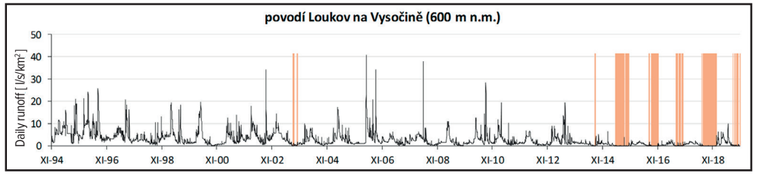


Figure 8: Daily runoff from the Loukov forest catchment area in the Bohemian-Moravian Highlands, recorded from November 1994 to October 2019. Orange fields indicate dry periods without obvious surface runoff. Prepared by Filip Oulehle

Table 1: Changes in hydrological characteristics of the Modravský potok/Modrava Brook catchment area. Prepared on the basis of scenarios elaborated by Lamačová *et al* (2018)

	1981–2010	2021–2050	2071–2100
Number of days with extreme precipitation*	63	86	97
Average annual number of days without precipitation	157	150	151
Average daily maximum flow (m^3/s)	32	39	41

* number of days with precipitation higher than 48.9 mm, which is 99% quantile of all days when it rained in the period 1981–2010

ceeding saturation capacities of river catchment areas), but also an increase in the frequency of periods with very low precipitation, and thus also periods when there will be water shortages in river catchment areas. It was the period of 2014-2019 that probably offered us a hydrological excursion into the future. However, so far only a "dry" variant without extreme precipitation.

Specifically, for the already mentioned Modravský potok/Modrava Brook catchment area, climate models (a combination of many scenarios of climate change different levels) predict an increase in the number of days with extremely high precipitation (Tab. 1). Although in the thirty-year control period (1981–2010) there was a total of 63 days with precipitation higher than 49 mm (99% quantile*; i.e.,* 1% of the highest precipitation totals), for 2021–2050 it will increase to 86 days and for 2071–2100 to 97 days (*i.e*., by about a third). The number of days without precipitation will not change much. Alongside an increase in the frequency of extreme precipitation, there will be an increase in the maximum daily flows, namely up to values of about 20-30% higher than those recorded so far (Tab. 1). Total precipitation totals will increase by about 10–15% for the whole Czech Republic (Štěpánek *et al.* 2019).

Thus, a combination of drought and short-term high rainfall and floods can be expected. And, in both cases, more extreme than we have been used to. Both the extremes will occur regardless of vegetation cover in a catchment area, which will probably not change very much.

Conclusion

The current collapse of commercial forests (especially spruce) is a consequence of the low ability of monoculture/plantation management to cope with rapidly changing environmental conditions, such as rising temperatures and increased variability in the total and distribution of precipitation. Forest production, obviously and purposefully set to the conditions experienced in recent centuries, has been reaching its limits, especially in areas where the demands for evaporation are close to the precipitation amount. These areas can be roughly defined in the range of altitudes 450–600 m a.s.l. Monoculture/plantation spruce management leads to a reduction in the input of precipitation into forest soil due to high interception losses (up to 40% of precipitation loss when the rain passes through a treetop) and to high transpiration demands of forests primarily grown to maximize biomass production there. Reducing precipitation input, often combined with higher temperature, then results in drought stress due to reduced soil moisture and groundwater levels, followed by reduced photosynthetic activity in trees. At such sites, it is essential to adapt forest management to conditions with an expected increase in temperatures (increase in transpiration requirements) and the possible periodic occurrence of years with below-average precipitation. Growing and managing structurally rich forests with a natural species composition should reduce interception losses and strengthen the use of available water in the entire soil profile. This is best achieved by growing mixed forests with variable root zone depth and varied crown architecture.

The landscape and water regime would greatly benefit from restoration of streams and their floodplains, as well as restoration or building of new wetlands. Drainage, with the aim to gain productive land for growing trees, has been carried out in forests since the end of the 18th century. The water was more of an obstacle in the forest. However, this situation is changing dramatically today, and rapid runoff of water from the landscape is not desirable. Capture the expected large rainfall on the spot, and not guide and direct it elsewhere. Dams are not known to protect against major floods, nor can they hold back water. Wetlands and restored valley floodplains will contribute to a better groundwater supply which can then subsidize runoff and soil profile for longer. The goal of current landscape protection should be to retain water in the places where it has fallen, because only there can it provide the landscape with water and keep it functional, even under the conditions of expected and projected climate change. We must consider water retention in the landscape context, and not as a medium that has primarily economic functions. Of course, we cannot do without drinking water; however, reducing the water cycle to supplying the population and industry with water would certainly be short-sighted and counterproductive.

Acknowledgements

The article was elaborated with the support of the AV21 programme "Water for Life" and the project "Balance of groundwater reserves in the crystalline rocks" implemented by the Czech Geological Survey.

A big thank you to all those involved, whether now or in the past, in the monitoring of GEOMON small forest catchment areas, without which the study of the hydrological regime of small catchment areas would not be possible. Namely, it goes to colleagues from the Institute of Geology of the Czech Academy of Sciences (Tomáš Navrátil), the Institute of Hydrodynamics of the Czech Academy of Sciences (Miroslav Tesař), the Forestry and Game Management Research Institute (Vladimír Černohous & Zdeněk Vícha), and the Czech Hydrometeorological Institute. We would also like to thank Daniela Fottová, an emeritus employee of the Czech Geological Survey, who founded the GEOMON network and coordinated it for two decades.

The Grey Wolf Management Programme in the Czech Republic – An Introductory Presentation

Vladimír Dolejský

"Presumption is our natural and original malady. The most calamitous and fragile of all creatures is man, and at the same time the proudest. He goes installing himself in his imagination that he makes himself God´s equal, that he ascribes himself divine attributes, that he winnows himself and separate himself from the mass of other creatures, determines the share allowed the animals, his colleagues of faculties and powers as seem good to him."

(*Montaigne, An Apology for Raymond Sebond*).

Extermination of the wolf in the Czech lands and Moravia

Before the mid-18th century, Grey wolf (*Canis lupus*) numbers had dramatically declined and during the reign of Maria Theresa of Austria, Holy Roman Empress and Queen of Bohemia (1740–1780), wolves were rare. In 1747 the last wolf in the Novohradské hory Mts. was killed, in 1750 the last wolf in the Brdy Hills, and in 1756 the last two wolves in the Dominion of Vimperk. In Bohemia, wolves survived for the longest time in the Dominion of Krumlov, namely by 1795, thanks to its remotness.

In the 19th century, wolves were only exceptionally captured in Bohemia (*e.g.* the Doupov Hills in 1825, near the castle of Opočno in eastern Bohemia in 1837, in the Jizerské hory (Jizera Mts. in 1842 and 1866, in the Krkonoše/Giant Mts. 1861, near the town of Vimperk 1874). These were apparently often migrating animals. The last wolves in Bohemia were caught in the Šumava/Bohemian Forest Mts.in 1874 and 1891. In both cases these were also migrating animals.

The wolf has recolonized the Czech Republic. © Jaroslav Vogeltanz.

The situation was different in Moravia, particularly in the Beskydy Mts., where the Grey wolf occurred much more frequently in the 19th century. There, 38 wolves were caught in 1815–1851, and after 1852 at least another three. The last historical records of hunted individuals in Moravia are known from the Kouty Forest District in the Jeseníky Mts. (1907), close to the Town of Zábřeh (1908) and finally from Červený Grúň near Jablunkov from 2014.

From the first wolf return to the present situation

The first wolf record in the Czech Republic after the World War II came from the surroundings of Staré Město pod Sněžníkem in northern Moravia in 1947. Other documented records are from Štáblovice in the Opava region (1963) and Kunčice on Mt. Kralický Sněžník (1965). During the 1970s, a strong increase in the number of records. *i.e.* shot animals, occurrence, observations, occurred. Migrating animals appeared in the Šumava/Bohemian Forest Mts. (1976), Krkonoše/Giant Mts. (1977), Rakovník region in Central Bohemia (1988), and the Krušné hory/Ore Mts. (2002). Observations and shot animals are known from the Hrubý Jeseník, Kralický Sněžník and the Bílé Karpaty/White Carpathians Mts.

Migration of individuals from the Carpathian wolf population in Slovakia and Poland has led to the situation that a group of wolves regularly has been appearing in the border area of the Beskydy Protected Landscape Area (PLA) since 1995.

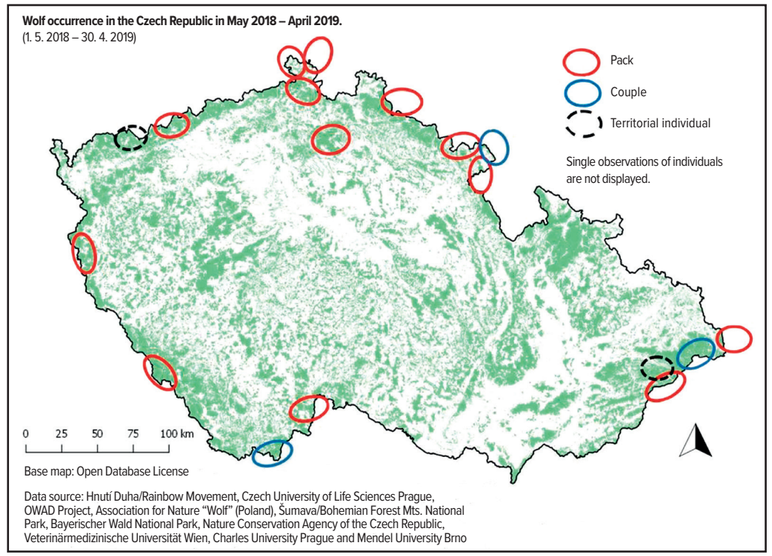
Their presence gave hope for the establishment of a viable, reproducing subpopulation. In 2008, the number of wolves in the Beskydy PLA was estimated at 7 animals, based on observations as well as footprints and other traces. However, in 2003–2012, based on systematic monitoring, the occurrence in the Beskydy PLA and the adjacent territory in Slovakia was assessed as extremely sporadic. Since 2012, wolves have yearly again been captured in camera trap images there.

Since 2017, several individuals have been appearing sporadically in the Bílé Karpaty/White Carpathians. In spring 2018 the occurrence of a new 'Carpathian' pack was documented in the Beskydy Mts. and in 2019 reproduction was confirmed for this pack. This is the first documented reproduction in the area since wolves returned there in the 1990s.

The Grey wolf's current occurrence in the Czech Republic is mostly related to the Central European lowland population. Wolves from northeastern Poland have recolonised western Poland and eastern Germany. Since 2000 they have regularly reproduced in the area of German Lusatia, from where they have spread. The latest monitoring in the 2018/2019 season in Germany confirmed the existence of 105 wolf packs, 27 pairs and 12 territorial individuals. In 100 cases also reproduction was confirmed.

The first reports of possible wolf expansion from Upper Lusatia to the Czech Republic come from 2012, when a wolf was captured with a camera trap close to the Czech border for the first time. Credible observations also come from the Krkonoše/Giant Mts. (2011) and the Broumov region in north-eastern Bohemia (2013). There is also a record of its presence in the Ralsko region, a former military training area, from 2013. In 2014, the presence of two adults and three young wolves was documented there. Therewith the first pack of Bohemia was established and since then, its reproduction has been recorded yearly.

In autumn 2015, a wolf couple had settled in the Broumov region and produced at least two cubs already the following year. Reproduction of this pack around the Czech-Polish border has also been recorded in later years. According to images from camera traps, three wolf cubs were born in 2017 and four in 2018 there. Another area in Bohemia where occurrence of wolves has repeatedly been reported, is the Šluknov Promontory. Since 2015, wolves have also regularly been observed



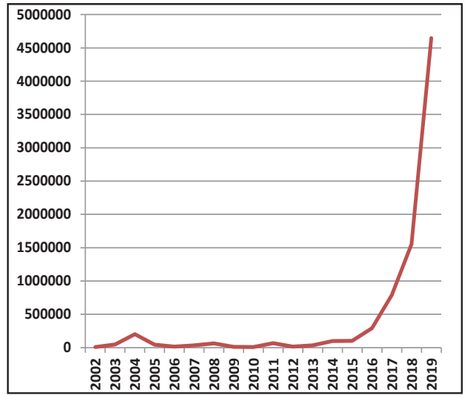
Night shot from a camera trap. © Miroslav Kutal

in the Šumava/Bohemian Forest Mts. and their foothills, Novohradské hory Mts., Český les Mts., Krušné hory/Ore Mts., České Švýcarsko/Bohemian Switzerland, Jizerské hory/Jizera Mts., Krkonoše/Giant Mts. and the Jeseníky Mts.

In 2017, a pack was documented in the Šumva/Bohemian Forest Mts.´ central part. Newly, evidence of reproduction has also been found in the Šluknov region. Records of wolves have gradually been reported also from other places in the Czech Republic. In 2018 the occurrence of wolves was confirmed in the Lužické hory /Lusatian Mts. and the České Švýcarsko/ Bohemian Switzerland NP, and reproduction in the Třeboň region (south Bohemia).

Wolf management plan as a reaction to its expansion

The return of the strictly protected Grey wolf to our region has brought a range of ambiguities and conflicts with it in the past two years. Particularly damage to domestic animals has been increasingly reported, but also concerns of the public about a possible attack by the large carnivores have been raised. A new strategy of the Ministry of the Environment of the Czech Republic titled Grey Wolf Management Programme will make way for a systematic response to the Grey wolf´s expansion in the Czech Republic. It is a set of measures aimed at reducing damage to livestock and other conflicts connected to the presence of wolves in the Czech Republic´s landscape, including a future determination of the so-called species/population favourable conservation status and a uniform procedure by the competent authorities in the case of non-standard wolf behaviour. The management plan has been prepared by the Ministry of the Environment of the Czech Republic with the Nature Conservation Agency of the Czech Republic and scientists. It has also been commented on by representatives of livestock breeders' associations, the Bohemian-Moravian Gamekeeper Association and the Ministry of Agriculture of the Czech Republic. The management programme will be updated after two years.



Year	CZK (EUR = 25.5 CZK)
2002	9 000
2003	48 000
2004	203 000
2005	45 000
2006	15 000
2007	35 000
2008	63 000
2009	11 000
2010	9 100
2011	66 025
2012	17 140
2013	34 300
2014	98 861
2015	102 458
2016	293 189
2017	788 089
2018	1 554 336
2019	4 648 269

Damages paid for losses caused by wolves, Czech Republic 2002–2019, as of November 2019.
Source: Ministry of Finance of the Czech Republic

Female wolf in the Broumov region. © Miroslav Kutal

The Grey wolf is protected by European legislation, namely the EU Habitats Directive and the Bern Convention practically throughout Europe. The Management Programme does and will not change the fact. It is thus not a legislative norm but a plan of the strategic approach, the different measures of which will now be implemented by the Ministry of the Environment of the Czech Republic in collaboration with the competent State Nature Conservancy authorities as well as the Ministry of Agriculture of the Czech Republic, livestock breeders' associations, hunters/gamekeepers and other stakeholders in the countryside.

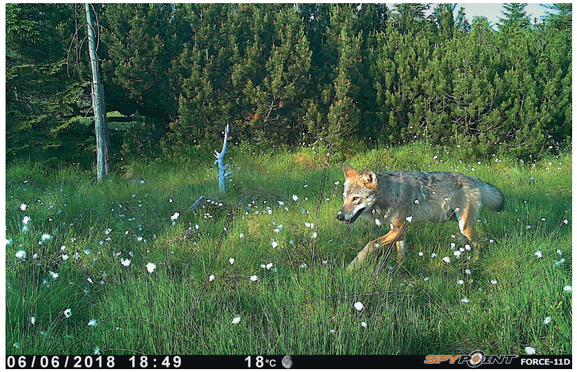
The Management Programme is a strategic document which sets basic steps needed to prevent and solve conflicts with the presence and development of the wolf population. According to the Management Programme, the Ministry of the Environment of the Czech Republic has already been working on legislative changes in the field of damages, aimed at simplifying the provision of compensations to affected entities and facilitating all related administration.

The Nature Conservation Agency of the Czech Republic has been preparing documents such as specifications of effective livestock herd protection measures and guide for dealing with trouble-making wolves.

Collaboration with neighbouring states is necessary

The Management Programme also includes the task to collaborate with Germany and Poland (and with Slovakia in the Carpathian region) on the determination of the so-called favourable conservation status, *i.e.* a population size (and its corresponding proportion for the Czech Republic) which, when reached, gives the Czech Republic and neighbouring states the right to negotiate with the European Commission on amending the EU legislation and possibly setting wolf hunting quotas. The specific target numbers of wolves have as yet neither been set in the surrounding states (such as Saxony, where the wolf population has been developing since 2000 and the first programme was adopted in 2009). One of the few EU Member States with a specific 'viable wolf population' value (not a threshold) for its territory is France. However, the country has been dealing with development of the wolf population for many years and the figure is the only part of the latest, third management plan from 2018.

Concerning the setting of the favourable conservation status value from the conservation perspective, the European Commission recommends for large carnivores and their transboundary populations (see Guidelines on Population Level Management Plans for Large Carnivores) not to apply these values to the territory of the single country only (where, given the low carnivore population density, it may not even be realistic to achieve a favourable species population), but to the popu-



Wolf captured with camera trap in the Krušné hory/Ore Mts. © OWAD Project

Wolf captured with camera trap in southern Bohemia. © Nature Conservation Agency of the Czech Republic archive

lation as a whole. It is obvious that particularly the so-called European lowland population from which wolves have recently been spreading to the Czech Republic, shows a long-term growth, but a specific favourable population size (and its possible proportion corresponding with the area of the Czech Republic) must be determined in collaboration with neighbouring states. This figure could therefore not be incorporated into the programme, although it is a priority measure at the very beginning of its implementation. If the moment of reaching the favourable conservation status has to be an impulse for the abovementioned initiative, leading to a change in the legal status of wolf protection, it is essential that well-documented and evidence-based data not disputed by any of the involved parties are available and there is at the same time agreement, if possible, on a joint approach with neighbouring countries sharing the same population.

The programme includes measures which should react to the situation that a wolf behaves abnormally. Such behaviour must be evaluated properly, and individuals with disturbed, trouble-making behaviour posing a security risk should be removed from nature. Such an individual can only be eliminated based on an exemption according to the Nature Conservation and Landscape Protection Act (and relevant European legislation). The Management Programme requires the introduction of a detailed procedure in these cases up to the level of the implementation, in which both the State/Public Administration in nature conservation and hunting/gamekeeper authorities, *i.e.* specific hunting ground tenants, participate. For the determination of conditions and method of elimination of problematic wolf individuals, the basics are generally obvious (reasons and conditions for a possible exemption). It is however necessary to specify more precisely how to assess if the statutory reasons and conditions are met, *i.e.* specify the procedure for nature protection authorities in granting exemptions. At the same time, there also are needs to be clarified how to proceed in the case of the trouble-making individuals. There, collaboration between the Ministry of the Environment and the Ministry of Agriculture and between State Nature Conservancy authorities, hunters/gamekeepers and other specialists is essential, just like their joint understanding of legislative conditions and requirements (not only the Nature Conservation and Landscape Protection Act, but also the Hunting/Gamekeeping Act and possibly other relevant regulations) and the practical possibilities and circumstances of a solution.

Prevention of damage to livestock and compensation for such damage

The most serious problem with the occurrence of wolves in the Czech Republic´s landscape is the damage caused to livestock. The main objectives of the Grey Wolf Management Programme therefore include particularly the establishment of a functional system for the provision of financial support for the implementation of preventive measures to protect herds, and the improvement of the investigation procedure and the compensation payment for the damages caused. It is also important to provide the public with quality information on *e.g.* ensuring the necessary monitoring and collecting further information, and to share it with the stakeholders (State/Public Administration authorities, livestock breeders, hunters/gamekeepers).

An important issue in the programme is the mentioned financing of preventive measures. At the moment these can be funded from the Operational Programme Environment. This is however a complicated and administratively demanding instrument. Therefore, attempts should be made to set up more effective conditions to make support easily accessible to livestock breeders. Logically, the most appropriate solution would be to link them with other subvention programmes/subsidy schemes for farmers. However, the Ministry of Agriculture of the Czech Republic has not yet agreed to the proposal. The matter needs to be discussed further and alternative solutions must be found.

Species management programmes are as a rule adopted for a ten-year term, but the Ministry of the Environment of the Czech Republic counts with an update after already two years in the case of the Grey wolf. By then, several important measures should be implemented, *e.g.* determining the population size (so-called favourable conservation status values according to European requirements) and determining conditions for supporting the introduction of measures to protect herds in the programme period 2021–2027.

In the Western world and in the natural sciences, we have extraordinary instruments at our disposal to study animals, we have a system for their classification, and thanks to libraries and periodicals we also have a system of spreading information. However, if we want to learn more about animals, and by that I mean real knowledge, not more factual information, we have to go to the forests to observe them. (Barry Lopez, Of Wolves and Men)

Butterfly Conservation in the Era of Climate

Václav John, Jiří Beneš, David Čížp, Miloš Andres, Martin Konvička

Europe has considerably warmed up during the past decades, which is reflected in changes in the insect fauna. The most recognizable example is an expanding distribution range of the Praying mantis (*Mantis religiosa*), which has occupied, starting from the south, the whole of Moravia including the Jeseníky and Beskydy Mts during the 1990s, and has arrived in Bohemia via the Svitavy region. At present it occurs not only in Central Bohemian lowlands but also in the foothills of the Krkonoše/Giant Mts. or in the Bohemian-Moravian Highlands. Expanding butterflies include the Large copper (*Lycaena dispar*), which spreads at the same rate and in the same direction as the mantis, Great banded grayling (*Brinthesia circe*) and the Scarce swallowtail (*Iphiclides podalirius*).

Effect of year-round free grazing by native European grazers, horses and “aurochs”, at Milovice, Central Bohemia. © Miloň Jirků

Some expansions have been very recent. Examples include the Adonis blue (*Polyommatus bellargus*), which has been returning to eastern and central Bohemia from Moravia only in the past five years, and the Spotted fritillary (*Melitaea didyma*), which has been occupying its historic sites in southern Moravia since 2017. Some species are colonising new areas: *e.g.* the Short-tailed blue (*Cupido argiades*) has reached the north of Moravia. Other ones are completely new to the Czech Republic, the Eastern pale clouded yellow (*Colias erate*) already since the 1990s, and the European beak (*Libythea celtis*) since 2019. In a total, 20 diurnal butterflies display recent expansion in the Czech Republic. There are of course more nocturnal moths showing expansion. The probably most prominent are arrivals of the well-known migratory Death’s-head hawkmoth (*Acherontia atropos*) and the Oleander hawkmoth, known as the Army green moth (*Daphnis nerii*), whose numbers have been higher in the last decade than in the past fifty years.

Paradoxically, warming has a positive effect on species diversity. Since the number of species increases from north to south, there are more species profiting from warming than those driven to the north or into the mountains. Warming will however not solve the increasingly acute and pressing of insect extinction (*cf.* Čížek *et al.*, *Živa* 5/2019, 247–250). In the past, the largest declines were seen in species of open-canopy forests, park landscapes and all non-forest vegetation types, *i.e.* habitats typical of the ‘ancient’ cultural landscape, which has been destroyed by industrialising farming on the Czech Republic´s territory in the past 150 years or so. Today mainly generalist species in southern regions expand to the Czech Republic. More specialised species, dependent on high-demanding management of their (often protected) habitats, do not spread there nor in neighbouring countries. Besides, also the abundance of hitherto common species has been declining.

North-south and altitudinal shifts in the distribution range of butterflies were the first evidence of the climate change influence on the occurrence of organisms (Parmesan *et al.*, *Nature* 399, 579–583). Knowledge of the mechanisms of these changes also comes from Western Europe. Until the 1990s, the Silver-spotted skipper (*Hesperia comma*) had been very rare in Great Britain. Then an expansion to the north took place. It has been shown that larvae currently develop in different conditions than a few decades ago. The butterfly used to develop on south- or west-facing short grasslands. Today it prefers taller grassland, even on north- or east-facing slopes. The caterpillars still require the same microclimate, but that is found elsewhere in hot summers (Davies *et al.*,