should have been exterminated in all regions close to our borders (PARKER *et al*., 2012). However, it is not possible to definitively preclude its local random presence, because the North American Beaver is very frequently kept by zoos from where it can easily escape into the wild (SCHLEY *et al*., 2009). There is also still doubt concerning the genetic “purity" of reintroduced individuals – for example in Belgium, Luxembourg etc. (SCHLEY *et al*., 2009)

In relation to this, we must point out the threat posed to the Eurasian Beaver population in Europe by the North American Beaver. As stated above, both species do not hybridise, but the North American Beaver could be a serious competitor to its European relative. The aforementioned species can be undesirable due to the fact that it probably has much greater reproductive capabilities (NOVAK, 1977; PARKER *et al*., 2012), which could mean that it could relatively quickly and easily force its reproductively less capable European relative out of settled habitats (DANILOV in ERMALA & LAHTI, 1997). Interspecific relations are discussed further in chapter 1.3.7.

In relation to degradation of the gene pool, whether this is the result of hybridisation or introgression of subspecies, we must also briefly mention the risk of genetic disorders in small isolated populations. According to authors HALLEY & ROSELL (2003) there is no evidence as yet that we should be concerned about inbreeding. There is also no data about epidemic diseases, which would originate from the small genetic variability within an isolated population. This in spite of the fact that only very small foundation groups of beavers existed in Europe until recently (e.g. numbering only six reproductive pairs for example). However, these gradually developed into several populations, which are developing successfully today (HALLEY & ROSELL, 2003).

On the other hand some isolated sub-populations suffer from fairly frequent genetic disorders and morphological anomalies (SAVELJEV & MILISHNIKOV, 2002). On the basis of current biological and molecular knowledge we can say that greater polymorphism of a population generally has a beneficial effect and there is no reason to prevent “hybridisation” of subspecies. According to their results the reproductive success of individuals originating from large, multi-source and intermingled populations, increases. In other words, it has been demonstrated that the frequency of some anomalies in small populations that have been isolated for an extensive period, is several times higher than the probability of genetic defects in large, intermingled and therefore polymorphic populations.

1.4 Impact on the landscape complex

The Eurasian Beaver may also be an important agent in the cultivated landscape of Central Europe. This frequently concerns a key species, which actively changes the environment of watercourses and bodies of water and the adjoining flood plains. In landscapes with little human activity this effect is frequently very positive, because the ecological value and biodiversity of the area demonstrably increases in most localities affected by beaver construction activities (ROSELL, *et al*. 2005; BARTEL *et al*., 2010).

The impact on the ecosystem can be divided into the causes and impact. The activities by means of which beavers actively assure their key requirements must be defined initially. This basically concerns digging dens, felling trees and constructing dams. These activities satisfy the necessities of life for beavers as a result of which they cause changes to the parameters and conditions of a specific area. The aforementioned activities frequently have an impact. From the biological aspect this frequently concerns positive effects (increasing biodiversity, diversification of landscape and biotic components), however, in a landscape cultivated by humans, so-called conflict situations frequently arise, which have a negative impact.

The impact of the aforementioned behavioural activities is not inevitable and pervasive, but is the effect of the key biological requirements of beavers. Most of these result from interaction of the beaver's activities with configuration of the landscape and particularly with landscape functions (agricultural use and infrastructure elements). They are frequently the result of modification of the area surrounding watercourses and bodies of water caused explicitly by humans and human requirements on the landscape.

The above is analysed in detail in each of the following sections. The biological basis of the beaver's activities is initially stated. The consequences of these activities are then given, including a list of more frequent potential conflicts with human interests.

1.4.1 Construction of shelters (burrows and lodges)

This activity affects the "micro-conditions" of a locality significantly. This is not the beaver's main and significant impact on the surrounding eco-system. However, in some specific areas (with a high density of ponds, the existence of flood embankments or areas that are forcefully urbanised) this may be a fairly important aspect, which may influence the character and further development of an area.

Construction of locally appropriate shelters is the beaver's basic need. Its only purpose is to establish a shelter with an underwater entrance and a main rest zone in the dry part of the bank. In general the beaver initially endeavours to establish burrows in a high bank, and if this is not possible it builds an above-water shelter – lodge. Dens can be found in high clay-sand banks, where the main dry, rest chamber is safely above the ground water level. Lodges are built on flat flood plains, where the dry part of the den cannot be built in the bank and above ground water level. Lodges are above-ground conical, frequently fairly tall structures, which the beavers use gnawed branches and mud to build. A semi-lodge is a temporary phase of shelter between a burrow and lodge.

The beavers maintain the fairly complicated layout of their shelter during all possible water conditions within their territory. At sites where the water level around the shelter fluctuates significantly, beavers tend to have an elaborate system of substitute exits from and dens in the shelter, so that two conditions are always met – an underwater entrance and a dry main chamber.

In some localities the water level, character of the bank and material on the bed do not allow the beaver to ensure underwater entrances (sometimes during dry seasons). Entrances to the burrow are then frequently evident above the water level, but this is an emergency solution.

From spring to autumn the beaver family uses a greater number of burrows (lodges), until winter when the entire group gathers in several small shelters, usually in a single shelter.

The positive points of this activity

Diversification of the bank line

Construction of a greater number of dens results in significant disturbance of the cohesiveness and rigidity of the banks of watercourses. In ameliorated watercourses this may have a local positive effect, as a result of which the "de-naturalised" bank line is diversified. During higher streamflow the banks are disintegrated to a greater degree if they are affected by a large number of beaver dens. This phenomenon results in widening of the streambed and reduction of the steepness of the banks. The positive effect occurs regardless of any construction modifications made to the specific watercourse, but the impact of these activities is only mentioned here as positive when changes caused by beavers do not endanger utilisation of surrounding areas, or if there is no negative impact on adjunct structures (bridges, buildings, flood embankments).

Negative impact of this activity

Damage to pond and reservoir dams

Dams made from un-reinforced, loose material, etc. are especially at risk. Older water management works are consequently at particularly risk, where finer loose material was used to construct the dam (the České Budějovice region and the Třeboň basin area, the Poodří Area and also remainders of mostly defunct pond systems, for example in the Pardubice Region, Central and South Moravia, smaller pond systems in the Bohemian-Moravian Highlands, etc.).

Damage to flood embankments and walls of artificial water channels

The risk of beavers building their shelters on watercourses with flood embankments is not very high (this concerns technically modified parts of the channel, which are not attractive to beavers), but they are very dangerous if they do occur. Under normal water level conditions the shelters are built into the banks of watercourses and do not affect flood embankments. The risk occurs during increased flood conditions, when the water level rises for a time and the beavers are forced to dig dens according to the new water level, and these may penetrate embankments and endanger their impermeability and safety. In spite of the fact that this is a temporary effect, when individuals return to dens on the original level in banks after the floods subside, they still cause significant damage to the embankments.

The existence of beavers in above-ground water channels (raceways, etc.) in which the water is guided through soil or rock-filled embankments, poses a much higher risk. If these are damaged by beaver dens, the water may flood the lower terrain. The risk of this issue is not very probable, but serious.

Destabilisation of upper parts of dams and banks of watercourses

The problem associated with construction of shelters is the risk that the upper parts of dams may collapse or paths may be tunnelled under and collapse. Multiple perforation of banks and embankments may pose a risk to the movement of people and mechanisation along the crowns of dams, and the functional use of these areas is also restricted.

1.4.2 Felling woody plants (trees and bushes)

By felling woody plants, beavers affect the composition of vegetation in the settled localities in several aspects. The beaver's food source in autumn and winter is mostly the bast and bark of woody plants.

is capable of felling trees of any size, but does prefer branch and trunk diameters between 2 and 12 cm, although thicker trees are also felled. Strongly preferred species are willows and poplars, and beavers also fell oaks, birches, alders, ashes and other trees normally growing in areas surrounding watercourses. Food ecology is described in more detail in chapter 1.3.4.

Positive impact of food activities

Changes to the species and age structure of woody plant growth in the area surrounding watercourses and bodies of water.

The initial effect of this food activity is changes to the species and age structure of woody plants. Because the beaver's food preferences focus on easily rejuvenating woody plants – poplars and willows – an increased rate of felling has more positive than negative impact. These easily and quickly regenerating woody plants begin to regenerate practically immediately from vegetative remainders.

Increased biodiversity as a result of food and construction activities

The species spectrum in the settled locality is also transformed in the event that the beavers build dams. The increased wetness of the site practically immediately limits colonisation by species that are unable to tolerate the increased water levels and species that seek such sites are encouraged. The vegetative conditions of these sites quickly change as a result of similar regulation (VLACHOVÁ, 2001; VLACHOVÁ & VOREL, 2002).

Negative impact of food activities

Threat to the species composition of cultivated forests and the yields from fields near watercourses.

Beavers usually limit their tree felling activities to growth on the banks, however, they may also affect cultivated growth in some cases. Growth in these areas may be felled during flood conditions and at quite a distance from the water. As well as forest trees, they may also gnaw on fruit or decorative woody plants. In agricultural areas they frequently eat agricultural field crops during the vegetative period: sweet corn, potatoes, Jerusalem artichokes, sunflowers, sugar beet and feed beet, etc.

Reduced non-production function of woody plant growth in the area surrounding watercourses

Felling may disrupt the aesthetic and cultural values of bank or park growth, etc. The phenomenon, which will increase in significance, is felling linear (reinforcing) woody plants along ponds and reservoirs. Important bird nesting sites in riparian zones are also endangered.

Increased number of trunks in the channels of watercourses

The felled trunks frequently lie either on the banks of watercourses or directly in the streambed and create barriers as further material catches against them. The risk posed by washed away food remainders increases during flood situations, obstacles also occur on the lower parts of watercourses, particularly by bridge structures. It must be pointed out that the beaver is a less significant factor increasing the quantity of wood washed down along watercourses in comparison with other factors (MÁČKA & KREJČÍ, *et al*. 2011). On the contrary, the stabilised elements of the wood material (dams, some felled trunks) may contribute to improvement of the ecological condition of watercourses.

1.4.3 Construction of dams on small watercourses

The evidently greatest impact on the surrounding area is caused by construction of damns. The main reasons for damning watercourses is the shallow depth at the entrance to the shelter (see chapter 1.4.1) and

the lack of woody plants on the banks. The purpose of construction of this structure is to ensure that the entrance to the shelter is below the water level, so that the entrances are not revealed even when the water level is at its lowest point.

The second reason for constructing a damn is to flood part of the territory, which improves access to growth and enables easier manipulation of wood. As a result, dams do not appear only at sites where the family lives, but also at sites with suitable extensive growth.

The dams are also used to assure safe movement around the inhabited area. The nearness of the water provides a certain means of escape from predators in places where beavers consumer their food or groom their fur. Beavers are stressed if they have to travel through dry or too shallow areas every day.

Positive impact of construction of dams

Water accumulation and retention

Beavers' damns change the character of a locality in many sites and create standing water. This particularly concerns the uppers parts of water catchment areas of small watercourses. Larger or smaller cascades created by cross-wise structures leads to origin of extensive wetland systems in wide and unused flood plains, which are capable of performing a significant retention and accumulation function in the landscape water system and also serve as a reserve area for balancing unstable streamflow to a specific degree. This leads to stabilisation of fluctuating water levels near beaver shelters (VLACHOVÁ & VOREL, 2002) and significantly reduces the speed of drainage of water from the water catchment area.

Increased diversification of flooded ecosystems

Biomass production is demonstrably transformed as a result of diversification of watercourses (changes to the character of watercourses and creation of still or slow-flowing water). Dams promote significant development of plankton, benthos and littoral vegetation. The diversity and abundance of all groups of organisms, which are linked to primary production and its consumers, increases. The impact of the beaver's activities significantly and positively increases the quantitative and qualitative parameters of ecosystems, even on the highest levels of the food chain; for example in relation to predatory fish, water fowl, etc. (NAIMAN *et al.*, 1984; NUMMI, 1989; SCHLOSSER, 1995; FRANCE, 1997; ROSELL *et al.*, 2005).

Sedimentation of eroded washed away particles

Reduction of the speed of the current is accompanied by reduction of its ability to wash away materials and eroded particles settle in front of dams. In the long-term horizon the entire flood-plain is filled with soil, with the exception of the main stream-line (NAIMAN *et al.*, 1984; JOHNSTON & NAIMAN, 1990).

Revitalisation of "de-naturalised" ecosystems

Damns have a significant impact on the character of watercourses on formerly drained linearized watercourses. Flooding part of such watercourses results in diversification of the character of the watercourse and reduces the frequently inappropriate depth of the channel. This subsequently also results in changes to the development of the littoral zone. Potential water-logging of surrounding non-production areas (natural flood-plains) changes the moisture-content and subsequently the biotic conditions in these adjunct sites. The food behaviour of beavers may also have a specific and positive function here. Selective gnawing of rapidly regenerating woody plants enables some types of growth to increase in density.

Negative impact of dam construction

Water-logging of transport corridor bodies

Beavers very frequently seek out narrow areas for building dams on small watercourses, where it requires less energy to flood the required area. Sluices and bridges below road and rail embankments are frequently used in this manner. Beavers are able to effectively dam watercourses here and use the body of the road or railway for this dam. Apart from flooding a more extensive area, sometimes including human buildings, this frequently endangers the body

of the actual road or railway track, which is usually water-logged or even overtopped, resulting in erosion of its surface.

Flooding of infrastructure structures

New streamlines originating as a result of damming of the original stream-bed, may cause origin of areas posing a risk to water management. This results in undermining and other risks to structures in the surrounding area.

Structures that do not tolerate flooding or water-logging may also find themselves in an area flooded by beavers, for example potable water bores, fish ponds, waste water treatment plant outlets, pond and reservoir dam bodies, etc.

Flooding of production areas

With regard to the potential rise of the water level by 1-2 metres, agricultural and forest land is also at risk to an extent of acres or even hectares (depending on configuration of the terrain and the locality). Significant and long-term waterlogging reduces the production function of these areas and further complicates, or even prevents access to these areas by machinery.

Changes to drainage parameters

Changes to the parameters of the stream-bed and changes to drainage parameters may occur as a result of damming of the original stream-bed; the main current seeks a new trajectory. Beavers usually endeavour to dam all other originating outlets, which results in extensive cascades and damn systems (VLACHOVÁ & VOREL, 2002). Origin of damn cascades causes extensive flooding and also creates a secondary channel, which cuts into the surrounding terrain as a result of erosion. This effect is also frequently accompanied by increased washing away of eroded material.

Reduced permeability of the profile of small watercourses

A large quantity of washed away material, which may gather locally in the lower sections of watercourses, is released downstream below the constructed lodges and dams. This increased quantity of caught material creates barriers to the current, which may also pose a risk of banks bursting locally. This situation requires attention during floods when accumulation of wood may cause an obstacle to drainage of water. Dams on small watercourses in trout and grayling zones change the current conditions and reduce the permeability of the watercourse for rheophilous species of fish (however, the permeability of dams varies depending on their condition and character and depending on the size of the migrating fish – dams mainly represent a barrier to larger categories of fish).

1.5 Causes of endangerment

1.5.1 Historic causes

There were multiple causes for extermination of the Eurasian Beaver in Central Europe in historic times. HOŠEK (1978) states in his work that the beaver used to live wild in our landscape until the middle of the eighteenth century and was hunted throughout this time for several reasons.

The beaver was hunted for it excellent quality fur. It was also hunted for castorea – its skin gland, extracts from which were used and continue to be used in the perfume industry and in medicine. The beaver's numbers also fell because it was considered a fish in mediaeval times and could therefore also be eaten during lent. With regard to the fact that pond management was fairly well developed in historic times, the concerns that beavers would damage pond dams also played a role.

As well as direct hunting, beaver numbers also fell due to indirect, but significant interference into the species' habitat. The reason for this was transformation of natural biotopes such as riparian forest and wetlands into fields and other agricultural areas (HOŠEK, 1978; HALLEY & ROSELL, 2002).

During the 19th century the existence of the beaver was partially renewed in the Czech lands. In spite of this actually being mostly beavers kept in captivity, many individuals escaped into the wild or beavers were actively reintroduced. After the initial enthusiasm had waned, and along with increasing pressure by land administrators (pond managers, millers and farmers), the beaver was again hunted. The main reason for this was the concerns about the risk to pond management and protection of the water management infrastructure (HOŠEK, 1978). The speed at which beaver numbers fell was related to payment of a bonus for every beaver shot. It can therefore be stated that the main reason for the second extermination of the beaver in the Czech lands was fear of agricultural damage. Illegal hunting also played a significant role (ZÍBRT, 1929; ČENĚK 2011).

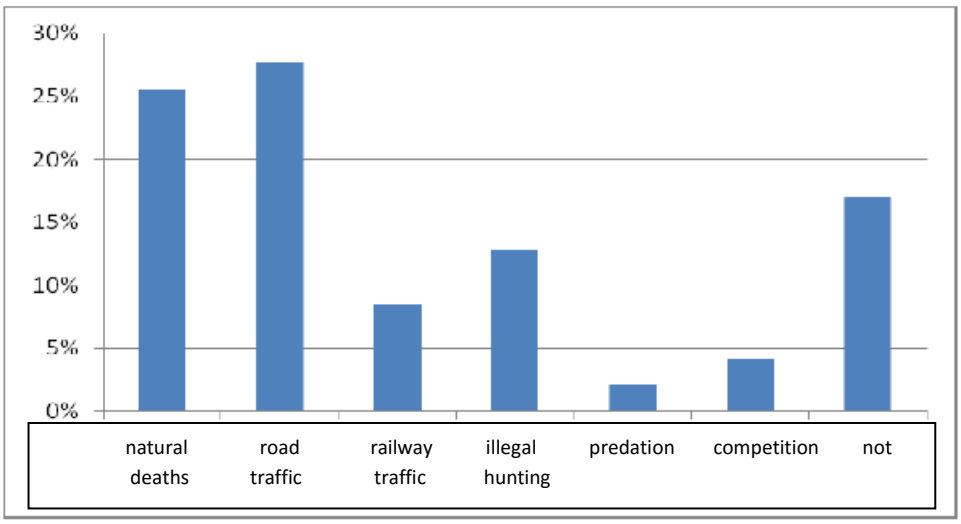
1.5.2 Current causes

The following text gives the causes of endangerment of the beaver in order from the most important to less serious.

Hunting and direct destruction of settlements

The conclusion that the main factor determining survival of the beaver as a member of our fauna was the scale of hunting by man, can be made on the basis of substantiated historic experience. As well as hunting for utility purpose, extermination of the species in our country and elsewhere in Europe was also the result of uncontrolled efforts to eliminate damages caused by beavers in a landscape utilised by humans. Both factors are currently gaining importance again. At present the beaver is classified as a protected species on a national and European level and according to Act No. 449/2001 Sb. on game management it is classified as species hunting of which is prohibited all year round. Under the condition that valid legal regulations are respected, hunting should not represent a risk factor.

However, in the conditions of the Czech Republic and some other countries in Central Europe, there is a rising intensity of illegal hunting and also destruction of settlements. If both of these activities take place during inappropriate seasons, the beaver settlement may be eliminated permanently. Illegal hunting or elimination of beaver settlements has been documented a number of times over the last decade, particularly in the region of South Moravia (cadavers found, individuals who are telemetrically monitored have been killed, beaver lodges have been burnt or otherwise destroyed). For the time being the scale of these activities has not exceeded the level where the drop in numbers of individuals is significant. In spite of this, and on the basis of historic experience, the risk of uncontrolled hunting and destruction of settlements must be considered very serious.



Picture 6: Percentage of selected causes of death of Eurasian Beaver individuals over the period from 2007 to 2010 in South Moravia, relative numbers are derived from a sample of 56 individuals (Source: Faculty of Environmental Sciences CULS Prague); data on illegal hunting includes documented cases (post-mortem findings, photographic documentation), cases are being investigated by the police, or potentially closed without a guilty party being established.

The following factors can be considered the main causes of illegal hunting of beavers

- hunting of beavers for the damages they cause to bank (frequently agricultural) growth, flooded areas or structures, to dams and other water structures;
- the public's conviction that beavers are overbreeding.

Permeability of the landscape and watercourses

It is clear from data about the mortality of Eurasian Beaver individuals that an important risk factor is (similarly to a large number of other vertebrates) encounters with vehicles, which are usually primarily caused by the existence of migration barriers and fragmentation of the species' biotopes in general. From the long-term aspect, limited communication and isolation of small populations or origin of sub-populations behind artificial obstacles, is a clear risk to the stability of the species throughout the Czech Republic. The decreasing opportunities for communication and passage of individuals and the flow of genes, and thereby the theoretical reduction of heterozygosity, may have extensive impact on the quality and numbers of some isolated populations.

Other factors of moderate to little importance

Most other risk factors include risks that can have an impact on a local scale or a negative impact on individuals. These factors have a low impact on the overall stability of beaver populations in the Czech Republic. The percentages of these causes in the monitored sample are given in picture 6. The key factors of individual risks to individuals can be classified as follows:

- construction of and repairs to roads and railways and their technical structures: particularly disturbance of individuals and demolition of structures constructed by beavers;
- interference in the water regime (water structures, modification of streambeds and banks of water courses, drainage, etc.): threats to the beaver biotope by manipulation of the water level or direct destruction of their settlements;
- intensive road and rail transport: death of individuals on roads and railways (see above);
- logging and cultivation of crops (particularly harvesting) affecting growth in the riparian zone: particularly destruction of the food base in the riparian zone;
- shipping: disturbance of individuals and the threat of mechanical injuries to beavers during operation of boats.

1.6 Conservation status

1.6.1 Conservation status on an international level

The beaver is classified in Annex III (protected species) to the Treaty on Conservation of European Wild Flora, Fauna and Natural Habitats (Bern Agreement).

European Council Directive 92/43/EEC on the conservation of wild habitats, wild fauna and wild flora classifies the beaver in Annex II (plant and animal species of Community interest, whose protection requires the designation of special areas of conservation) and in Annex IV (plant and animal species of Community interest, in need of strict protection according to Article 12 of the Directive). In some EU countries conservation of this species is reduced – for example Sweden, Finland, Poland and the Baltic states (Estonia, Latvia, Lithuania) where, with regard to the numerous population of Eurasian Beavers, Appendix IV and the requirement of strict conservation according to Article 12 of Regulation 92/43/EEC does not apply. In these countries the beaver is classified in Appendix V with the option of specification of the terms of use (including regulated hunting) and measures assuring preservation of beneficial numbers of the species (Article 14 of the Directive).

The "Ramsar Convention" on wetlands of international interest, chiefly for protection of water fowl biotopes, protects the Eurasian Beaver indirectly. This assures protection of wetland systems in the Czech Republic, i.e. including Eurasian Beaver biotopes, which are registered in the List of Wetlands of International Importance.

The Eurasian Beaver has been classified as a species of little concern (LC) in the worldwide red list IUCN (International Union for Conservation of Nature and Natural Resources) from 2009.

1.6.2 Legislative aspects of conservation of the species in the Czech Republic

Act No. 114/1992 Sb., on nature and landscape conservation

With regard to European legislation (see above – requirement of strict protection according to Article 12 of Directive 92/43/EEC) the European Beaver is classified as an especially protected species of animal according to Act No. 114/1992 Sb. Implementary Decree No. 395/1992 Sb. (as amended by Decree No. 175/2006 Sb.) classifies the beaver as a "*critically endangered*" species according to Section 48, paragraph 2, letter b) of Act No. 114/1992 Sb. The key terms of conservation of especially protected animals are stipulated in Section 50, paragraph 1 and 2 of Act No. 114/1992 Sb. and also anchor protection of all the development stages, natural and artificial settlements and biotopes of these animals. It also prohibits harmful interference in their natural development, which also includes trapping, keeping in captivity, disturbance, injury or death, and also other types of intervention, which could lead to a threat to individuals of an especially protected species (such as intervention in the biotope leading to reduction of food sources, breeding areas, restriction of movement within the territory or between territories, etc.). Collection, destruction, damage or movement of their developmental stages or use of settlements is also banned, as well as holding, transporting and commercial use. According to section 48, paragraph 4 of the aforementioned act, this protection also applies to dead individuals or products made from them. According to Section 56 of the Act on Nature and Landscape Conservation, an exception can be permitted to the abovementioned bans. In the case of the Eurasian Beaver, as an animal "*That is the subject of protection according to EC law*", permission of an exception is possible

only if another public interest has precedence over the interests of nature conservation or in the interest of nature conservation, if any reason or purpose set out in Section 56, paragraph 2 (e.g. the reason of preventing serious damages, the purpose of research and education, etc.) is simultaneously fulfilled. In all cases fulfilment of the condition of non-existence of another satisfactory solution must be taken into consideration when permitting an exception and the permitted activity must not affect achievement or maintenance of beneficial numbers of the species from the aspect of protection according to Section 3, paragraph 1, letter t/ of Act No. 114/1992 Sb.

As well as specific species protection, Specific Areas of Conservation (SAC) (Section 45a – 45c of Act No. 114/1992 Sb.) are also designated within the terms of the Natura 2000 system in relation to the requirements of Directive 92/43/EEC for conservation of the Eurasian Beaver in the Czech Republic. The beaver is currently the subject of protection in a total of seven Special Areas of Conservation in the Czech Republic (see chapter 1.7.1, tab. 1), which represent various types of environment (submontane watercourses, larger lowland watercourses and riparian forest). A number of these localities are already part of existing SAC, which sufficiently assures their protection. Protection of newly defined localities will be realised in compliance with the procedure stipulated in Section 45c of Act No. 114/1992 Sb. In relation to SAC, which will not be declared as Specifically Protected Areas (hereinafter SPA) for other reasons, the so-called basic protection regime will apply, which is fully sufficient for conservation of the Eurasian Beaver. Proper agricultural practice carried out in compliance with the valid legal regulations is not considered harmful to the locality.

Act No. 115/2000 Sb. on provision of compensation of damages caused by selected especially protected animals

Act No. 115/2000 Sb. gives the Eurasian Beaver as one of the selected species, in relation to which compensation of damages resulting from damage to forest or *"permanent growth"* or during damages arising to un-harvested field crops, can be claimed. Compensation of other types of damage, which may be caused by beavers, is basically not allowed by Act No. 115/2000 Sb.

Compensation for complication of farm or forestry management within the meaning of Section 58 of Act No. 114/1992 Sb. cannot be claimed in cases when this damage is caused by an especially protected animal (damages arising from the activities of this animal, according to the current interpretation (notification No. 4/2006 by the secretariat of the Remonstrance Commission on interpretations of legal regulations, accepted by the Interpretation Commission of the Ministry of the Environment, Ministry of the Environment Bulletin No. 5/2006). Compensation of damages can therefore only be claimed if the owner or lessor of land is restricted in it forestry or farm management as a result of respecting the provisions of the law (the bans stipulated in Section 50 of Act No. 114/1992 Sb.) or the implementary legal regulation or decisions issued on their basis. In the case of damages caused by beavers it is also not possible to deal with duplicate compensation, e.g. for damaged woody plants or crops directly consumed by beavers, according to Section 58 of Act No. 114/1192 Sb., but a claim can be applied in the field of increased costs or reduced yields on land flooded in the long-term (in cases when it is essential to preserve beaver dams resulting in an increased water level and an exception was not permitted for removal of these dams) and in other similar cases.

Act No. 4492001 Sb. on game management

According to the provisions of Section 2, letter c) of Act No. 449/2001 Sb. the Eurasian Beaver is classified as a game that cannot be hunted according to international conventions or national legislation. Hunting is only possible in cases when an exception was permitted according to Section 56 of the Act on Nature and

Landscape Conservation No. 114/1992 Sb. and a permit subsequently issued by the state game management administration body according to Section 39 of the Game Management Act (the need to reduce wild animal numbers due to origin of damages) or according to Section 40 of this act (hunting for the purpose of research, whereas even trapping live individuals, for scientific purposes for example, is a method of hunting according to the Game Management Act). Other provisions of the Game Management Act are also applied with regard to classification of the beaver as a game animal. This particularly concerns the general duties and restrictions stipulated for protection of game animals in Section 8 and 9 of the Game Management Act (e.g. the prohibition of alarming game animals in any manner and disturbing them while giving birth to young and carrying out any other activities negatively affecting the life of game animals as wild animals). The restrictions of execution of some activities or these being dependant on the consent of state game management administration bodies or the possessors of hunting grounds also apply. For example, according to Section 5, the consent of the possessor of the hunting ground and the state game management administration is required when releasing game animals into hunting grounds, according to Section 7, the consent of the state game management administration is required for keeping game animals in captivity, a special procedure is stipulated in the case of rescue stations. Hunting and hunting licences are governed by Section 39-42, 46-48. Only people authorised to do so according to the Game Management Act are permitted to hunt, i.e. holders of a valid hunting licence, hunting permit and insurance. Section 45 of the Game Management Act stipulates the prohibited methods of hunting.

With regard to deceased Eurasian Beaver individuals, the finding of which could be an important source of information on distribution of the species and the structure of its population, the Game Management Act generally stipulates within the terms of definition of Game Management rights (section 2, letter h) the right to appropriate deceased game animals. Further regulation of this issue is not stipulated in the Act (including regulation or restriction of possessing dead animals by persons not specified by the Game Management Act or stipulation of the duty to hand over found deceased game animals to the user of the hunting ground for instance). According to some interpretations (for example ŘEHÁK *et al.*, 2002) and established practice, deceased game animals are usually awarded to the user of the hunting ground with reference to section 43 of the Game Management Act. This concerns a provision on tracking wounded or otherwise injured game animals. Paragraph 3 stipulates that, *"....the tracked game animal belongs to the user of the hunting ground, from which it came; and deceased game animals, which were otherwise found on non-hunting land, belong to the user of the nearest hunting ground...."*. In the case of especially protected animals, which are also classified as game animals according to the Game Management Act (and therefore also in the case of the Eurasian Beaver), the legally stipulated prohibition of possession according to Section 50, paragraph 1 of ACt No. 114/1992 Sb. applying also to deceased individuals and their parts according to Section 48, paragraph 4 of this Act, applies. The decision on permission of an exception according to Section 56 of Act No. 114/1992 Sb., which may permit possession by a specific person, is decisive. Information about found deceased individuals is however essential with regard to the other provisions of the Game Management Act (particularly in relation to the provisions of Section 36 and 37 on planning game management) and must be provided to the user of the hunting ground, particularly planned targeted searching for and collection of deceased individuals should be discussed in advance with the user of the hunting ground.

Act No. 254/2001 Sb. on water

With regard to the fact that the beaver is a semiaquatic animal, the activities of which are capable of affecting some hydrogeological parameters of smaller watercourses (positively and negatively) and particularly damaging hydroelectric structures, etc. water management infrastructure structures as a result of denning or raising water levels (see chapter No. 1.4 for more information), it is also necessary to point out selected provisions of Act No. 254/2001 Sb., on water and on amendments to some Acts (Water Act), as amended, in more detail.

Due to its links to the aquatic environment, the beaver must be considered a part of aquatic ecosystems and ecosystems linked to the aquatic environment, protection of which is one of the purposes of the Water Act (see Section 1, paragraph 1) and one of the functions of watercourses. According to Section 2, letter e/ of Decree No. 178/2012 Sb. watercourses also fulfil an ecological function assuring creation of conditions for aquatic ecosystems and ecosystems linked to the aquatic environment. Fulfilment of the aforementioned purpose of the Water Act, which is based on Directive 2000/60/EC by the European Parliament and Council, which stipulates the framework for Community activities in the field of water policy (so-called EU Water Framework Directive), is subsequently assured to varying degrees within the terms of the individual provisions of the Act. From the aspect of management of watercourses, this approach is also projected into the current wording of the Water Act, directly into the provisions of Section 47, paragraph 5 (*"administration of watercourses....must be carried out in such a way that negative impact on aquatic ecosystems and ecosystems linked to the aquatic environment is as small as possible, and with regard to achievement of good water conditions")* and in general to some expansion of active care of the channel of watercourses (according to Section 47, paragraph 2, letter b/ of the Water Act, care of channel of watercourses and maintenance of riparian growth on the land on the banks of these, should only be assured in the scope of *"not creating an obstacle preventing uninhibited drainage of water during floods").* The provisions of Section 46, paragraph 1 of the Water Act then generally prohibit changes to the direction, longitudinal slope and crosswise profile of the channel of a watercourse, i.e. prohibits in general any intervention in the channel – however this naturally does not apply to the influence of *"natural factors"*, including the beaver, which is directly emphasised within the terms of definition of the natural channel of a watercourse in Section 44 of the Water Act – *"The natural channel of a watercourse is the channel or its part that originated as a result of the natural effects of flowing surface water and other natural factors or implementation of measures to remedy interference caused by human activities and which could change its direction, longitudinal slope or crosswise profile"* (see KRÁTKÝ & NIETSCHEOVÁ, 2010 for more information). Changes caused by beaver activities (changes to the cross-wise profile as a result of denning for example, the longitudinal slope as a result of dam construction, possibly changes to direction caused by both factors simultaneously) can therefore clearly be considered the influences of *"another natural factor"*. Such situations should be respected during management of natural channels of watercourses in relation to Section 46 of the Water Act. As derived by KOŽENÝ *et al*. (2011), removal of wood materials, which are in contact with the banks and channel of the watercourse (e.g. including beaver dams or lodges) would be interference in the natural channel of a watercourse and therefore in conflict with the aforementioned provisions. Work related to execution of duties stipulated by the Water Act, which particularly includes restriction of the risks related to flood streamflow and removal of flood damages in these cases (flood damages cannot occur to the natural stream-bed due to the definition of a natural stream-bed, but the surrounding land or structures may suffer damages), is the only exception. The requirement of maintaining unrestricted drainage is important in areas where a rising water level caused by riparian growth or the presence of wood (beaver damns, etc.) in the channel causes damages. In other localities slowing of drainage and retention of water is a welcome function of the watercourse. The most frequent risk caused by loose wood floating on the surface (if this comes loose from beaver dams or wood felled by beavers) during floods, is accumulation at the flow-through profiles of bridges, weirs or outlet structures in water reservoirs. The priority at sites of structures, at which such problems may occur, is assurance of the function and stability of such structures. This may also be achieved by using suitable technical measures, not necessarily removal of beaver dams, which have a positive impact from the aspect of function and ecological status of watercourses. In some cases, changes to the characteristics of a watercourse caused by beavers may be, in spite of the above, evaluated as *"serious defects caused by natural causes"*, which the administrator of a watercourse is required to report to the relevant water management authority according to Section 47, paragraph 2 letter f/ of the Water Act. In relation to the definition specified in Section 2, letter d/ of Decree No. 178/2012 Sb. such serious defects are only considered to be cases representing *"the risk to human lives and health and origin of damages to property, particularly in adjunct developed areas"*. The effects of the presence of beaver dams or other .

changes to the channel of a watercourse caused by beavers, should therefore be thoroughly evaluated from the aspect of the probability of origin of the aforementioned risk and only classified as a potential defect on the basis of this evaluation.

The situation is different in the case of water management structures – water management structures, including modified channels of watercourses, must primarily fulfil the function for which these structures were constructed. According to Section 47, paragraph 2, letter c/ of the Water Act, the manager of a watercourse is required to maintain a water management structure or other structures on the water way in a proper condition, essential for assuring the function of the watercourse (however, this may also include ecological functions). The owner of a water management structure (according to Section 59) is generally required to maintain a water management structure in proper condition so that there is no risk to the safety of people, property and other protected interests. It is in the case of water management structures that conflict may most frequently occur between the requirements for assuring their safety and function and the consequences of beaver activities (damage to dams by denning, damage or damning of outlet, etc. structures, etc.). The priority here is (in most cases) to assure the safety of water management structures and fulfilment of their function, either by accepting suitable technical measures or removal of the impact of beaver activities. In cases when such measures cannot be carried out without interference in the key conditions for conservation of the beaver as an especially protected species, the prior permission of an exception according to Section 56 of Act No. 114/1992 Sb. is essential. The water management authority is the affected body in such proceedings and should issue a statement chiefly concerning how serious the damages are (or the degree of risk of occurrence of such damages) to the water management structure – see below. However, in places where the water management structure is defunct (particularly in cases of lengthwise technical modifications of water courses, their dredging, etc.), natural re-naturalisation of a watercourse as a result of beaver activities may be a suitable and cost-effective alternative to revitalisation (renewal of the natural channel of a watercourse). In these cases it is appropriate, and in compliance with the goals of the Water Act and EU Framework Water Directive to cease renewal of the function of a water management structure and utilise the opportunity to eliminate the water management structure, as presumed by Section 15 of the Water Act.

Specific regulations concerning water management structures, specifically embankments used to protect against floods, rising water levels or accumulation of water, concern the duty of removing naturally seeding woody plants. According to Section 59, paragraph 1, letter j/ of the Water Act, protection according to Act No. 114/1992 Sb. does not apply to this duty, with the exception of protection of memorial trees, especially protected species of plant, especially protected animals (i.e. including the beaver) and wild bird species. In the event of very extensive felling of these woody plants, this may result in significant restriction of food sources for the beaver and also interference in the key conditions for its protection within the meaning of Section 50, paragraph 2 of Act No. 114/1992 Sb. and this situation must then be dealt with within the terms of a proceeding for an exception (where the risk of origin of damages and the interest of protection of specific individuals within the dam area, will be considered).

Special regulations also apply to the procedure when removing flood damages, which must be dealt with immediately. In the case of these activities, protection according to special regulations, i.e. Act No. 114/1992 Sb. is absolutely precluded according to Section 83, letter m/ of the Water Act. Evaluation of the extent of damages and therefore also the need for their removal, is the subject of an inspection of the watercourse with the participation of the administrators of the watercourse, water management authorities and nature conservation bodies and a record is always made of the results of these inspections. The record of inspections of flood damages and their subsequent removal performed outside the process regime of special legal regulations, should only apply to such damages, that brook no "*delay*" from the aspect of the acute risk they pose to lives, health or property, which would require execution of an administrative proceeding according to the special legal regulations, and which simultaneously do not consist (in compliance with Section 65, paragraph 5 of the Water Act) of construction, maintenance and repairs to structures and other equipment.

Another point of contact between conservation of the Eurasian Beaver and the Water Act is planning in the field of water. Localities of European significance with subjects of protection, which are linked to an aquatic environment (i.e. including SAC in which the subject of protection is the beaver) are included in the register of protected areas according to Section 22, paragraph 5 of the Water Act. Plans by catchment areas may also include measures for these areas and it is also possible to identify the risk related to the presence and activities of the beaver (risk to water management structures, etc.) in other areas in individual water systems and propose the necessary measures.

From the process aspect it is particularly necessary to point out the provisions of Section 104, paragraph 9 of the Water Act, according to which a decision may be issued or another administrative action may be taken in proceedings according to selected special regulations (including Act No. 114/1992 Sb.), in which the interests protected by the Water Act may only be affected on the basis of a binding statement by the water management body. In the case of the beaver this will also concern the aforementioned, more frequent, proceedings related to dealing with various conflict situations and the water management body should issue a statement here, as the affected body, regarding how serious the damages to "water management" (i.e. to water management structures, the scale of impact on the flood risk, etc.) are. However, the provisions of Section 90, paragraph 15 of Act No. 114/1992 Sb. also apply, according to which the nature conservation bodies are the affected bodies in proceedings according to other legal regulations, in which the interests protected by the Nature and Landscape Conservation Act may be affected. The water management body should therefore notify the relevant nature conservation body, which is the regional authority with local jurisdiction or other body with the corresponding competence in the case of special species protection (the administration of the protected landscape area or nature park, the Military Training Authority, the Ministry of the Environment) in all proceedings that may affect the beaver and its biotope.

Red list

The Eurasian Beaver is classified as a vulnerable species in the Red List of endangered vertebrates of the Czech Republic (ANDĚRA & ČERVENÝ, 2003).

1.6.3 Conservation status in other countries with recent incidence of the species

The Eurasian Beaver is present in abundant numbers in countries neighbouring the Czech Republic. With regard to the membership of neighbouring countries in the EC and the validity of Directive 92/43/EEC, protection of their habitat is on a similar level to our legislation. The beaver is classified as an especially protected species in compliance with its classification in Annex IV of the aforementioned Directive (with the exception of Poland) and selected areas where this species occurs are also legislatively protected with regard to its classification in Annex II of Council directive 92/43/EEC. In general the beaver and its biotope are the subject of conservation in the countries given below and occurring conflicts are the subject of increased attention.

Slovakia
Nature and Landscape Conservation Act No. 543/2002 Z. z. and its implementary decree 24/2003 Z. z. classifies the Eurasian Beaver in Annex IV part B of the Decree, i.e. it gives it in the "List of species of European significance, species of national significance, species of bird and priority species, for whose conservation protected areas are declared." The Eurasian Beaver is also listed in Annex No. 6 to the Decree in part A among species of European significance (VALACHOVIČ & GÍMEŠ, 2003). Within the terms of the implementary decree the social value of the species is determined in the value **€** 995,81 per individual.

Poland

The beaver is protected by implementary decree (Dzienik Ustaw 2001 – 130/1456) of the Nature Conservation Act (Legal Gazette 2001–99/1079). On the contrary to the Czech Republic and other neighbouring countries, this species is removed from Annex IV of Directive 92/43/EEC and classified in Annex V to this Directive (the same as in other Baltic or Scandinavian states with large Eurasian Beaver populations). The beaver is therefore classified as a species of animal of Community interest, disappearance of which from the wild and use of which may be the subject of specific measures for its management (i.e. including hunting). Poland is therefore only bound to protect selected areas where the Eurasian Beaver occurs within the terms of the Natura 2000 System and to maintain beneficial numbers of the species in general, from the aspect of EC regulations (GLOWACINSKI pers. comm. 2004).

Germany

According to the Federal Nature Conservation Act (BNatSchneurG/2002) the Eurasian Beaver is strictly protected, including its biotope. Killing, hunting, trapping and interference in its life cycle are all specifically prohibited. Nature conservation bodies (on a national level) may grant permits to remove problematic beaver structures and trap and move problematic individuals. In problematic situations a permit to shoot individuals may also be issued, but only under the condition that there is nowhere to move trapped animals or individuals cannot be trapped. Cadavers may be subsequently used for scientific purposes (SCHWAB pers. comm. 2004). Individual federal countries with greater numbers of beavers have gradually adopted, or are executing, management plans similar to this document.

Austria

In Austria the Eurasian Beaver is protected by federal law in all nine federal states, in spite of the fact that there is strong pressure here to reduce its conservation status. In some federal state (Salzburg, Carinthia and others) the beaver is actually listed in game management acts as a game animal, but no hunting season has been specified for it as yet. With regard to the validity of Directive 92/43/EEC, changes to the legislative protection of the species cannot be assumed without amendments on the level of the EC.

1.7 Existing measures for conservation of the species

In the middle of the 20th century the Eurasian Beaver was still at risk of extermination. During the second half of this century the species was successfully reintroduced to a large part of its original European habitat. The species can currently be considered stable and gradually also a standard element of European fauna.

This great success has two causes: a European-wide wave of reintroduction and extensive species and biotope protection.

1.7.1 Non-specific protection

One of the key methods of indirect protection of the beaver is maintenance of the sufficient quality of the environment and subsequent conservation of existing or potential biotopes. Sites in areas with the best-preserved ecosystems are usually selected for releasing the initial population when planning reintroduction or transfer.

The second group of non-specific protection measures mainly consists of technical measures, which enable resolution of arising conflict between the requirements of beavers and the needs of other users of the landscape.

Non-specific protection of the species in other countries

Existing protected areas are used during reintroduction programmes in surrounding countries or new areas are established for future protection of the beaver. For example, the Steckby – Lödderitzer Forst reservation was established in the middle of the 20th century for protection of a residual population of *C. f. albicus* in former East Germany, this subsequently became part of an UNESCO site. The quality of the biotope was also taken into consideration in Austria during realisation of the beaver reintroduction programme and the first individuals were released in the Donau-Auen National Park (SIEBER, 1999). Hungary also took a similar approach, when several groups of beaver were released into the Duna –Dráva NP, Ferto – Hanság Np and Hortobágy NP (BOZSÉR, 2001) national parks. Protection of beavers is also indirectly assured by the Ramsar Convention, which is intended to generally promote protection of wetland ecosystems with especial emphasis on waterfowl, but one consequence of this international convention is also that it protects and improves the environment of many populations of Eurasian Beaver within the territories of the signatories of this Convention.

A second and fairly large group of measures for indirect protection of the species is the aforementioned group of technical solutions to problematic situations. It generally applies that the more the landscape is used by humans, the greater the number of conflicts between its users and beavers. This is why passive methods for resolving conflicts with the interests and requirements of subjects active in the landscape are used frequently in the USA, Poland and Bavaria. Various solutions to protection of sluice gates below roads, drainage of beaver dams, repellent and mechanical protection of threatened woody plants, electric fences, etc. are applied in particular. Measures that end with local elimination of beaver dams and lodges are also used. Problematic individuals are only shot after all the aforementioned measures have failed and do not lead to the desired effect in the specific case.

Table 1: Summary of Special Areas of Conservation (SAC) in which the Eurasian Beaver is the subject of protection, together with currently valid proposal of categories for declaration of SPA

SAC name	Number	Area (ha)	Region	SPA category
Kateřin and Niva stream	CZ0323151	980.2	Pilsen	PLA, NP
Elbe valley	CZ0424111	1,372.4	Ústí	PLA, NP
Strážnická Morava	CZ0624068	658.6	South Moravian	PR, NP
Dyje flood plain	CZ0624099	3,249.0	South Moravian	PLA, NNR, NNP, NP
Confluence–Podluží	CZ0624119	9,718.2	South Moravian	PLA, NNR, PR
Litovelské Pomoraví	CZ0714073	9,725.6	Olomouc	PLA, NP
Chropyňský flood plain	CZ0714085	3,205.3	Olomouc	NNR, NNP, NP

Non-specific protection of the species in the Czech Republic

Ecosystem protection with regard to the requirements of the European Beaver was applied during the fist half of the nineteen nineties. At that time one of the reasons for declaring the Litovelské Pomoraví protected landscape area was the suitability of the biotope for the commencing reintroduction of the beaver. The fact that the area is an extensive complex of riparian forest surrounding a medium large water source, which provides beavers with very varied food sources, played a very important role in its declaration (BEDNÁŘ *et al*., 1989). Use of the status of declaration of a SPA for protection and undisturbed development of the population of a species played a similar role in declaration of the Nebočadský luh Nature Monument on the Elbe, not far from Děčín (established in 1994). The biotope here is also a riparian forest, but incomparably smaller than the previous area.

Of the existing technical measures to prevent conflict between beaver activities and human interest, only some have been used in the Czech Republic to date. The most frequently used measures for protection of endangered woody plants against gnawing is wire fencing. On the basis of a decision by nature conservation bodies dams have been drained in some places in the Czech republic (the goal was to preserve conditions for settlement of the locality by beavers, but also satisfy the requirements of subjects affected by the beavers' activities at least partially). Other technical measures used consisted of application of plastic sheeting barriers or animal repellents based on the faeces of large predators (bears, tigers, wolves, lions, etc.) however according to existing unpublished results these measures were not successful.

In order to assure protection of the Eurasian Beaver Special Areas of Conservation were declared in 2005 by Government Regulation No. 132/2005 Sb. within the terms of the Natura 2000 System (see table 1). In general a regime of so-called basic protection is sufficient for these localities. However, a large part of the SAC in which the beaver is the subject of protection, were designated within the terms of existing SPA and additional SAC are proposed for protection in this manner with regard to other subjects of protection. Table 1 gives an overall summary of Special Areas of Conservation, in which the beaver is the subject of protection and more information can also be found on the Nature Conservation Agency of the Czech Republic website devoted to the Natura 2000 issue.

1.7.2 Specific protection

Activities targeted particularly at direct and active support of development of the population of a specific species are generally considered to be specific species protection. In this case the Eurasian Beaver. This usually concerns measures for protection and support, or revival of a species and its populations by means of specific activities focusing on individuals and their environment. Realisation of specific measures in other countries, which are responsible for development of the population of the species in the Czech Republic to a specific degree, are briefly mentioned in the introduction.

The following chapter (devoted to measures in the Czech Republic) gives realised activities in support of the species and also evaluates the effectiveness of specific administrative and legislative tools accepted for support and protection of the Eurasian Beaver population in the Czech Republic. Current activities in the field of work with the public are also briefly summarised. And targeted support of the species also includes primary or applied research of the species in our conditions, which is why a brief summary of the achieved scientific results, which have been reached in the Czech Republic to date, is also given here.

Measures for protection of the species realised in other countries

With regard to the practically total extermination of the Eurasian Beaver within the terms of West and Central Europe, reintroduction programmes have taken place in most European countries (see Annex 2). These events contributed significantly to the revival of the Eurasian Beaver that has occurred over the last approx. 50 years.

Transfer to a new locality is a method also used by countries that had surviving beaver populations or populations that were developed in the first half of the 20th century (Russia, Norway, Sweden, Germany, Poland, France). Additional populations were primarily established so that a continuous and the biggest possible settlement in the former habitat was achieved (in a number of cases in order to expand distribution of a game species). The primary source of on-going reintroduction projects over several decades were surviving refugia of beavers (*C. f. fiber, C. f. albicus, C. f. galliae, C. f. vistulanus*). Other countries frequently used individuals from the abovementioned successfully developing populations or from prospering newly established individual populations for introduction of the beaver. This form of active support of establishment and further development of the Eurasian Beaver population was realised in a great number of European countries (HALLEY & ROSELL, 2002). Compared to the situation at the beginning of the 20th century, when there were only 1,200 individuals in Europe in several isolated residual populations, the total number of the *Castor fiber* species in Europe is estimated today to be 1 million ex. (HALLEY *et al*., 2012). It can therefore be stated that actual execution of reintroduction, in combination with strict protection of the beaver and its habitat, leads to successful revival of the species in its original habitat.

Specific protection of the Eurasian Beaver was realised on an international level also by including the species as a subject of protection in several international documents (see chapter 1.6. Conservation Status).

Species conservation measures implemented in the Czech Republic

Legislative protection of the species was not dealt with before implementary decree No. 395/1992 Sb. to Nature Conservation Act No. 114/1992 Sb. came into force, because until that time the Eurasian Beaver practically did not occur in the Czech Republic. In spite of sporadic records from the nineteen eighties, the species was registered in the Red Book of the Czech Republic (BARUŠ, 1989) as an extinct species.

State nature conservation bodies only acknowledged the existence of the beaver in the Czech Republic on the basis of the aforementioned Decree and classified it in the strictest protection category at the time, the critically endangered species category, effective from 13 August 1992 (Decree No. 395/1992 Sb.). On the basis of Decree No. 175/2006 Sb. which amends Decree No. 395, the beaver was then transferred to the endangered species category among species needing strict protection according to Directive 92/43/EEC – see chapter 1.6.1.).

Reintroduction

In addition to legislative protection, efforts were also made during the second half of the 20th century to actively reintroduce beavers to our territory. The first attempts to renew their existence in the Czech Republic

took place at the turn of the nineteen fifties and sixties. In 1956 a reservation called SPR Stará řeka was established at "Stará řeka" by Třeboň, the purpose of which was protection of a potential biotope for the Eurasian Beaver. However, individuals brought in from former East Germany were probably not of satisfactory origin, and so were not released but placed in Ohrada Zoo by Hluboká nad Vltavou, where they spent the rest of their lives (ŠAFÁŘ, 2002).

Another project for active support of the species in the Czech Republic was the attempt to reintroduce the beaver to Central Moravia at the turn of the nineteen eighties and nineties. At that time the presence of the first individuals of this species was registered in the former Czechoslovak Federal Republic (Záhorie in Slovakia, confluence of the Morava and Dyje Rivers, etc.). The team of Otakar Štěrba from Palacky University in Olomouc consequently began considering revival of the beaver population in the area of Litovelské Pomoraví. The main reason for reintroduction was to revive a formerly extinct species. Furthermore, there was the expectation that the Eurasian Beaver would have a strong revitalising effect on the landscape. It was expected that the beaver would construct dams to significantly change the surrounding environment and help increase the biodiversity of river ecosystems in natural systems. An evaluation was performed before actual reintroduction to find whether it would be was appropriate to reintroduce this species. An analysis of causes of endangerment, which gave the main threats behind the historic disappearance of the species in the Czech and Moravian lands, was also available. At the time the programme was realised the biological requirements of the species were only known from foreign literature. Although the food sources in the area selected for the reintroduction programme were evaluated in great detail, the appropriate care was not taken with preparation and realisation of the project itself, particularly in the field of work with the public and legislative preparation (VOREL & KOSTKAN, 2005). The authors stated that 19 animals (22 without 3 demonstrably deceased individuals) were introduced in the Litovelské Pomoraví area in 1991, 1992 and 1996. According to current results, the existing population in Central Moravia has expanded very quickly. It was estimated that the population in this area numbered 300 individuals in 2004 (JOHN, 2004a).

The second source of the beaver population in he Czech Republic was spontaneous dispersal of individuals from surrounding countries. During the nineteen eighties the Eurasian Beaver was introduced in a number of sites in Bavaria, Poland and Austria (KOSTKAN, 1992). An extensive programme for research and support of the beaver on the Elbe River was carried out in former East Germany. Which is also why the introduced and strictly protected autochthonous population in Central Europe began to grow slowly and subsequently expand, including natural dispersal into our territory. As a result beavers began to spread spontaneously across our borders at the end of the nineteen sixties, seventies and eighties.

Evaluation of the effectiveness of economic instruments (Act No. 115/2000 Sb.)

Act No. 115/2000 Sb. on compensation of damages caused by selected especially protected animals was adopted as a tool to increase the effectiveness of protection of selected conflict species in 2000. On the basis of a decade of experience it can be stated that the goal of the Act has only been fulfilled partially – for example in the case of large predators the extent of endangerment as a result of illegal hunting evidently did not fall at all, however, the option of compensation of damages did increase acceptance of these animals by agricultural subjects. In the case of fish-eating predators methodological and systematic deficiencies appeared (the impossibility of feasibly demonstrating the incurred damages).

Compensation of damages caused by the Eurasian Beaver can be considered relatively functional from this aspect only in the scope of situations that Act No. 115/2000 Sb. enables solution of (damages to forest and permanent cultures or field crops). Many deficiencies have become apparent in this Act throughout its validity. The total value of compensation paid out or its value in the South Moravian Region, where 97% of all funds are paid out, is for example significantly influenced by claims made by the state organisation Lesy ČR, s.p. in the Soutok forest area and claims by the National Heritage Foundation in the Lednice Chateau Park. Damages incurred

Table 2: Claims for compensation of damages caused by the Eurasian Beaver (*Castor fiber*) by region and individual year according to the provisions of Act No. 115/2000 Sb. (data from the Ministry of Finance and the Nature Conservation Agency of the Czech Republic as of XII/2010)

year	South-Moravia	Olomouc	Zlín	Pilsen	Pardubice	claims	total CZK*
2001	-	9 345	-	-	-		9 345
2004	2 309 978	25 133	93 732	-	-	10	2 428 843
2005	4 169 518	-	-	17 230	-	11	4 186 748
2006	6 865 475	-	-	-	-	8	6 865 475
2007	5 065 511	27 914	-	10 658	-	14	5 104 083
2008	6 520 538	151 567	-	-	-	19	6 672 105
2009	4 389 874	128 252	3 000	-	1 315	14	4 522 441
2010	7 404 037	302 464	-	-	169 409	22	7 875 910
total * CZK	36 724 931	644 675	96 732	27 888	170 724	98	37 664 950

* financial scope of the claimed and required compensation of damages at the time of their payment to the applicant's account

to pond or flood embankments cannot be covered at all on the basis of Act No. 115/2000 Sb., similarly to a range of other types of damages which are not related to farming and forestry management. This situation may lead to a situation when the affected subjects start to deal with the problems by persecuting the beaver (this very probably happens already). Even in the aforementioned areas covered by this Act, the entire burden borne by the affected subjects is not dealt with (for example these subjects are still required to pay property tax, even though it was not possible to use such land agriculturally). In the case of the socially most serious damages to flood embankments, the catchment administrators are the affected subjects. In these cases, similarly to the case of the above-mentioned state organisations, it would be expedient to handle problems by targeted increase of the budget funds for the organisation or the option of writing off losses. This approach is also indicated by current court practice (see ruling by the Municipal Court in Prague 21Co84/2011-64 in relation to a similar procedure according to Section 58 of Act No. 114/1992 Sb.).

The number and volume of claims is growing proportionally to the rise in beaver population numbers and the growing extent of damages. Table 2 gives their numbers and the value of compensation paid out in individual regions between 2000 and 2010 in relation to the European Beaver's activities (the data is not complete, Act No. 115/2000 Sb. does not establish a central register of claims). However, it must again be stated that most funds were drawn by the two aforementioned state organisations (Lesy ČR – LZ Židlochovice and the National Heritage Foundation – SZ Lednice) within the terms of the South Moravian Region.

As well as Act No. 115/2000 Sb., Section 58 of Act No. 114/1992 Sb. allows claims for compensation of damages due to complication of agricultural or forestry management. The procedure according to this legal standard cannot be applied in cases when this concerns damages caused by the activities of an especially protected animal (such damages are covered according to Act No. 115/2000 Sb. in the scope permitted by this act), according to current interpretation of the act. Compensation of damages by procedure according to Section 58 of Act No. 114/1992 Sb. can be claimed only if the owner or tenant of land is restricted in its forestry or agricultural management by respecting the provisions of the law (prohibitions in Section 50 of Act No. 114/1992 Sb.) or the implementary legal regulation or a decision issued on their basis. In the case of the Eurasian Beaver this may concern cases for example when an agricultural subject respects protection of a settlement (dens, lodge), including dams, and does not intervene against them and as a result of this it is restricted in its agricultural activities (this enables compensation of damages incurred as a result of restriction of agricultural activities as a result of long-term flooding of land). But not even according to this provision is it possible to reimburse subjects for damages arising from beaver activities to ponds or flood embankments.

In the future compensation of damages should be retained as one of the tools contributing to reduction of pressure on extermination of the beaver. It is therefore important to focus our attention on optimising this tool so that the image of the beaver as a clear pest is not promoted. It will be necessary to methodologically modify procedures and existing legal standards or the issue of compensation of damages will have to be dealt with potentially within the terms of new legal modifications.

Prevention and minimisation of damages

The Eurasian Beaver is an extraordinarily active animal with extraordinary impact on ecosystems, including cultures, water management and other structures (especially roads and railways) established and maintained by humans. Precise records of conflict and damages to date (apart from those covered according to Act No. 115/1992 Sb. or dealt with within the terms of administrative proceedings according to Section 56 of Act No. 114/1992 Sb.) caused by the Eurasian Beaver are not available.

The most serious damages generally include the aforementioned damages to water management and other structures. These are either directly damaged (denning in the body of structures), and also by structures becoming water-logged as a result of creation of beaver dams on adjoining land. Flooding of sources of potable water (bores and wells) and disruption of the function of wastewater treatment plants as a result of the water level rising above beaver dams has also been registered. Flooding of land in the past frequently resulted in restriction or elimination of the possibility of its agricultural use and destruction of production (death of economically viable woody plants, agricultural crops, etc.). From the aspect of frequency, the most frequent damages are the beaver's food activities, i.e. gnawing on woody plants (not only in forests but also fruit trees in gardens, etc.) and consumption of agricultural crops. Table 3 gives some examples of specific issues.

From 2007 funding of measures for prevention and minimisation of damages caused by critically and very endangered animals is enabled within the terms of the Environmental Operations Programme (hereinafter the EOP, which could be used to resolve a number of the situations described above. Unfortunately, probably as a result of low awareness and high administrative demands, use of these funds is minimal (in the second half of the programme period). Only the Povodí Moravy, s.p. project for renewal of the flood embankment damaged by beaver dens by Břeclav (total costs CZK 10.6 million, funding from the the EOP CZK 7.5 million; another project is also approved in the same area of a total value of CZK 92.1 million) and the project by the National Heritage Foundation for assurance of protection of SZ Lednice Chateau Park (construction of functional fencing and other protective elements of a total value of CZK 31.7 million, funding from the EOP CZK 26.1 million) have been realised using EOP funds.

With regard to the fact that minimisation and particularly prevention of damages is always more effective than their repeated coverage, more attention should be given to promotion of this option utilising the EOP, the continuity of the programme should be assured in the subsequent period and a less administratively demanding source of funds for resolving minor issues should potentially be added.

Overall, from the aspect of the financial demands for remedying or preventing damages, it can be summarised that the beaver's activities have officially caused (reported and claimed) damages in the scope of millions to tens of millions of Crowns per year, to date (particularly to water management structures and other structures, agricultural and forestry production growth, etc.). The extent of real damages will certainly be higher, but cannot be calculated or estimated at present.

The existing economic tools enable part of these damages to be compensated (damages to agricultural crops and other cultures) and an offer of funding for measures for preventing and minimising damages also exits. However, these tools are not capable of covering the entire extent

Table 3: **Examples of conflict situations caused by the beaver (apart from cases dealt with according to Act No. 115/2000 Sb.)**

Locality	Time of conflict	Character of the conflict	Estimate of scope of damages	Measures, solutions	Success of the measure
Tovačovské ponds	from 2001	dens in pond dams	CZK 30,000/year	pond owner fills in dens	Need for repetition
Hosťka	2002	flooding of the foot of a road element	CZK 300,000	repairs to and aeration of the embankment	successful for the time being
Lobodice	2002	damage to the flood embankment	approx.. CZK 1 million	renovation of the embankment, addition of plastic sheeting	damaged by erosion (plastic sheeting not appropriate)
"Písečný dolní" pond	2005	dens in the dam	CZK 550,000	repairs by the pond owner	successful for the time being
Nadsádky pond	2005	dens in the pond dams, felling of trees	CZK 220,000	repairs by the pond owner	successful for the time being

of the arising problem from the aspect of their focus (a number of types of damages are not compensated, funding of realisation of measures is administratively demanding and minor low-cost measures are not therefore covered, etc.) and also the total scope of damages, which is rising along proportionally with the growing Eurasian Beaver population.

The situation will have to be dealt with complexly by optimisation of existing economic tools and assurance of a more flexible approach to dealing with damages (including elimination of settlements in the highest-risk localities), within the terms of the Management Plan. The goals of the Management Plan will consequently not focus on increasing the burden on society from the growing beaver population, but on the contrary, these will concern regulation of development of the population and development of effective tools to make cohabitation between humans and beavers in the landscape of the Czech Republic sustainable in the long-term.

Work with the public

No complex targeted education or promotion of the species has taken place here since the beginning of the nineteen nineties. The only more or less comprehensive publications, which endeavoured to focus on the beaver, were works by ZAJÍČEK & VLAŠÍN (1992) and PÁLENÍK (2000). Both come from non-government organisations. The latter originated as part of a campaign by the NGO Přátele Přírody (Ústí nad Labem). This has focused its activities on the issue of the Eurasian Beaver since approximately 2000, but it is primarily interested in the population on the "lower" Elbe.

More or less professionally competent articles have been published in magazines on biological topics very sporadically and unsystematically (for example: Vesmír (Universe), Živa (Live), Ochrana přírody (Nature Conservation)) or in periodicals partially devoted to nature – Myslivost (Game Management), Svět myslivosti (The World of Game Management), Rybářství (Angling), Lesnická práce (Forestry Work), etc. (JOHN, 2004b).

The issue of the Eurasian Beaver has only appeared in ordinary nationwide and regional dailies the moment a conflict has occurred, regardless of whether the beavers caused the conflict by their activities (for example the Chateau Park in Lednice) or whether they were involved in the conflict innocently (for example the plan to construct weirs on the Elbe River).

Protected Landscape Area administrations and regional Nature Conservation Agency of the Czech Republic centres also carry out their own activities in the field of promotion of beaver conservation where this species exists in high numbers. For example an educational trail was established in the Bohemian Forest protected landscape area at the Kolmu nature monument and

a travelling exhibition called “Focus on the Beaver” devoted to the phenomenon of this species was arranged between 2010 and 2011. Field trips are regularly organised here in relation to work with the public. In 2008 the regional Nature Conservation Agency of the Czech Republic centre in Pilsen issued a popularisation brochure called the Eurasian Beaver in the Pilsen Region, which discusses the biology, distribution, conservation and other aspects of this species. The Litovelské Pomoraví protected landscape area administration also occasionally carries out activities in relation to the issues of the Eurasian Beaver.

Work with the public on such a problematic species as the beaver is absolutely fundamental in the Management Plan. In this aspect the Czech Republic still lacks a comprehensive publication or other form of information focusing directly on cohabitation with the beaver, on prevention and resolution of damages and other conflict situations.

Summary of research of the Eurasian Beaver in the Czech Republic to date

Since the beginning of the nineteen nineties research of this species has focused on two topics. The first of these was monitoring and evaluation of colonisation of our territory by this species. There is a very detailed summary available of all localities settled to date by the beaver and in which the beaver has gradually established itself. The second main direction of the research at that time was studies of the food relationship of the species, particularly from the aspect of the composition of its food throughout the entire year. This is why there is a large quantity of food analyses available today, which provide a very detailed overview of the food requirements of the species during the vegetative (particularly the herbaceous spectrum of plants) and non-vegetative (particularly the woody component) season.

Regular methodologically unified monitoring of some of our populations (in the Bohemian forest, Litovelské Pomoraví and on the Elbe) has taken place from the middle of the nineteen nineties. Monitoring has also been carried out in other Moravian areas since 20404 (Soutok, Lednicko-Valticky Complex and Chropyňský luh). There are also development series of settlement of all these regions available to date. The registered development of the population in Bohemia includes the progress of colonisation from the first settlement to the present.

At the same time intensive research focusing on the species’ population ecological relations in our conditions began in 2004; key etiological and ecological factors of the species were monitored: territoriality, social and age structure within territories, numbers in soc. units, food and habitat requirements and the impact of civilizational aspects on distribution of settlements. Crucial telemetric monitoring of individuals in various biotopes also took place so that the beaver’s most detailed etiological-ecological requirements on the environment were collected. A monitoring system enabling extensive mapping of the population using non-destructive methods was also developed and calibrated. A predictive model of the speed of dispersal of the species in our conditions was also created, and historic data about colonisation of the Czech Republic by beavers was used for this. The toxicological burden in some biotopes or the spectrum of parasitic infections in our beavers is also monitored. Key populations were also subjected to molecular-genetic analyses, and there is now a summary of the origins of our beavers, the level of genetic isolation of some populations and the genetic structure of the main areas of settlement available.

2 Management Plan goals

The goal of the Management Plan is to ensure a permanent viable population of the Eurasian Beaver in the Czech Republic in the Danube, Elbe and Odra catchment areas. Furthermore to ensure the existence of populations in lowland and submontane type biotopes, including creation of conditions for natural communication between individual populations and the essential exchange of the gene pool between these. A key aspect is also assurance of the social-economic sustainability of the presence of the Eurasian Beaver in the Czech Republic, particularly from the aspect of its impact on economic interests in the landscape.

The time line of effect of the Management Plan is 10-15 years, but individual measures will be examined and evaluated during its progress and if these measures are not sufficiently effective, they will be reviewed.

The executed rescue programme – Management Plan has the following goals:

- **ensure the viability of the Eurasian Beaver population* in all three key catchment areas, while maintaining the social-economic sustainability of its presence;**
- **maintain the at least the current numbers of the species and condition of the environment in *zones A* (see the following chapter for definition of all three zones);**
- **enable natural interconnection of Eurasian Beaver populations (with the exception of *zone C)* in the Czech Republic;**
- **restrict permanent settlement of *zone C* by the Eurasian Beaver;**
- **configure condition's and tools for minimising damages and resolving conflict situations caused by beavers.**

These goals should be achieved by means of **differentiation of protection of the Eurasian Beaver in the Czech Republic** and by means of the following key groups of measures:

- assurance of administrative and legislative tools for better social-economic sustainability of the presence of the Eurasian Beaver and prevention of damages;
- assurance of the public's awareness, particularly the awareness of economic subjects affected by the beaver's activities in the landscape;
- creation of conditions for elimination of permanent settlements in *zone C;*
- elimination of potential presence of the North American Beaver throughout the Czech Republic;
- monitoring development and dispersal of the population in the Czech Republic, applied research.

Proposal of medium-term goals, differentiation of protection and individual measures is based on valid legal regulations, which are primarily conditional to EU legislation and obligations arising from international conventions (Directive 92/43/EEC, the Bern Convention – see chapter 1.6.1.). In the event of legislative changes on this level, the Management Plan will be updated as necessary. The Ministry of the Environment will also actively support a more flexible approach to protection of this species in the event of changes to EU legislation (or other obligations) and depending on development of the population of the European Beaver and the extent of damages.

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* minimum requirements for the viability of the population:
i. minimum number of individuals in *zones A* (total) will be 2,000 individuals; ii. mutual natural connectivity of populations will be assured.

The principles of differentiation of protection of the European Beaver in the Czech Republic

The Eurasian Beaver finds a significant range of conditions for its existence and expansion of the population in the landscape of Central Europe. The settlement gradient includes warm areas of riparian forest with a high water content and also areas of significance to water management with sufficient riparian growth. The offer of biotopes mostly consists of all categories of watercourses and bodies of water, whereas their suitability for settlement by beavers falls along with rising altitude. Beaver settlements will be sporadic at altitudes of over 800 metres above sea level.

It is already possible to estimate which areas will provide a crucial base for settlement by the species. It is also possible to fairly clearly differentiate areas with a significant potential for origin of damages and conflicts caused by the beaver. On this basis it will be essential to differentiate the scale of interest in protection of the beaver in individual areas. Differentiation of protection does not (and cannot) result in changes to the level of legislative protection of the Eurasian Beaver. However it enables us to weigh the requirements for protection of the species on one hand and economic and social interests on the other hand, by means of a group of recommendations for nature conservation bodies.

Three various areas of differentiated protection of the Eurasian Beaver (hereinafter the *zones*) were proposed on the level of the Czech Republic on the basis of expert materials and analyses.

Different emphasis on protection of individuals and entire populations will be given in these zones, depending on the character of the landscape and biotopes, their importance for preservation of the population in the Czech Republic and depending on the extent of risk of origin of serious damages. As well as the species' biotope requirements, this regional classification is also based on the economically tolerable and socially acceptable requirement for protecting a stable population of the species in the Czech Republic. Nationwide representation of individual zones in the Czech Republic is given in table 4. Existing administrative classification [the borders of regions, municipalities and cadastres for *zone C*) were primarily used for actually defining the borders of the zones on the basis of an expert proposal and other existing borders [the borders of SAC as a basis for definition of some localities in relation to *zone A* in the case of the Elbe catchment area and the Bohemian Forest area, further specification is necessary, which will limit the scope of the area of *zone A* to the essential parameters].

Annex 3 gives a detailed description of the progress of proposal of zones. We give only a brief summary of the procedure of the proposal here:

> The goal of zoning was to differentiate the degree of conservation of the Eurasian Beaver in the context of the entire Czech Republic. A sufficient number and scope of areas, which would provide the beaver with enough space for undisturbed development of parts of the population (potential *zone A*) were initially selected. A crucial aspect in this type of area is the low risk of origin of serious damages and an area that may assure long-term and undisturbed development of several of our populations. A detailed field and GIS survey of 20 potential selected areas helped determine seven resulting parts of *zone A*. The second aspect that was heavily emphasised during preparation of zoning was the consideration of the accumulative effect of risk factors, together with the high carrying capacity of the environment. On the basis of knowledge of the biology of the species and the character of basic landscape components of the Czech Republic, the key parameters that could lead to origin of extensive (extra-regional) damages, if these are combined in one area (on a regional scale) were defined. A GIS analysis of the Czech Republic took place from this aspect, which defined areas with a regionally high potential for origin of damages and simultaneously with high potential for origin of a numerous beaver population: areas with extensive pond systems. These were subsequently merged into one unit (*zone C*). The remainder of the Czech Republic (apart from *zone A and C*) was classified as *zone B*.

Table 4: Area and percentage of zones of differentiated protection of the Eurasian Beaver in the Czech Republic

area	km^2	%
zone A	943.5	1.2 %
zone B	67,500.0	85.5 %
zone C	10,470.5	13.3 %
CR	78,914.7	100.0 %

In relation to differentiation of protection and the approach to management of the Eurasian Beaver population, recommendations for procedure by nature conservation bodies during protection and conservation of this species will be proposed so that the goals of this Management Plan are fulfilled. Detailed definition of the specific borders of all zones will be performed on the basis of the procedure mentioned in Annex No. 3. A map of zones will subsequently be available in electronic form on the website at www.zachranneprogramy.cz operated by the Nature Conservation Agency of the Czech Republic, where rescue programmes accepted according to Section 52, paragraph 1 of Act No. 114/1992 Sb. and Management Plans are published.

Differentiated protection zones

Zone A

The highest degree of protection of the Eurasian Beaver is proposed in *zone A*. This zone includes all Special Areas of Conservation where the beaver is the subject of protection. Its key function is to guarantee the minimum conditions for long-term stable development of the population in the Czech Republic due to its area, hydrological conditions, food sources and migration opportunities. The area of *zone A* has sufficient capacity for assuring the existence of the species in various types of environment within the terms of key catchment areas in the Czech Republic.

Intervention in the beaver population in these zones should always be thoroughly individually evaluated with regard to the need to maintain beneficial numbers of the species. Measures to prevent or minimise damages should be used preferentially, lethal (trapping) or destructive methods (demolishing dams, filling in dens) should only be considered in extraordinary cases.

A more detailed proposal to the approach to protection of the beaver in individual localities will be chiefly dealt with within the terms of the Summary of recommended measures executed according to Section 45c, paragraph 3 of Act No. 114/1992 Sb. for individual SAC, possibly within the terms of the conservation plan for individual SPA.

Zone B

The permanent presence of the beaver, its reproduction and dispersal, while simultaneously applying measures to prevent and minimise beaver damage, is possible in the proposed transitional *zone B* (areas in the Czech Republic outside *zone A and zone C*). The goal is therefore not to enable origin of a blanket settlement, but to create balanced conditions for dealing with serious impact on economic activities, administration, development and utilisation of the landscape and also enable the presence of the species in localities, where serious damages do not occur. *Zone B* will provide such conditions for communication of populations from *zone A*.

In this area, which will cover most the Czech Republic, it must be assumed that a higher number of conflict situations will occur. These will particularly occur within the terms of administration of watercourses and execution of ownership rights and duties to water management structures (for example management of ponds and manipulation of pond levels, maintenance of riparian growth, watercourses, extraction of sediment, etc.) and also partially within the terms of agricultural and forestry management (flooding of land as a result of construction of beaver dams, etc.). Problematic areas on the scale of the entire Czech Republic cannot be clearly identified and defined as is possible in relation to the following area – *zone C*. Identification of the risk of origin of serious damages can also be performed in *zone B* on a lower level (e.g. in regional areas or individual catchment areas) and this step can potentially be combined with preparation (update) of the plans of catchment areas.

A methodological instruction for the procedure by nature conservation bodies when making decisions according to Act No. 114/1992 Sb. and when assuring beaver protection, will be created primarily for specification of the procedure in *zone B*. A manual will simultaneously be created (summary of technical measures) the purpose of which will be to provide managing and affected subjects with information about procedures to prevent or minimise damages. Practical management of the species in *zone B* will be a combination of technical measures (measures to protect dams, so-called beaver sluices, fencing and electric fences, etc.) and elimination of individuals in places where there is a risk of more serious damages or where technical measures cannot be applied.

Zone C

In the environment of the cultivated landscape of Central Europe settlement of areas with a high concentration of ponds and water reservoirs, simultaneously accompanied by a large number of high carrying capacity biotopes, can be considered high-risk (with regard to the possibility of origin of extra-regional serious damages). Rapid development of beaver settlements can be assumed in such areas, which would result in an enormous risk of origin of damages to water management etc.

structures, including the risk of a direct threat to the human population (breakage of multiple pond dams in systems or races at once). Under the conditions of the Czech Republic these factors are met in the case of the extensive areas of the South Bohemian pond basins (see zoning map on pic. 7). The significant capacity of the area (for development of beaver populations) was also independently confirmed by analysis of the potential capacity of areas in the Czech Republic for development of beaver populations (VOREL *et al.*, 2010a). A critical parameter of the aforementioned area is the combination of several specific characteristic – high concentration of sites with water (ponds and their systems), significant food source potential and the presence of easily threatened historic rock and earth filled dams and above-ground races. *Zone C*, where any Eurasian Beaver settlements should be eliminated (hunting in compliance with special regulations), was defined in this area on the basis of these facts.

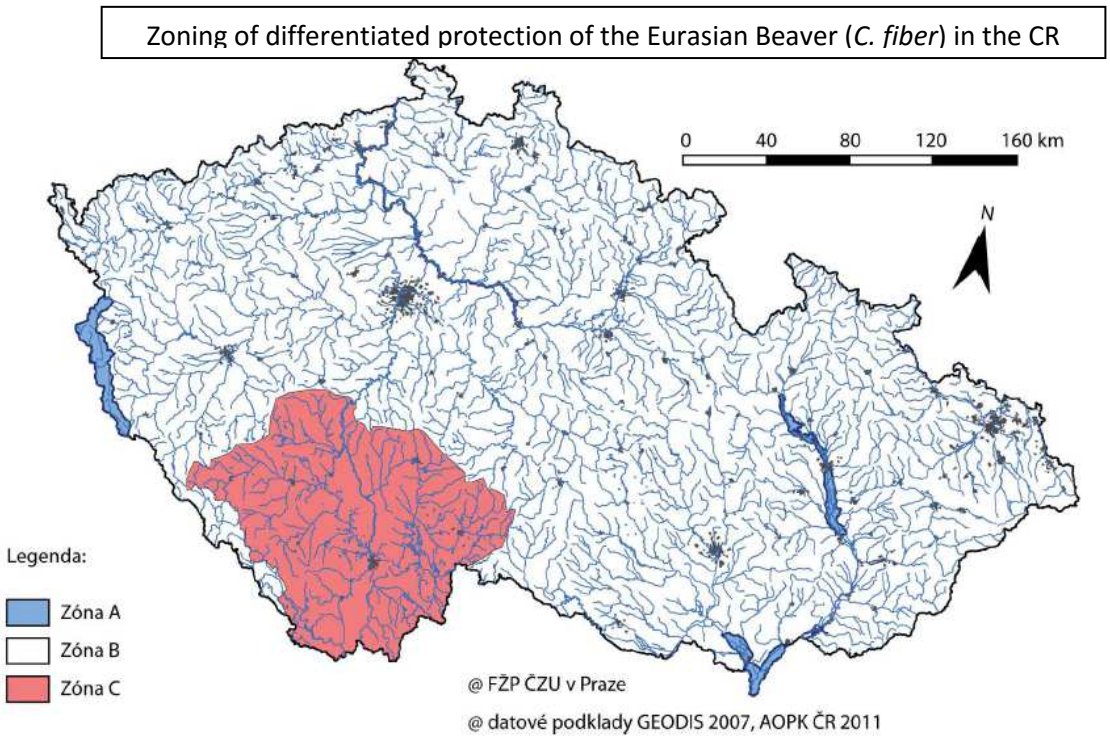
For the long-term and functional isolation of the area from existing or future settlement of surrounding regions, *zone C* must also include the surrounding area and not just the territory of the South Bohemian pond basins itself. It would be best if natural or artificial migration barriers were used to define the borders of this zone (the watershed of the entire South Bohemian region in the catchment area of the Vltava River, with an enclosing profile in the form of large water management structures on the Vltava – particularly the Orlík water management structure). The Šumava Nature Park has an exclusive status in *zone C* with regard to its mission. Nature park areas are excluded from the zoning of *zone C* and a regime identical to *zone B* is assumed here.

From the biological aspect and the aspect of the goals for protection of the species, it is significant that South Bohemia is still without any permanent beaver settlement, which provides enough time and space to eliminate settlements now and in the future. Potential intervention will currently be limited to individuals dispersing from the surrounding areas with more or less saturated populations (Bavaria and Upper and Lower Austria).

In spite of definition of this zone along the watershed (migration barrier – high weirs, dam reservoirs, watersheds of major watercourses) it must be assumed that individual animals will occasionally but continuously immigrate (the intensity of dispersal will depend on the degree of saturation of the population across the borders). Using the administrative tools proposed below and under the condition of coordination of the involved subjects (nature conservation, users of hunting grounds, owners of land), timely elimination of any permanent settlement of this region can be assumed.

Annex 3 gives more detailed information about the methodology for defining individual differentiated protection zones.

Comment regarding zoning:
The text below always specifies which zones the measures apply to if necessary.



Picture 7: Map of distribution of differentiated Eurasian Beaver protection zones in the Czech Republic

3 Plan of measures

	Measures	Priority
3.1	**Conservation of the species**	
3.1.1	Administrative measures in individual differentiated protection zones	1
3.1.2	Prevention of damages	1
3.1.3	Compensation of damages	1
3.1.4	Seeking out and eliminated the North American Beaver in the Czech Republic	**3.2**3
	Biotope conservation	
3.2.1	Protection of especially valuable areas transformed by the Eurasian Beaver's activities	3 2
3.2.2	Assurance of the permeability of critical sites on watercourses	
3.3	**Monitoring**	2
3.3.1	Mapping the presence of the beaver in the Czech Republic	2
3.3.2	Long-term monitoring of the Eurasian Beaver population in SAC	
3.4	**Research**	2
3.4.1	Impact of the beaver on the landscape and ecosystems of Central Europe	1
3.4.2	Development and verification of technical measures	
3.5	**Education and provision of information**	1
3.5.1	Manual for dealing with problematic situations (damages, etc.) caused by beavers	2 1
3.5.2	Support of provision of information to the public	3
3.5.3	Coordination of Management Plan measures	
3.5.4	Replacement of North Canadian Beavers in captivity	

Explanation: Priority means configuration of the importance of the proposed measures of this Management Plan. The priority of individual measures was conceived so that important measures for assuring and improving functional protection of the Eurasian Beaver population was dealt with preferentially. Therefore measures that are considered crucial for conservation of the Eurasian Beaver population have priority 1. On the contrary, not all measures are absolutely fundamental for rapid assurance of the goals of this Management Plan, which is why they have a lower (2) or even the lowest (3) priority.

3.1 Conservation of the species

In the case of the European Beaver it is not necessary to propose any specific measures for conservation of the species or individuals (breeding in captivity or reintroduction). Care of injured or otherwise handicapped individuals should be assured in the standard manner by means of rescue stations in compliance with Section 5, paragraph 8 et seq. and Section 52, paragraph 2 of Act No. 114/1992 Sb.

However, in general a number of legislative-administrative and economic tools can be used to support the species, which may eliminate conflict between the beaver and human economic interests. The population dynamics in the Czech Republic raise the question of potential future regulation of increasing numbers. Execution of the methodological procedure, including specification of conditions under which this regulation will take place (concerns differentiated protection *zone B* and *C*) will be part of realisation of measure 3.5.1 Manual of solutions to problematic situations (damages, etc.) caused by beavers.

3.1.1 Administrative measures in individual differentiated protection zones

nationwide (specifications for individual zones are given in the text)

Motivation

As described above, the Czech Republic represents a varied mosaic of various landscape types and subsequently also various suitable biotopes for survival of beaver populations. It is simultaneously possible to differentiate areas with various potential for origin of damages (and other conflicts) caused by beavers in our territory. With regard to these facts it is necessary to differentiate the scale of protection of the European Beaver in the proposed zones. It is therefore possible to propose utilisation of various administrative tools – in relation to the difference in approach and suitability of nationwide (in *zone C*) or individual (*zones A and B*) evaluation and solutions. It will mainly be desirable to suitably combine the option of permitting exceptions according to Section 56 of Act No. 114/1992 Sb. in the form of individual administrative proceedings and in the form of measures of a general character. *)

With regard to the type of damages, when the most serious are damages to flood embankments and water management structure damns, coordination with water management bodies and with administrators of watercourses and water management structures will be necessary (including assurance of potential links to catchment region plans; see also chapter 1.6.2.). With regard to the fact that the Eurasian Beaver is classified as a game animal according to Act No. 449/2001 Sb. on game management, it is also essential to coordinate with state game management administration bodies and users of hunting grounds. The goal is to utilise the potential of the legislation and also the staff capacity of game management associations to assure the protection of the European Beaver and deal with occurring damages.

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*) Comment: According to Section 56 of Act No. 114/1992 Sb. the exception proceeding (similarly to most other administrative actions in this Act) is a so-called proposal proceeding – it cannot be initiated by public powers, but always at the suggestion of subjects who incur damages or who submit another reason for a permit. In the case of damages related to Eurasian Beaver activities a request for an exception will most frequently be submitted by owners or administrators of water management structures and other structures, which are at risk of serious damage, owners of related damaged land or municipalities in which safety or health is at risk. In the case of submission by a "group of unidentified parties", nature conservation bodies may permit an exception to measures of a general character according to Section 56, paragraph 4 of Act No. 114/1992 Sb. By principle, this form assumes initiation on the basis of an own suggestion on the basis of facts known to nature conservation bodies, whereas these facts also include suggestions and impulses by individual affected subjects. In the case of damages caused by beavers, this will most frequently concern owners of water management structures and damaged land, possibly water management authorities, etc.

Subject of the measure

Within the terms of Act No. 114/1992 Sb. on the general conditions set out by the Rules of Administration, recommendations will be determined for utilisation of measures of a general character and for procedure during individual administrative proceedings. These recommendations will have the character of a methodological instruction for the procedure by nature conservation bodies. It will be differentiated according to individual zones with regard to the requirement of individual evaluation (individual administrative proceedings) or, on the contrary, more general preventive solutions (measures of a general character) when permitting exceptions according to Section 56 of Act No. 114/1992 Sb. and will specify the methods of suitable solutions of individual types of conflict situations when making decisions in *zones A and B* (see the concept in Annex 4 "Proposal of solutions to individual conflict situations according to differentiated protection zones") and issue of measures of a general character mainly for *zone C*. Coordination of individual state administration bodies will also be assured methodologically, particularly in relation to the status of water management authorities as the affected bodies according to Section 104, paragraph 9 of Act No. 254/2001 Sb. on water (see also chapter 1.6.2). Evaluation of the risk of origin of serious damages can also be linked to planning in the sphere of water management in the case of water management structures.

In order to fulfil methodological recommendations it is necessary to regularly provide nature conservation bodies with additional methodological support and expert support (discussion of the procedure during consultations with the state administration, provision of current information and expert consultations, etc.). In addition, the Ministry of Agriculture will also have to provide support and cooperation during regulation of execution of state game management administration and coordination of procedure by individual users of hunting grounds (particularly in *zone C*) with regard to classification of the beaver as a game animal.

3.1.2 Prevention of damages

nationwide, primarily in zone A

Motivation

At the site it inhabits the beaver transforms the surrounding area by several described methods (see chapter 1.4). As a result of its activities it usually increases the biological value of the area, but it may also cause a range of damages to managed areas and technical structures. However, these damages can be prevented by realising preventive measures. At sites where the beaver has space for permanent settlement and where damages have already occurred, these damages must be minimised and incurred losses must potentially be compensated (see measure 3.1.3 Compensation of damages).

Preventive and minimising measures can currently be covered using funds from the Environmental Operations Programme (area of support 6.2 – *"measures to minimise and prevent damages caused by critically and very endangered especially protected species of animal to roads, water management structures, agricultural or forestry cultures, farm animals, fish and bee farms").* With regard to the relatively high administrative demands of the programme, these funds are only used very infrequently. The national programmes by the Environmental Department (Landscape Management Plan, Programme for Renewal of the Natural Functions of the Landscape), which have lower administrative demands, do not enable funding of these measures. The exception is measures that simultaneously contribute to improvement of the condition of the biotope of an especially protected species or the condition of an especially protected area.

As a result, preventive measures against beaver damage are currently only realised very infrequently (see chapter 1.7.2). In general there is also very little information about what measures can (should) be realised. With regard to the assumed further dispersal of the beaver within the Czech Republic and with the related increase in damages caused by beavers, this sphere of the issue of beaver protection, becomes absolutely crucial. It is necessary to offer

the option of technical solutions to assure functional landscape elements and the production function of landscape components as support of and an alternative to administrative financial measures. These measures will be prioritised in *zone A* with regard to minimisation of the impact of beaver settlements.

Proposals of individual measures, their specification, determination of priorities from the aspect of nature conservation and the required provision of information, will be dealt with within the terms of realisation of measure 3.5.1. Manual for dealing with problematic situation (damages, etc.) caused by beavers.

Subject of the measure

The continuity of financial support of measures intended for preventing and minimising damages caused by beavers from EC funds must be maintained, also within the terms of the new programme period after 2013. Assurance of sufficient national funds also seems to be essential in this aspect. Financial tools must have low administrative demands and must enable support of small land owners and tenants (legal entities and natural persons).

In areas that are vulnerable to the beaver (e.g. on the basis of structures that the beaver may negatively affect by its activities) it is necessary to make financial support conditional to inclusion of preventive measures or measures for minimising damages caused by beavers – for example during construction of or repairs to water management structure or flood embankments measures that permanently prevent their damage, etc. must be applied.

It is essential that land owners, administrators of catchment areas and other involved subjects are sufficiently informed and motivated to prepare and realise such measures (see also measure 3.5.1 Manual for dealing with problematic situations (damages etc.) caused by beavers).

3.1.3 Compensation of damages

nationwide

Motivation

Compensation of damages (to forest or permanent growth and field crops) can be claimed in compliance with Act No. 115/2000 Sb. on compensation of damages caused by selected especially protected animals. Compensation of harm incurred as a result of restrictions, that did not originate as a result of the activities of especially protected animals, can be claimed in compliance with Section 58 of Act No. 114/1992 Sb. on nature and landscape conservation. Evaluation of the effectiveness of economic tools (see above) indicates that some of the incurred damages are not covered. The evaluated issue of state organisations drawing compensation is also conceptually disputable. Actual legislation within the terms of Act No. 115/2000 Sb. and Section 58 of Act No. 114/1992 Sb. also contains some procedural and methodological confusion or deficiencies, which must be responded to.

Subject of the measure

A complex analysis of the status and opportunities for handling economic damages caused by the beaver must be executed. The analysis must focus on situations involving private landowners and the relationship between state organisations and the institution of compensation of damages. The current experience with application of Act No. 115/2000 Sb. must be taken into consideration in the analysis focusing on subject matter and procedural deficiencies and the scope of damages caused by the beaver, which cannot be covered at present, must be evaluated. The current system must be evaluated and compared to models from other countries. A proposal for modification of the existing legislative standard, Act No. 115/2000, possibly a new system of economic and administrative tools for compensation of damages as a unit, must be created on the basis of this analysis.

3.1.4 Finding and eliminating the North American Beaver in the Czech Republic

nationwide

Motivation

The North American Beaver is not a geographically indigenous species in our country. With regard to its competitive abilities and different population dynamics, its immigration may cause undesirable displacement and replacement of our original Eurasian Beaver.

The North American Beaver may appear in the Czech Republic from two sources. The first may be its spontaneous dispersal from Austria, where it was released in the nineteen sixties and seventies. According to the situation in 2001 when DNA tests were performed (MOUTOU *et al.*, 1997; SIEBER, 2001), the entire, potentially "infected" Austrian population was removed along with the individuals closest to it. In spite of this it is still theoretically possible that individuals of this foreign species could disperse from Austria along the Morava River through Slovakia, or directly across river watersheds. Because there is also information about the presence of the North American Beaver in Germany and Poland (see PARKER *et al.*, 2012), there is a possibility of such undesirable immigration at any point in the Czech Republic. No individual in the wild that is a member of *C. canadensis* has been reported in the Czech Republic to date (2011) (NOVÁKOVÁ, 2007; PÁRTL *et al.*, 2008; ALBRECHTOVÁ *et al.*, 2011).

It is much more probable for the North American Beaver to randomly occur in this country as a result of individuals escaping from captivity at breeding facilities (zoos, zoo-parks, zoo-corners, etc.). This is where North American Beavers are usually kept (ŠAFÁŘ, 2002).

Subject of the measure

A database of all North American Beaver individuals kept in captivity in the Czech Republic will be created within the terms of this measure. Intensive cooperation with these facilities will also be established and if captive individuals do manage to escape into the wild, they will be captured as soon as possible.

Data about the presence of the North American Beaver will be compiled. This will consist of compilation and evaluation of osteological materials (different nasal and interparietal bones of the cranium), potentially DNA analyses. If a North American Beaver is found in the wild it will immediately be eliminated as an non-indigenous species (by procedure according to Section 5, paragraph 6 of Act No. 114/1992 Sb.).

3.2 Conservation of the biotope

The current beaver population status in the Czech Republic does not require any active biotope conservation measures to be realised (it is simply necessary to assure the general principles of biotope protection – maintenance of food sources, etc.). This is why only the two specific measures below have been proposed, of which the first focuses more on protection of the natural value of an area, conditional to the presence and activities of the beaver and the second focuses on resolving specific risk factors, which are fragmentation of the environment.

3.2.1 Protection of especially valuable areas transformed by the Eurasian Beaver's activities

zone A, B

Motivation

The influence of beaver settlements on the ecological value of an area is usually positive. The diversity and abundance of plant and animal species rises in the transformed areas (particularly in localities with more extensive dam systems) and the balance of water in the landscape is also positively affected. Accumulation and infiltration of water is usually increased, the speed of drainage from the catchment area is reduced and less sediment is washed away. In spite of the fact that areas affected by beavers usually become very valuable sites from the aspect of nature and landscape conservation (they are de facto revitalised free of charge), sites transformed by beavers lose their production function from the economic aspect (agricultural, forestry) and may be a source of a number of conflicts.

Subject of the measure

The subject of this measure will be to monitor and evaluate the ecological value of areas transformed by the beaver in *zone A* and in *zone B*. Areas, which have significant natural value, will be protected using available administrative tools or retained as state owned property, land will possibly be transferred/purchased by the state (with the goal of restricting the state's potential costs related to compensation of damages and harm).

Process of realisation of this measure:

1. within the terms of fulfilling the PP, criteria will be created on the basis of which a list of localities "re-naturalised" by the beaver, of high ecological value, will be created; these areas will be monitored and their list will be regularly updated;
2. the most valuable localities suitable for long-term protection, will be chosen on the basis of evaluation of the quality of localities, their perspective, ownership relations and the risk of origin of damages;
3. administrative tools for species protection and protection of areas will be used and purchase/transfer of land to the ownership of the state will be used to assure long-term preservation of the originating ecological values of the selected areas.

3.2.2 Assuring the permeability of critical sites on watercourses

zone A, B

Motivation

The Eurasian Beaver disperses practically exclusively through the aquatic environment. Crosswise structural obstacles in watercourses are not a significant problem for semiaquatic species of animal (as well as the beaver this includes mammals such as the Eurasian Otter, etc.). If necessary, these mammals are usually capable of overcoming these obstacles along the bank. However, dispersal through significantly modified watercourses in urbanised and industrialised areas may be blocked by impassable (even along the bank) obstacles. This frequently forces migrants to circumnavigate the impassable obstacle through a high-risk environment (injury or death of these animals following collision with a vehicle, falling into various shafts and tanks, etc.).

A typical example for the beaver (and priority from the aspect of the need to find a solution) is the very difficult to pass obstacle of the Střekov Dam (Ústí nad Labem). This structure is located in an area heavily affected by industry and traffic, within a narrow cliff profile of the Elbe River. This is a major element restricting dispersal of individuals down and upstream, which also slows natural migration pressure from the population in the Střekov-Hřensko area (the origin of individuals who appeared not far away in Roudnice nad Labem in 2010 is not known). The Střekov Dam does have a chamber type fish passage, but this means that the beaver is practically prevented from passing upstream.

Subject of the measure

Creating the opportunity for passage along watercourses for semiaquatic animals for the purpose of migration

The purpose of this measure is consideration of the needs of semiaquatic animals when planning and realising measures for making watercourses permeable for migration purposes. When preparing proposals of technical measures, the possibility of permeability will be evaluated not only with regard to the character of the cross-wise obstacle, but also it surroundings (high banks, roads and railways on the edge of the bank, etc.). The principle should be to apply requirements for assuring the permeability of watercourses in general within the terms of conceptual documents concerning town and country planning, environmental conservation and also in Catchment Area Plans and within the terms of preparation of plans for construction of new structures on watercourses (environmental impact assessment processes, town and country planning proceedings, etc.).

Enabling passage past Střekov Dam

Střekov Dam must be made passable as a priority, as it is the most significant obstacle to dispersal of the Eurasian Beaver. Making this obstacle passable should be realised by construction of a so-called green terrestrial overpass. This is a band of vegetation (3 – 4 m wide) circumnavigating the cross-wise structure along the left bank (former delivery track). This band should be edged with vegetation (hedges), bushes, which will guide migrating beavers to the band of vegetation and will restrict their dispersal into the surrounding area. It is also necessary to establish a safe unrestricted entrance into the water above and below the structure. Dispersal upstream could be aided by a parallel channel with a slow flow-through rate, passing along the entire green band, which will open out into the river below the structure at the site of unrestricted entry.

Organisational-technical measures at Střekov Dam, which may partially reduce its impassability, include the method of manipulation during and after passage of flood waves. During the annual rise in streamflow (opened weir fields) the period when the weirs are opened should be extended even after the culmination wave passes. This will increase the opportunity for upstream migration of aquatic animals.

3.3 Monitoring

Mapping and monitoring is a key measure for establishing and verifying the numbers and development of the Eurasian Beaver population in the Czech Republic and also a basis for evaluation of the effectiveness of the Management Plan. Basic biological research has been carried out in recent years (see VOREL *et al.,* 2010a) as a response to queries concerning the rise in numbers and scale of colonisation by this species in the Czech Republic. They provided basic and initial data about the beaver populations in the Czech Republic. Monitoring and mapping will ensure compilation and evaluation of data about the numbers of the species in the Czech Republic in subsequent periods, furthermore with regard to the assumed continuing expansion of the species in unsettled areas. Mapping particularly in the area surrounding *zone C* is an absolutely fundamental measure for maintaining and preserving its zero status.

3.3.1 Mapping of the presence of the beaver in the Czech Republic

Nationwide

Motivation

A key condition for successful function of the Beaver Management Plan is information about its current dispersal (as well as monitoring development of model populations see chapter 3.3.2). Mapping enables extensive monitoring of spontaneous dispersal of the species. In spite of the fact that this concerns random and non-systematic mapping of new presence of the species, its speed and simplicity will provide a rapid overview of colonisation of the Czech Republic. This information will be utilised as a basis for realisation of additional measures in the Management Plan (elimination of the North American Beaver, elimination of beavers in *zone C,* etc.).

Subject of the measure

Because establishing the number of individuals is methodologically and technically very demanding, the basis of regular mapping will simply be records of newly originating and confirmation of old sites of settlement (colonies, families, territories). The optimum period for monitoring new presence of the beaver is October to March (for detailed methodology see Annex 5), when beavers leave a large quantity of easily visible traces and determination of settlement of a locality is therefore simple and effective. It will subsequently also be important to obtain information about situations in surrounding countries, particularly in areas adjoining *zone C*.

The subject of this measure will also be creation and supplementation of the list of especially valuable damn systems, which locally increase the quality of the ecosystem from a biological and hydrological aspect, in relation to measure 3.2.1.

3.3.2 Long-term monitoring of the Eurasian Beaver population in SAC

zone A

Motivation

The foundations for long-term monitoring of several model populations were laid in previous years. An extensive data file describing the current numbers and historic development of some populations was compiled. Changes and development of some population parameters may occur in the future in existing areas settled in the long-term.

Development in several model populations monitored in the long-term must continue to be monitored. Regular and detailed monitoring is used to acquire information about the status of model populations and whether there is a significant increase or decrease in numbers. Changes to population parameters can be expected, which may indicate stabilisation of the population (saturation of the area). On the contrary rapid decreases in some population parameters may reveal the effects of significant disruptive factors (illegal hunting, parasite infection, loss of food sources, etc.). Further monitoring of selected populations and definition of the populating phase of development must be preceded by announcement and realisation of potential management intervention in relation to protection of the species.

A methodology for monitoring the population of the Eurasian Beaver has been created for the purpose of monitoring selected populations.

Subject of the measure

Populations will continue to be monitored in all *zones A* at least once every two years and current data will therefore regularly be available, which is essential for high-quality management of the species. The acquired data will also be used as a basis for regular execution of reports to the European Commission about the numbers of the beaver population in our territory.

Data will be evaluated in the context of previous information and materials from long-term monitoring of the species in the monitored *zones A*. Basic population parameters (numbers, population density, population phases and distribution) will be monitored in several populations monitored in the long-term (South Moravia, West and North Bohemia).

All data findings will be saved in the Nature Conservation Finding Database (NC FD), which is administered by the Nature Conservation Agency of the Czech Republic. This data will be shared with the relevant nature conservation bodies by means of a website.

3.4 Research

There is currently already a concept of the standing of the Eurasian Beaver in ecosystems of the cultivated landscape of the Czech Republic, what its basic ecological behaviour is and the development of existing populations. The key questions, which are still not clarified, include the impact of construction activities (dam building) by the beaver on ecosystems of the central European landscape.

3.4.1 The effect of the beaver on the landscape and ecosystems of Central Europe

Motivation

The Eurasian Beaver can actively change the settled environment. It very frequently changes the hydrologic regime in an area by its activities, with the subsequent significant impact on the landscape biota. In spite of the fact that this is a frequently studied aspect of settlement of ecosystems by the beaver, this issue has strong links to a specific landscape.

No such research has been performed yet in our environment. It is therefore impossible to clearly say to what degree the beaver influences settled ecosystems. The second unresolved issue concerning the beaver's activity in the environment is complex assessment of the impact of dam systems on the hydrological landscape component (accumulation of water in the catchment area and slowing of drainage and carrying away of sediments with the water). From the water management aspect it is also necessary to study the risks related to construction of dams and felling of trees (assessment of the stability of dams during increased streamflow, determination of the distance material originating from the beaver's activities is carried and the degree of risk, etc.) more.

Subject of the measure

Determination of the degree of positive or negative impact of beaver dams on a key group of organisms is crucial. Changes to sites subject to various successive stadiums, from the moment of settlement by beavers, will be monitored.

The goal is also to determine the impact of the species on the hydrology of the landscape. Determine the hydrologic balance in a logical and comprehensive catchment area (with beaver activity) subsequently compare it to an equivalent catchment area of comparable parameters (without dam activity) and ensure evaluation of the stability of dead wood accumulated in dams and outside them.

The beaver's effect on changes within the landscape in comparison to other revitalisation measures will be determined.

3.4.2 Development and verification of technical measures

Motivation

There are currently a number of measures to limit (minimise) and prevent damages, which were developed and are utilised in countries where beavers have been present in the long-term, such as North America, North and East Europe (e.g. LISLE, 2003; BOYLES & SAVITZKY, 2008). However, only some of these have been tested in the conditions of the Czech Republic (for example electric fences – see KOSTKAN *et al*., 2006). Many measures are significantly dependent on the individual and his experience. At the same time application proposals are not optimised to Central European conditions (technical regulations and standards) and the requirements of users or specific environmental parameters. There is also no clear experience in utilisation of measures so that application is simple and transferrable.

In some cases it will be essential to verify the feasibility and effectiveness of measures while using these in specific cases (for specific technical elements, etc.) and their mutual impact (and potentially their effects on non-target species) in a pilot area.

There are a great number of elements in our landscape, which may be and are already at risk from the beaver, however technical (so-called “soft”) measures against the beaver may significantly reduce these risks. Data obtained from monitoring the effectiveness of the realised measures will enable better utilisation of measures executed for preventing and minimising damages and simultaneously provides the affected subjects with information about the most suitable procedures.

Subject of the measure

Monitoring and evaluation of the effectiveness of measures to minimise and prevent damages will be assured on model cases or in a pilot area. The infrastructure elements most frequently affected by the beaver and cases when beavers restrict or complicate management and care of property in the area surrounding watercourses will be monitored. The considered list of measures includes for example securing road and railway embankments against waterlogging, protecting water management structures (bridges, sluices), protection of ponds and flood embankments or reduction of flooding of productive areas (farming or forestry).

The deficiencies, or unresolved situations, or technical elements will be evaluated on the basis of monitoring of effectiveness. If there is a risk of serious agricultural or economic damages (forestry, farming, pond industry, flood prevention), or if the health and lives of people are at risk (transportation routes) the missing technical measure, which could significantly reduce the extent of damages or negative impact of the beaver’s activities on infrastructure elements, will be proposed, developed and tested.

In order to fulfil this measure it is necessary to apply measures to model structures, monitor their effectiveness and assure their optimisation during the pilot phase. The results will then be published in the form of simple and effective methodological instructions and recommendations (these will be used to update or supplement the manual according to measure 3.5.1).

3.5 Education and provision of information

The Eurasian Beaver is considered attractive and is a popular animal with some of the public, but on the other hand, its existence in the cultivated landscape of Central Europe is linked to a high number of conflicts and problems. The presence and activities of the beaver are noticeable, they affect a number of subjects. Beavers may be perceived variously by groups of inhabitants, whereas the negative image of the beaver is naturally perceived by owners of the damaged land and other subjects who are concerned with maintenance and use of landscape components professionally. Information that will help and simplify management and care of property or other administered values should be preferentially intended for these professional groups.

The general lay public should be adequately and openly informed of the biology and numbers of the beaver population and of the issues of its protection, including the approach chosen within the terms of this document (particularly explanation of the reasons and principles of zoning, the need to prevent a numerous population in *zone C* and the approach to resolving individual types of damages).

Information about the strategy will be focused in two directions:

- active provision of information – specifically targeted towards subjects carrying out activities in the landscape (where conflict occurs with beaver settlements) and, on a limited scale, towards the general public when implementing measures of a general character (particularly in *zone C*);

- passive education – on a nationwide scale, in the form of episodic events: by means of the media and electronically, by support of environmental education, etc.

3.5.1 Manual for dealing with problematic situations (damages, etc.) caused by beavers

Motivation

The Eurasian Beaver's activities in the landscape may directly affect forest land and farmland, ponds, traffic etc. infrastructure (railways and roads, water management structures), flood embankments, etc. With regard to the importance and effectiveness of prevention of damages, it is essential that owners, tenants or subjects assuring administration of this land and these structures have a sufficient and easily available summary of suitable solutions to individual situations, from the technical aspect (measures to prevent and minimise damages such as installation of dig-proof barriers, so-called beaver sluices, fencing and electric fencing, etc.) and from the aspect of information about legislative and financial conditions (what the conditions are for permission of exceptions, where and how to apply for these, what the options and sources of compensation of damages are and subsidies for realisation of measures).

Subject of the measure

The goal of this measure is to create a "Manual for dealing with problematic situations (damages, etc.) caused by beavers", which will provide options for resolving situations arising from cohabitation with beavers, i.e.:

- brief information about the biology of the beaver and its impact on the ecosystem;
- key information about the concept of protection of the Eurasian Beaver (Management Plan);
- list of and conditions for use of individual known measures for preventing and protecting against beaver damage;

- administrative and legislative conditions for realising preventive and minimising measures;
- technical parameters and diagrams of structures.

The prepared material will be available in a user-friendly form (the option of downloading structural diagrams individually, or possibly publishing in multiple mutations depending on individual target groups, etc.) on the website and, if necessary and the affected subjects are interested, also in printed form at offices of nature conservation bodies and other places (for example the non-profit sector – NGO).

3.5.2 Support of provision of information to the public

Motivation

In spite of the relatively high popularity of the beaver, the public is not very informed about its ecology. The public receives information about the beaver practically exclusively through the media, which portrays it explicitly as problematic. The presence of the beaver in the landscape increases the attractiveness of the area to visitors and sometimes it is the presence of traces of inhabitation by the beaver or even the opportunity to observe the beavers that attract visitors to settled areas. It is specifically necessary to inform the affected subjects, whether these are owners of water management structures or land, which are at risk of damages, or users of hunting grounds, etc.

Subject of the measure

This measure will ensure the availability of objective information about the species and its role in ecosystems in Central Europe and the aspects related to its presence in a cultivated landscape (including information about the chosen concept of the approach to this species) utilising the following tools:

- information materials, cooperation with the media and publication of articles in available periodicals (regional and nationwide dailies, regional and state television, expert periodicals, etc.);
- a separate website closely linked to the Nature Conservation Agency of the Czech Republic (coordinator of the Management Plan) with key information about the concept of protection of the species and information materials for downloading, including provision of advice;
- application of information about beavers within the terms of local tourist information systems, educational trails, etc. (particularly in *zone A*) and creation of a so-called “beaver package” (summary of information about the biology, ecology and activities of the beaver and its protection) for environmental education within the regions;
- establishment of close cooperation with NGO, which are concerned with education in the field of nature conservation or directly carry out environmental education;
- special lectures focusing on discussion with users of hunting grounds, administrators of forest land and farmers who farm in areas where there is a risk of a greater number of conflicts in relation to the Eurasian Beaver’s activities in the cultivated landscape (provision of information about the legal and practical aspects of realisation of measures to prevent and minimise damages and their compensation etc.).

3.5.3 Coordination of Management Plan measures

Motivation

Conservation of the Eurasian Beaver population, realisation of potential measures in support of the species or resolution of arising damages and conflicts has been decentralised until now. The random encounters and conflict situations to date have been dealt with ad hoc, either by scientific workers at universities or employees of the Nature Conservation Agency of the Czech Republic who are familiar with the issue of dealing with conflict situations caused by the beaver.

However, fulfilment of individual Management Plan measures requires centralised and professional supervision and coordination: this will concern unrepeated measures (e.g. preparation and presentation of administrative and legislative tools), and also consultations and realisation of activities when dealing with conflict situations and application of management measures based on this Management Plan.

Subject of the measure

Creation of the position of "beaver manager" which will have the task of central coordination and realisation of measures based on the Management Plan, will ensure communication with the affected subjects and individual nature Management Plans, etc. This person should fall under the jurisdiction of the Nature Conservation Agency of the Czech Republic, which will ensure realisation of most measures arising from the Management Plan; this expert will assure or coordinate the following measures in particular:

- preparation of and cooperation on creation of methodological documents (see measures 3.1.1 and 3.5.1),
- consultation and services in relation to realisation of management measures (see measures 3.1.2 and 3.5.4),
- support of consultations and cooperation during fulfilment of measures (see measures 3.2.1 and 3.2.2),
- coordination and support of monitoring (see measures 3.3.1 and 3.3.2),
- realisation and support of provision of information to the public (see measure 3.5.2).

3.5.4 Replacement of North American Beavers in captivity

Motivation

There have been no reports of the North American Beaver in the wild in the Czech Republic as yet (see measure 3.1.4 Seeking out and eliminating the North American Beaver). However, beavers in captivity are mostly members of this non-indigenous species and the risk that these will escape into the wild is considerable in spite of a number of precautions.

Subject of the measure

In relation to measure 3.1.4 it is necessary to encourage that the Eurasian Beaver be kept in captivity in the Czech Republic and that the North American Beaver be replaced with its European equivalent. Individuals of the North American Beaver should be replaced with found handicapped Eurasian Beavers for example, or individuals who it was necessary to trap at sites were these were causing serious damages. Trapping individuals and keeping these in captivity requires permission of an exception according to Section 56 of Act No. 114/1992 Sb. (however this is for the purpose of education and, from the aspect of reducing the risk of escape of the non-indigenous North American Beavers, it is de facto also in the interests of protection of the Eurasian Beaver population, which is included in the reasons stipulated by the law for which an exception can be permitted).

It is also very important to inform people keeping beavers in captivity of the risk posed by this non-indigenous species. Assurance of a legislative framework for dealing with such escape from captivity or elimination of these risks is still lacking in the Czech Republic – it would probably be possible to apply the procedure according to Section 5, paragraph 6 of Act No. 114/1992 Sb. (decision to cull non-indigenous species), but not even this is a very operative solution and it is therefore necessary to optimise the legal regulations in this sphere.

4 Realisation plan*

Chap.	Measure	Priority	Period of realisation	Frequency	Links to other measures
3.1	Conservation of the species	1	regularly	annually	
3.1.1	Administrative measures in individual differentiated protection zones	1	regularly	annually	
3.1.2	Prevention of damages	1	regularly	annually	based on the results of measures 3.4.1 and 3.4.2, will be realised together with measure 3.5.1
3.1.3	Compensation of damages	1	regularly	in the first year of realisation	Linked to measure 3.1.1
3.1.4	Seeking out and eliminating the North American Beaver in the Czech Republic	3	regularly	annually	Based on the results of measure 3.3.1
3.2	Conservation of the biotope				
3.2.1	Protection of especially valuable areas transformed by the Eurasian Beaver's activities	3	regularly	repeated measure	Based on the results of measure 3.3.1 and 3.3.2
3.2.2	Assurance of permeability of critical sites on water courses	2	regularly	repeated measure	Based on the results of measure 3.3.1 and 3.3.2
3.3	Monitoring				
3.3.1	Mapping presence of the beaver in the Czech Republic	2	regularly	annually	Basis for realisation of measures 3.1.1, 3.1.2 and 3.1.4
3.3.2	Long-term monitoring of the Eurasian Beaver population in SAC	2	January - March	once every two years	Basis for realisation of measure 3.1.1
3.4	Research				
3.4.1	Impact of the beaver on the landscape and ecosystems of Central Europe	2	regularly	unrepeated measure	Basis for realisation of measures 3.1.2 and 3.1.3
3.4.2	Development and verification of technical measures	1	during the first to fifth year from approval of the CP	unrepeated measure	Basis for realisation of measures 3.1.2 and 3.5.1
3.5	Education and provision of information				
3.5.1	Manual for dealing with problematic situations (damages, etc.) caused by beavers	1	immediately after measure 3.4.2	unrepeated measure	Linked to measure 3.4.2 and will be the basis for realisation of measure 3.1.2
3.5.2	Support of provision of information to the public	2	regularly	annually	Will be realised particularly in relation to measure 3.1.2
3.5.3	Coordination of Management Plan measures	1	regularly	annually	linked to most measures in the CP
3.5.4	Replacement of the North American Beaver in captivity	3	regularly	annually	

* for a period of 15 years after approval of the document

5 Literature

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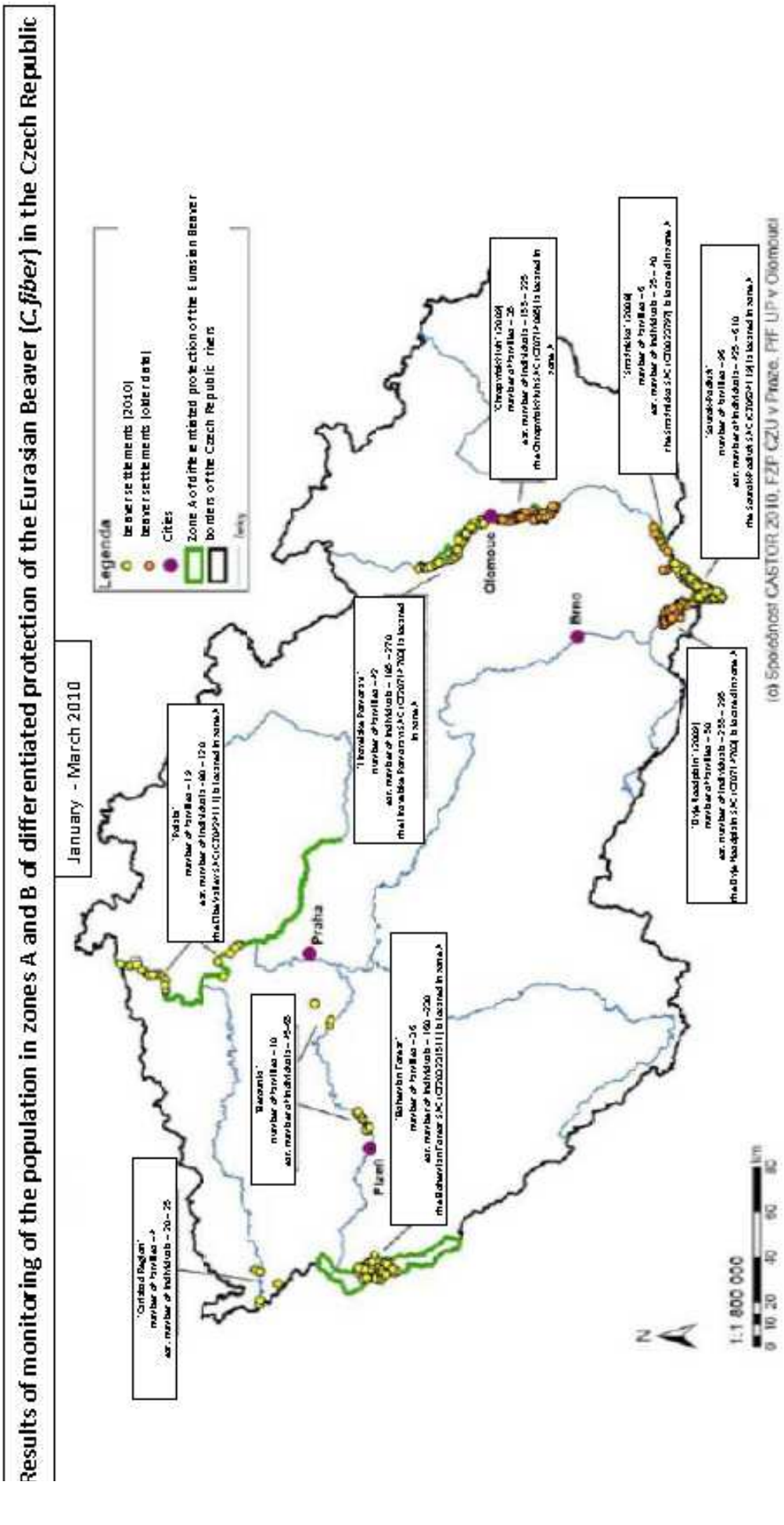

Results of monitoring of the population in zones A and B of differentiated protection of the Eurasian Beaver (C.fiber) in the Czech Republic
January - March 2010
Legenda
beaver settlements (2010)
beaver settlements (older data)
Cities
Zone A of differentiated protection of the Eurasian Beaver
borders of the Czech Republic rivers
Praha
Plzeň
Brno
Olomouc
1:1 800 000
0 10 20 40 60 80 km
N
(c) Správa CASTOR 2010, FŽP ČZU v Praze, PřF UP v Olomouci

Summary of reintroduction and translocation programmes in Europe and Asia

The probable historic extinction of the species and the year that protection of the species began are also given. The last column gives the numbers (turn of 2001/2002) of the population in individual countries (modified according to HALLEY & ROSELL 2003).

Country	Extermination	Protection	Reintroduction/ translocation	Current population size
England *	12th century	-	2005	5
Belgium	1848	-	1998 - 2000	200 - 250
Belorussia	population survived	1992	-	24,000
Bosnia-Herzegovina	?	-	-	0
Bulgaria	?	-	Planned	0
Czech Republic*	**18th century**	**1992**	**1991 - 1996**	**2,500 – 3,000**
Denmark	11th century	-	1999	60-70
Estonia	1841	-	1957	11,000
Finland	1968	1968	1935-1937, 1995	2,000
France	population survived	1909	1959-1995	7,000 – 10,000
Croatia	1857	-	1996-1998	180
Italy	1541	-	?	0
Kazakhstan		?	-	1,000
Latvia		-1830	1927-1952	>100,000
			1975-1984	
Lithuania			1947-1959	>50,000
Luxembourg	1938	-	2000	1
Hungary	18th century	-	1991-1993	>400
	1865	-	1996-2003	
Mongolia/China			1959-1985	800
Germany	population survived	-	1936-1940	8,000 – 10,000
	population survived	1910	1966-1989	
			1999 – 2000	
Holland			1988-2000	177-227
Norway	1826	-	1925-1932	70,000
	population survived	1845	1952-1965	
Poland			1943-1949	>30,000
	1844	1923	1975-1986	
Austria			1970-1990	>1,300
Romania	1969	-	1998-1999	>170
Russia	1824	-	1927-1933	>250,000
	population survived	1922	1934-1941	
			1946-1946	
Scotland*			Planned	0
Slovakia	16th century	-	1995	>500
Slovenia	1851	-	1995	>500
Serbia	?	?	2004	30
Spain	1903	-	2003	18
Sweden	17th century	1981	1922-1939	>100,000
Switzerland	1871	1873	1956-1977	>350
Ukraine	1820	-	-	6,000
Wales	population survived	1922	-	0
	12th century	-		

Legend: *current data given not from the source Halley& Rosell (2002)

Creation of zoning of differentiated protection of the Eurasian Beaver in the Czech Republic

This annex describes the process for definition of areas of differentiated protection of Eurasian Beaver population in the Czech Republic for the purposes of the Management Plan. The key principles of differentiated protection (zoning) and the framework approaches in individual zones are given in the actual text of the programme.

The purpose of zoning is to differentiate the degree of conservation of the Eurasian Beaver within the context of the entire Czech Republic. The initial plan was to find a sufficient number and scope of areas that would provide the beaver with sufficient space for undisturbed development of parts of the population (*zones A*). A significant aspect in this type of area was the low risk that serious damages would occur. The second aspect, which was emphasised during preparation of zoning, was the aspect of the accumulative effects of risk factors, together with the high carrying capacity of the environment. Areas with a high degree of conflicts and simultaneously a high potential for origin of a numerous beaver population were chosen on the basis of knowledge of the biology of the species and the character of basic landscape units in the Czech Republic: areas with extensive pond systems (*zone C*). The remaining areas of the Czech Republic (outside *zones A and C*) were classified as *zone B*.

With regard to the requirements of the Management Plan, differentiation of protection was dealt with on a nationwide level, and is not consequently realised in detail – on a local or regional level. Similar principles can naturally be applied when dealing with issues related to protection of the beaver and the damages it causes on a regional level.

Within the terms of zoning, areas with the need to eliminate the presence of the beaver (*zone C*) were initially analytically (on the basis of evaluation of the significance of risks) created; an initial network of areas (*zones A*) was then created where the beaver could prosper. The last type of area is *zone B*, which covered the remaining parts of the Czech Republic after *zones A and C* had been designated. During preparation of zoning all *zones A* were evaluated to make sure they were designated appropriately. Mapping of selected factors in all the selected areas also took place. Some areas were subsequently included in *zone A* and unsuitable areas were eliminated (and moved to *zone B*).

Designating the borders of the zones

Zoning will generally have a declaratory meaning, therefore detailed and accurate specification for the requirements of OOP will not be necessary. When conflict situations arise, their resolution will always depend on the character of the problem being dealt with, taking into consideration the character of the area and its classification in one of the three zones.

The borders between the *zones A and B* will set out linearly (the corresponding GIS layer will be created) along existing separating lines in landscape units. All *zones A* contain SAC with the beaver as the subject of protection, they also include the surrounding and adjoining areas to the SAC. The plan was to define comprehensive and easily definable areas, which will form compact and logical units (borders of major landscape elements, etc.) together with the defined SAC.

The borders of *zone C* will generally be determined according to physical-organic topographic relief (the borders of catchment areas or borders of SPA). A 10 km wide transition zone will be designated on each side of such a border. Designation of *zone C* will be subject to additional legislative regulations (Game Management Act – designation of hunting grounds), so that the set borders (and their transition zones) are functionally sustainable.

Designation of *zone C*

Designation of zone C was preceded by an extensive analysis of the biology of the beaver (research of literature and our own research). The etiological requirements of the species (method of creating dens

in dam structures), its requirements for the quality of the environment and population dynamics were researched. At the same time the landscape matrix in the Czech Republic was evaluated with regard to finding landscape elements that could be at risk from the beaver on a large scale.

Monitored key risk factors in *zone C*

- *High concentration of ponds and water reservoirs,*
- *Technical parameters of the dams of water management structures,*
- *High carrying capacity of the local biotopes for the Eurasian Beaver,*
- *Ruggedness of the landscape and the nearness of human settlements.*

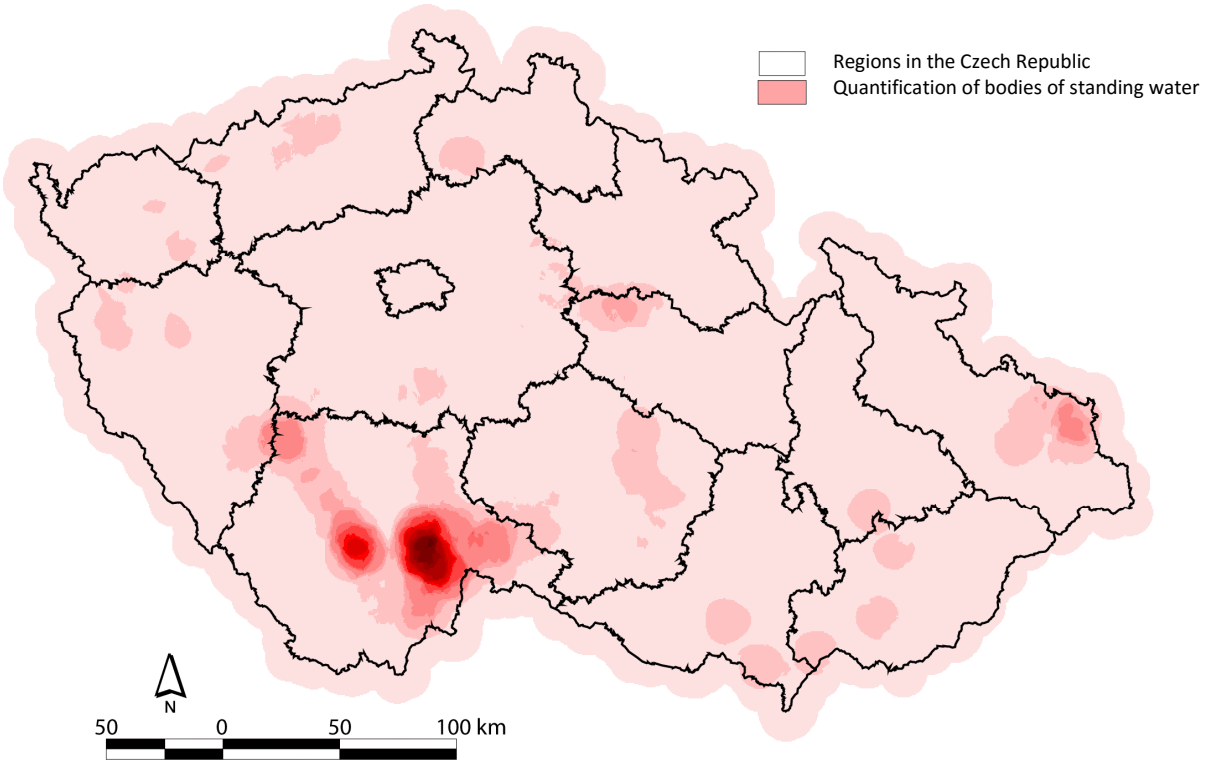
On the basis of this analysis it was found that the landscape element that was most negatively affected by the beaver from the aspect of functionality was earth and rock fill dam structures in pond areas.

The Czech Republic was subsequently subjected to a GIS analysis querying whether, where and to what degree there is a presence of a high concentration of earth and rock fill dams in pond areas.

Designation of *zone C* took place on the basis of the GIS synthesis of two information spatial layers of the Czech Republic (bodies of water, network of water courses).

A 1:25, 000 map with bodies of water was used as the initial layer. During this phases large water reservoirs such as the following were eliminated: Lipno, Rozkoš, Pastviny, Orlík, Slapy, Hracholusky, Nechranice, Jesenice, Skalka, Dářko. These major dams are not at risk from beaver activities and would distort the evidential value of the results. The Novomlýnské nádrže system is a specific element, which was also eliminated from the selection, in spite of the fact that its is partially at risk from beaver activities. In this case this is a lower risk than assumed for earth and rock fill dams.

The next step was to transform the water body layer of the Czech Republic into a grid with a pixel size of 50 x 50 m. A sum of all bodies of water in the surrounding area (10 km radius) was created over each pixel. This created a map in the form of a grid, where each pixel contains quantitative information about how many bodies of water there are in the surrounding area and how big these are. The resulting map provides a summary of the size and intensity of areas of bodies of standing water (see pic. 1).



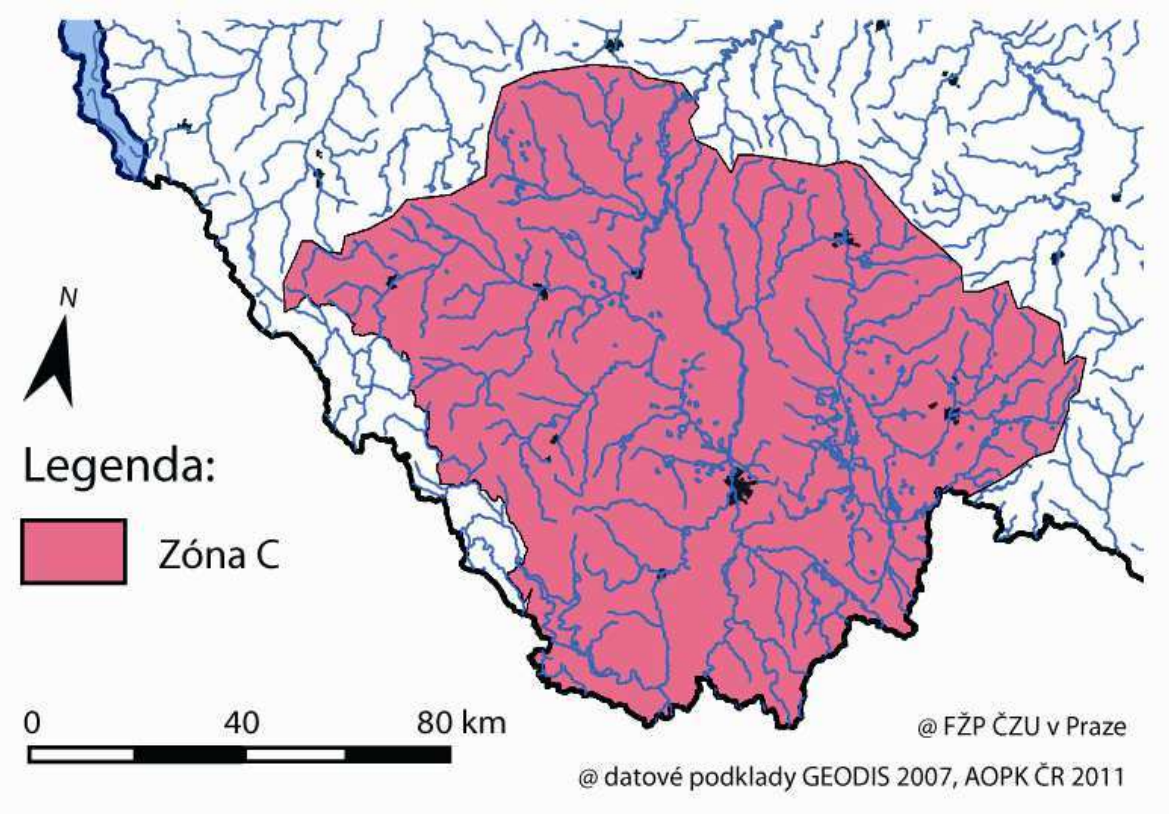
Pic. 1: Results of the GIS analysis for proposal of *zone C*

The resulting layer was then examined. The local presence of higher values of water in the area and whether these actually indicate ponds and other water reservoirs, or whether this concerns other bodies of water (not at risk from the beaver) (lakes, sand pits, etc.) was evaluated. If areas that cannot be negatively affected by the beaver were present on the map, these were not taken into consideration in the following steps. This particularly concerns areas with flooded subsidence lakes created by subsidence of the surface or areas with a significant volume of sand pits (Karviná and Pardubice regions).

The next phase was comparison of this GIS layer with knowledge of the areas that have an intensive concentration of high-risk water management structures according to this model. The result was selection of problematic areas – Třeboň, Jindřichův Hradec and the Blatensko pond areas.

The third phase was elimination of the Šumava Nature Park from the results of the analysis. The reason for this is the conflict between the regime in *zone C* and the purpose and essence of the National Park. National Parks in general have the primary goal of promoting the natural process and maintaining the presence of species in their original habitat. Elimination of the beaver in the Šumava National Park was in direct conflict with this purpose. Furthermore this area is not very suitable for development of a strong and stable population (poor submontane and montane conditions, unsuitable character of the watercourses, etc.) and its elimination from *zone C* does not represent any significant increase in risk. *Zone C* includes both banks of the Lipno reservoir (from the bridge in Nová Pec downstream along the Vltava River).

The last step was logical and sustainable designation of problematic areas, in the spirit of the aforementioned criteria for *zone C*. Because all the established areas were close to each other, it was possible to merge all three areas into one large zone. The natural borders of all the areas were designated so that one comprehensive catchment area was defined. Watersheds were sought as barriers, which would separate the entire area from the neighbouring hydrological catchment areas and reduce the probability of intensive dispersal of beavers into the area. Pic 2. shows the borders of *zone C*.



Pic. 2: Designation of *zone C* in the area of the South Bohemian pond basins

Resulting description of *zone C*

There are 3,349 ponds and water reservoirs in *zone C* of a total area of 19,767.3 ha. This is the location of the largest ponds in the Czech Republic, the existence of which could be at risk from the beaver. To demonstrate, the area and volume of retained water in the largest ponds is given in table 1 of Annex 3.

The dams of the ponds throughout the proposed *zone C* usually consist of materials from which they were built in the medieval age. Most of the dams were specifically made with a clay waterproof core, which forms ½ the profile of the dam and the remainder of the dam body consisting of material available at the specific site. The summary of materials from which the dams of large ponds in *zone C* are built is also given in table 1 to Annex 3. The upstream side of the dam is usually reinforced by laid stone or filled with stone. In some localities however, there is no clay core and the dam is made simply from the materials most easily available and most frequently also the cheapest materials. In the event that the upstream side of the dam is not reinforced, these dams may be easily used by the beaver to create a system of dens. But not even stone filled dams guarantee that the beaver will not be capable of creating individual dens or even systems in this material. It is also not possible to exclude situations when a beaver settles a tributary or circumventing channel of a specific pond and creates a system of dens from the exterior (downstream) side of the dam.

Another aspect that may increase the risk of conflicts is the fact that a number of ponds are also part of so-called pond systems, where some ponds do not have a catchment area and the water supply is assured by overflow from another pond. The beaver's activities in the dam of one pond of a pond system could influence the functionality of the entire system.

The feed channels of ponds or millraces are also a serous problem in relation to beaver activity, because these are frequently laid above ground-level. The banks of these feed elements are frequently made of sandy soil without any reinforcement.

If these are settled by the beaver, dens or dams may be created in this feed channel, which may reduce the functionality of these structures.

The common characteristic of most reservoirs and pond structures in *zone C* is the presence of littoral growth consisting of both herbaceous (reeds, bulrushes, *Carex* and water lilies), and also woody species (willows, *Spiraea*, poplars and alders). They consequently represent a biotope with a very varied food source for the beaver, which would enable the existence of a very numerous beaver population.

Tab. 1: Summary of the most important ponds in the South Bohemian pond basins

Name of pond	Dam material	Area (ha)	Volume of retained water (m3)
Rožmberk	Clay to sandy soil	489	5,860,000,000
Horušický	Sandy clay	416	3,970,000,000
Dvořiště	Sandy clay	337	6,650,000,000
Velký Tisý	Sandy soil	317	4,280,000,000
Záblatský	Sandy clay	305	3,350,000,000
Staňkovský	Medium sand	241	6,630,000,000
Svět	Powdery sand	201	3,320,000,000
Opatovický	Sandy clay	161	3,430,000,000

The last significantly negative characteristic of the area is that the pond basin landscape is usually flat and if a pond dam is damaged, the entire area could be flooded. In *zone C* there are villages right next to a number of ponds. Because there are such a high number of ponds with settlements right next to them, there is a high probability that villages will be flooded and human lives will be at risk.

The list above clearly indicates that beaver settlements would evidently cause enormous economic damage by damaging pond dams, flooding adjoining villages and agricultural areas (farm land, forests), the death of fish and completely unquantifiable damages in relation to the threat to human lives.

The situation of the South Bohemian pond basins is unique. Nowhere else in the Czech Republic is there such a significant accumulation of negative factors, which are simultaneously linked to the opportunity for development of a numerous population of Eurasian Beavers. This is why designation of a *zone C* in the aforementioned scope and prevention of permanent settlement by the beaver population here is proposed.

Designation of *zone A*

Selection of areas in the rest of the Czech Republic, which could serve as the *zone A* described above began after designation of *zone C*.

The plan was to select and evaluate all suitable areas, where populations of this species could develop. An essential condition was the potential to sustain a long-term and viable population of the Eurasian Beaver and little probability of origin of conflict situations in these areas.

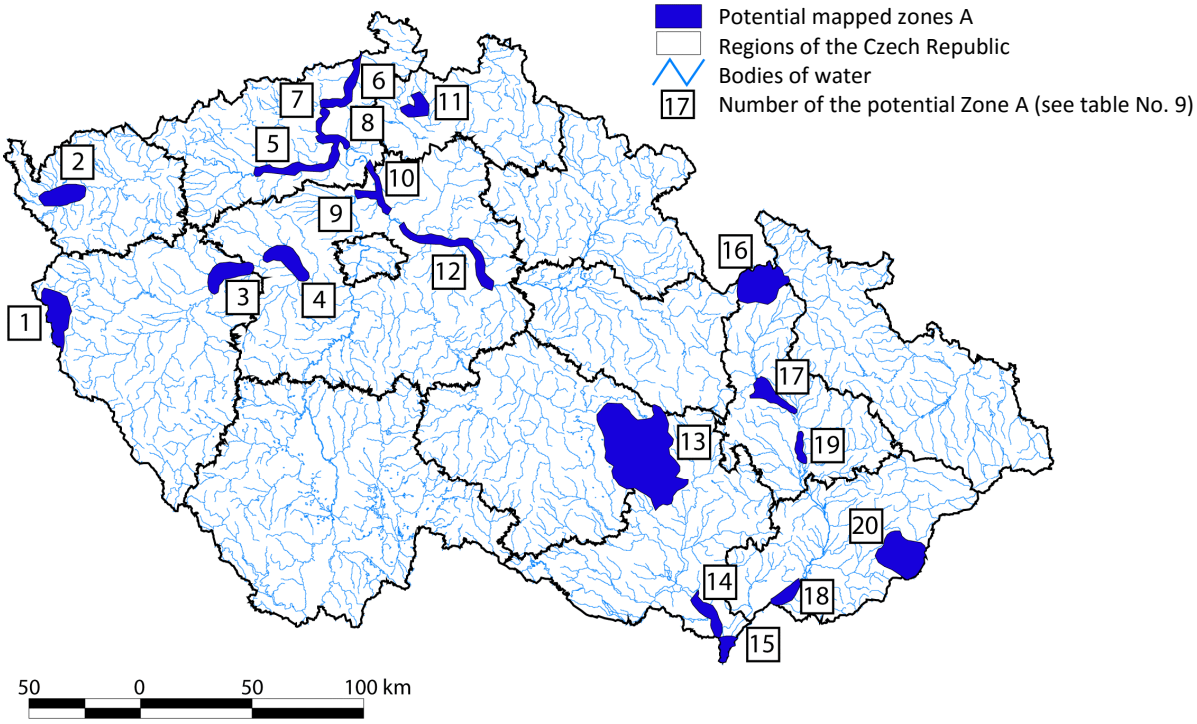
- **Criteria for a population in river ecosystem areas:**

- watercourse of at least 10 m in width,
- with predominating riparian forest type biotopes,

- the watercourse in this area must be at least 15 - 20 km in length.

- **Criteria for submontane populations:**
  - the search was narrowed to border areas in a zone from the west end of Šumava to Kralický Sněžník,
  - watercourses of a width of less than 5 metres,
  - watercourses not of a mountain stream character with little inclination,
  - mosaic-like biotope with developed riparian growth,
  - no or very little settled compact areas with a water network,
  - the watercourse must be at least 30–40 km in length in this area.

A total of 20 areas potentially suitable as *zone A* were selected on the basis of the aforementioned criteria (see tab. 2 pic. 3 of Annex 3).



Pic. 3: Map of evaluated potential areas of *zone A*

Tab. 2: Summary of values and parameters, which played a role during final selection of individual *zone A areas*

ID	District	Localisation	Zone A	Natura 2000	PLA	Type	Carrying capacity	Probability of conflict
1	Bohemian Forest	-	Yes	Yes	Yes	streams	moderate	low
2	Ohře	Carlsbad	No	No		river		
3	Berounka	Pilsen						
4	Berounka	Beroun						
5	Ohře	Louny					moderate	moderate
6	**Elbe**	**below Střekov**	**Yes**	**Yes**	**Yes**	**river**	**moderate**	**moderate**
7	**Elbe**	**above Střekov**	**Yes**	**No**	**Yes**	**river**	**moderate**	**moderate**
8	Ohře	confluence with the Elbe	No	No	Yes	river	high	low
9	Vltava	confluenc with the Elbe	No	No	No	river	high	low
10	Elbe	confluence with the Vltava				river	high	low
11	Ploučnice	Mimoň	No	No	No	river	high	moderate
12	**Elbe**	**confluence with the Cidlina**	**Yes**	**No**	**No**	**river**	**high**	**moderate**
13	Svratka	above Brno	No	No	Yes	streams	small	high
14	**Dyje**	**Dyje flood plain**	**Yes**	**Yes**	**No**	**river**	**high**	**moderate**
15	**Morava**	**Confluence**	**Yes**	**Yes**	**_No**	**river**	**high**	**moderate**
16	Morava	Hanušovice	No	No	Yes	streams	small	high
17	**Morava**	**Litovelské Pomoraví**	**Yes**	**Yes**	**Yes**	**river**	**high**	**low**
18	**Morava**	**Strážnice**	**Yes**	**Yes**	**No**	**river**	**high**	**moderate**
19	**Morava**	**Chropyňský luh**	**Yes**	**Yes**	**No**	**river**	**high**	**moderate**
20	Vlára	Vlár pass	No	No	Yes	streams	small	moderate

Legend: areas that are part of *zone A* are given in bold; * area forming part of overall *zone A* "Polabí"

- **Evaluation of potential *zones A***

  All selected potential *zone A* areas were subsequently subjected to:

  - a field examination of the area, during which determining factors were mapped (see below),
  - calculation of a model of suitability of the area,
  - evaluation of critical values,
  - evaluation of all potential areas mutually,
  - analysis of the distance and interconnection between *zones A* and *C.*

- **Description of the model for testing potential areas of *zone A***

All areas, which were selected as potential areas in *zone A* (see tab. 2) were mapped. Homogenous sections of the banks of watercourses and bodies of water up to a distance of 50 m from the surface of the water were evaluated. The values of the factors listed below were recorded for all sections. All sections of each potential area were subsequently analysed. The goal was to estimate whether and to what degree potential settlement of the area by the beaver would have the following characteristics:

- to what degree would the area be at risk of the probability of flooding from beaver dams; influencing factors: A, B, C, D;

- to what degree is the specific section at risk of an increased number of dens and whether this will be a limiting factor for other use of the area; influencing factors: E, F, H, C;
- whether there is a risk of intensive felling and how sustainable or unsustainable this will be for the surrounding landscape and agricultural subjects; influencing factors: C, E, G;
- whether the area is capable of feeding the beavers in the long-term; influencing factors: C, D, E, G.

Factor A – width of the watercourse

This factor divides localities into suitable and unsuitable depending on the probability of dams being constructed on the watercourse. The limit was set at 5 metres in width of the watercourse.

Factor B – depth of the stream-bed

This factor should determine the extent of flooding that could potentially occur; the higher the banks around the watercourse, the smaller the risk that the surrounding area would be flooded

Factor C – inclination of the watercourse

Enables evaluation of the attractiveness of the environment to beavers using one of the key limiting factors. A steep inclination gradient and mountain stream streamflow, and the related stony character of the bed and banks and poor, mainly coniferous growth, significantly limits the presence of beavers in watercourses such as those described above.

Factor D – poplars and willows

This factor enables assessment of the attractiveness of the environment to beavers within the meaning of the presence or absence of the preferred woody plants. If there is a significant proportion (over 25%) of the preferred species (poplars and willows) in the surrounding area, this may indicate long-term and intensive settlement by beavers. In this case all other woody plants are of no importance, in spite of the fact that some other species are locally consumed.

Factor E – assessment type

A factor indicating problems in relation to the beaver's food activities. The assessment type of an area adjoining a watercourse is important, up to a distance of 50 m from the bank. The type of area that is considered ideal is a wide flood plain without other human interest. Similarly, riparian forest without significant productive functions should not cause serious problems during settlement by beavers.

Factor F – roads

A factor that may indicate problems in relation to intensive beaver activity. This factor is assessed to establish whether or not there are any technical structures in an assessed zone around the watercourse or body of water (50 m). Such structures could sooner or later be negatively affected by construction of dams with the related consequences.

Factor G – coverage

The higher the coverage by riparian growth around the settled (or potentially settled) watercourse, the relatively less or shorter-term damage to the growth.

Factor H – body of water

If this concerns bodies of water that can potentially be settled by beavers, it is important to define their character and the resulting potential risks. This factor should eliminate or include the presence of problematic bodies of water: rock or earth filled pond dams (without a stone surface).

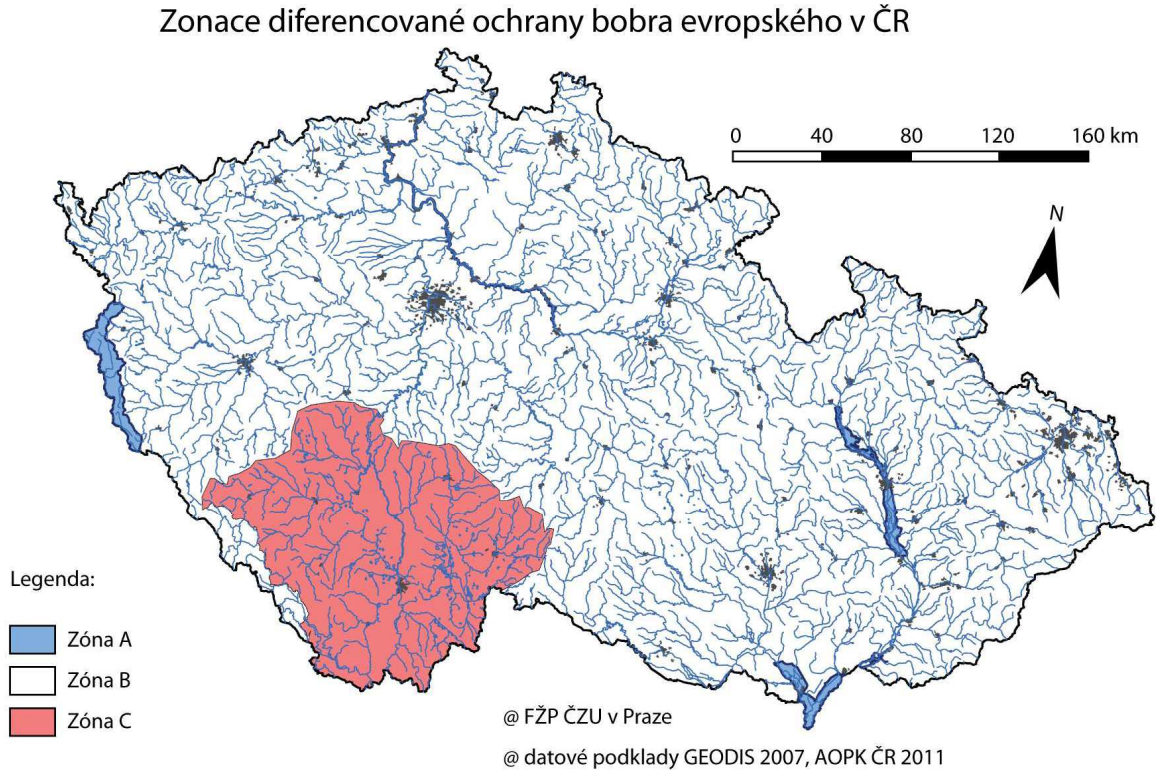
Large water reservoirs, sand pits, gravel pits and newly repaired ponds with a stone surface were not included in the evaluation.

In the final phase a total of 9 areas suitable for designation as *zone A* were chosen, three of which were on the Elbe River. These areas were subsequently connected into one continuous section called "Polabí". The result is a list of 7 areas forming the proposed zone 1 (see the map on pic. 4 and tab. 3).

Tab. 3: Summary of the resulting parts of *zone A*

ID	Area	Localisation	Zone A	Natura 2000	PLA	Type	Carrying capacity	Probability of conflict
1	Bohemian Forest	-	Yes	Yes	Yes	streams	moderate	low
6	Elbe	below Střekov	Yes	Yes	Yes	river	moderate	low
7	Elbe	above Střekov	Yes	No	Yes	river	moderate	low
12	Elbe	confluence with the Cidlina	Yes	No	No	river	high	moderate
14	Dyje	Dyje flood plain	Yes	Yes	No	river	high	moderate
15	Morava	confluence	Yes	Yes	No	river	high	moderate
17	Morava	Litovelské Pomoraví	Yes	Yes	Yes	river	high	low
18	Morava	Strážnice	Yes	Yes	No	river	high	moderate
19	Morava	Chropyňský luh	YE	Yes	No	river	high	moderate

Legend: * the area forms individual parts of overall *zone A* "Polabí"



Pic. 4: Zoning of the Czech Republic for the purpose of protection of the Eurasian Beaver

Designation of *zone B*

Zone B was designated in the remainder of the Czech Republic, outside *zones A* and *C*.

Proposal of solutions to individual conflict situations by zone of differentiated protection (concept)

Beavers activities	Type of damaged property	Scope or character of damages	Measures in zone A	Measures in Zone B	Measures in zone C
Felling wood	forestry agricultural growth	small scope	none	special beaver fencing	elimination of the beaver settlement
		area-wide scope	special beaver fencing	special beaver fencing	
	ordinary riparian vegetation growth		none	none	
	valuable woody plants (cultivated, landscaping)	individual plants	individual mechanical protection	individual mechanical protection	
		area-wide scope	complex mechanical protection	complex mechanical protection	
Growing on farm crops	interference in agricultural cultivation (including RRD)	small scope	none	e.g. electric fencing, beaver fencing	
		area-wide scope	e.g. electric fencing, beaver fencing	e.g. electric fencing, beaver fencing	
Dam construction	flooding or waterlogging forest		technical measures to reduce the water level (or removal of the dam in serious cases)	destruction of the dam	
	flooding or waterlogging arable land				
	flooding or waterlogging cultivated meadows or grazing land				
	waterlogging roads and railway tracks				
	restriction of the function of the infrastructure (sources of water, wastewater treatment plants, etc.)	damming the watercourse, waterlogging dam structures, etc.			
	worsening of the function of water reservoirs and their elements				
	channels of watercourses modified by water management structures				
	retum ichannels of watercourses		none	usually non, or destruction of the dam	elimination of the beaver settlement
Digging dens	damage to flood embankments*		elimination of the beaver settlement	elimination of the beaver settlement	
	damage to earth embankments of water reservoirs	problematic position (above human settlements)	repair and reinforcement of the embankment or elimination	elimination of the beaver settlement	
		problem-free position	repair and reinforcement of the embankment	repair and reinforcement of the embankment	
	damage to the bank of above-ground channels*	can be manipulated	repair and reinforcement of the embankment	repair and reinforcement of the embankment	
		problematic position (above human settlements)	repair and reinforcement of the embankment	repair and reinforcement of the embankment	
		can be manipulated	repair and reinforcement of the embankment	repair and reinforcement of the embankment	
		problematic position (above human settlements)	repair and reinforcement of the embankment	elimination of the beaver settlement	
		problem-free position	repair and reinforcement of the embankment	repair and reinforcement of the embankment	
	damage to embankments of roads and railway tracks	unpaved roads	repair and reinforcement	repair and reinforcement	
			repair and reinforcement	repair and reinforcement	
			repair and reinforcement	repair and reinforcement	
			repair and reinforcement	elimination of the beaver settlement	
			none	none	

* The above-ground part of the dam or embankment is not used to create permanent settlements, but usually only shelters when the water level rises, etc. – repairs and reinforcement preventing continued denning is sufficient to prevent further damages.

Proposal of methodology for mapping dispersal of the Eurasian Beaver in the Czech Republic

Mapping is based on non-systematic reports of all data about activities and observation of traces of the presence of the Eurasian Beaver. Voluntary activities by the lay public, the activities of state and private subjects, surveys by state nature conservation workers or research work by scientific and university workplaces can be used to monitor and report data. Compilation of data should be assured by the Nature Conservation Agency of the Czech Republic using the Nature Conservation Findings Database (NA FD). Evaluation of the compiled data should only be performed be experts on the biology of the Eurasian Beaver.

The entire procedure can be summarised as follows:

1. records of traces of the presence of beavers
2. transposition of data into the GIS environment, data analysis, creation of results

The main forms of output from mapping are:

- the number and localisation of recent territories in the specific year in the Czech Republic;
- the number and localisation of dispersal of pioneer individuals in newly settled regions in the specific year in the Czech Republic;
- the number of permanently settled quadrats in the specific year in the Czech Republic;
- the number of permanently temporarily (newly) colonised quadrates in the specific year in the Czech Republic.

The output of long-term compilation of map data could be estimates of population trends in the Czech Republic (potentially in parts of regions).

Records of traces of settlement

Mapping dispersal of the beaver is based only on seeking out new settlements or on confirmation of a permanent previously registered settlement. The mapping system in the Czech Republic is random, it does not concern systematic surveys. Data is usually compiled from research projects, from reports by professional OP workers, from published work or from random lay reports.

In disputable cases (in areas that require increased attention) unconfirmed (or lay) data must be verified by an expert.

Any fresh traces of settlement left by beavers are sought, this concerns (in order from data with the highest significance):

a) dams, shelters (burrows, lodges) and winter storage sites,

b) fresh intensive groupings of gnawed trees,

c) tracks, scent markings, cadavers,

d) observation of individuals, rescue translocation.

Each group of mentioned documents of existence of the beaver in a locality has a different evidential capacity:

re a) mentions an evident settlement of overwintering individuals (beaver territory), it is usually possible to use this data (evaluated as activity of a maximum of one season old) to confirm recent settlement of the locality;

re b) a zone of intensive beaver gnawing (of a length of several hundreds of metres) usually also means long-term settlement of the area by a group of beavers; a small and isolated group of gnawed trees (without other traces of residence (re a)) usually does not mean the existence of a territory in the locality;

re c) this data provides no other information than that there are several individuals in the area; this data cannot be used as a basis for confirmation of the existence of a settlement in the locality; this data of itself is simply evidence of immediate beaver activity in the locality (migration, temporary settlement by solitary individual/s).

Activity by the Eurasian Beaver most frequently appears in the littoral zone. Most traces of presence can be found on the banks at a maximum distance of 10 m from the surface of watercourses or bodies of water. It is occasionally possible to find some traces up to 50 and more metres from the water level.

In ideal cases all traces of presence, which can be found in the area, are recorded during mapping. Each finding should be registered and its location determined (in the map, ideally GPS coordinates).

Data analysis

The compiled data (from reports, finding database) should be converted to the GIS environment, including information about the type of finding.

Data analysis consists of determination of the number of territories (on the basis of data) for the specific year. The second level of output that can be detected is the temporary presence of pioneer individuals (without permanent territories) in new areas (dispersal of beavers to new regions can be observed).

Proposal of the methodology for monitoring the Eurasian Beaver in the Czech Republic

The goal of monitoring numbers (monitoring and mapping):

The purpose of monitoring the numbers of phenomena of European significance is primarily fulfilment of the reporting duty of EU member states according to Article 17 of the Directive on habitats (92/43/EEC; applied in Section 45f in Act No. 114/1992 Sb.) and execution of an Evaluation report. The evaluation reports have a unified format and require current knowledge: dispersal of the species, population values, population trends and the range and evaluation of the habitat of the species and risk factors (all on the most accurate achievable level). In order to establish current dispersal it is necessary to evaluate and systemise compilation of data about the presence of the species (mapping), to establish population trends, or establish precise population data a monitoring system must be implemented in permanent areas.

The attained results are secondarily used as a basis for conservation of endangered species and their habitats, on the level of nationwide concepts and also on a local level in cases of individually monitored localities.

Presence of the species and selection of monitoring localities

In the Czech Republic the Eurasian Beaver currently forms several larger permanent populations on the lower section of the Elbe in the region of Děčín, in South-West and North-East Bohemia, in Silesia and along the Morava and Dyje rivers and is also spreading dynamically – Berounka River from Pilsen to the Křivoklát region and the central section of the Elbe. All 7 SAC types are regularly monitored. New settlements are also established, verified and localised.

Monitoring

The purpose of monitoring is to establish current changes in longer-term populations in the Czech Republic (SAC types in the Czech Republic). On the basis of terrain mapping of traces of presence left by individuals of the species and after analysis of the compiled data, it is possible to evaluate changes to key population parameters and subsequently also the dynamics of monitored populations. The acquired data is also used to perform more detailed analyses of the food acquiring behaviour of monitored populations settling different habitats.

Monitoring of the Eurasian Beaver is based on counting settlement localities (colonies, families, or territories defended by these social units), because direct establishment of the numbers of individuals is methodologically very difficult and financially very demanding.

The period from November to March, when minimal changes to the location of individuals (dispersal) occur and families are stabilised, is ideal for monitoring the traces of presence of beavers. Recordable traces are very visible thanks to minimum vegetation coverage. This particularly concerns autumn modifications of the water level in small watercourses (construction of dams), construction and modification of winter burrows and lodges and chiefly preparation of winter stores of wood. During this period beaver activities are conspicuous and it is therefore relatively easy to determine and localise a maximum of traces of presence. On the basis of this data it is then possible to estimate the key parameters of the monitored populations. On the contrary, during the late spring, summer and early autumn periods the Eurasian Beaver's activities can be fairly inconspicuous and some settled sections may be overlooked.

Description of the territory is based on localisation of all registered traces of presence (active burrows, lodges as well as slides, pavements, tracks and particularly gnawed wood). Scent markings can be used to increase accuracy, however, finding and determining these requires more experience and attention when searching the terrain and their location is made more difficult in the winter period because the beaver's "scent marking activity" is minimal during this period. Only traces of presence originating from the time creation of winter stores begins (October – November) are registered.

To determine (estimate) the absolute number of individuals in regions (or in the entire Czech Republic) it is recommended that the conversion rate of 5.5 individuals per one territory be used. When estimating total numbers a significant variability of beaver numbers in one territory must be assumed. The trend that newly settled territories will have a smaller number of animals in families, because the entire generational structure will not be developed yet, while older and fully developed families will be more numerous, is probable.

Evidence of traces of residence

Traces of residence are registered when walking along the banks of watercourses or bodies of water. If the character of the area and body of water enables this, it is suitable to use a boat or inflatable raft for this work.

Primary data – traces of activities by the Eurasian Beaver in the studied areas – are obtained during the winter period, usually from January to March.

Traces of activity by the Eurasian Beaver most frequently appear in the bank zone. Most traces of presence can be found at a maximum distance of 10 m from the bank. It is occasionally possible to observe some traces of presence up to 50 or more metres from the surface of the water (for example during the spring melt). A fairly important time is fluctuation of the water level. In the event of significant fluctuation, the variability of the height of traces of presence (particularly gnawing) must be assumed when searching for traces of presence.

During monitoring all traces of presence that can be found in the area are registered in the area around watercourses and bodies of water. Each finding is qualified, quantified and the data is also precisely localised using GPS coordinates. Findings are classified in one of the five categories of traces of presence (gnawing, scent markings, shelters, tracks or construction activities). Each finding must also be described appropriately.

Incidents of gnawing are counted at the site of the finding by counting individual gnawed trees separately for each category of diameter; the genus of woody plant that was gnawed is also registered. If there are multiple gnawed woody plants at one site, these are counted for each genus separately. Scent markings are also counted at the site of the finding, and are classified as so-called active (identifiable by the human nose) and non-active (older, stale, but still visible). In the event that a den or lodge is found, it is important to determine whether the shelter is actively used or has been abandoned. Construction activities must be described in words and can also be quantified.

Form of results and data storage format

Establishment of the parameters of the Eurasian Beaver population in the monitored areas is initially based on data about beaver activity in the area. The acquired information has the form of a GIS layer of points, to which a database with a description of the findings belonging to each point on the layer is appended. It is possible to create and evaluate spatial distribution of families (territories), which is the basis for establishing population density and monitoring settlement dynamics on this basis.

The resulting monitoring files (scope and location of territories) will be entered into the MOD application and subsequently converted for portrayal in the Nature Conservation Finding Database administered by the Nature Conservation Agency of the Czech Republic.

Proposal of analysis of the territory

The size of the territory of a beaver settlement can be determined by procedure based on probability statistics – estimates of the density of compiled data (the method works with the behavioural expression of beavers in space). It is therefore possible to determine the scope and localisation of one or more centres of activities on the monitored watercourse. The advantage of this is the possibility of determining the number of territories even on a long, continuously settled watercourse. It can also be used to determine territories in extensive wetland areas or on significantly meandering watercourses.