Action Plan for the Conservation of the Bat Species in the European Union 2014 - 2020

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COVER PHOTOS:

- Top-left corner: *Rhinolophus ferrumequinum* – L. Spanneut (Ecosphère)
- Bottom-left corner: *Nyctalus leislerii* – G. Marchais (Ecosphère)
- Top-right corner: *Pipistrellus pipistrellus* – L. Spanneut (Ecosphère)
- Bottom-right corner: *Nyctalus leislerii* – N. Flamand (Ecosphère)

Contents

List of table, figures and maps

INTRODUCTION

European bats are a species-rich group widely distributed through the range of agricultural, forests and other habitats that form the landscapes of Europe. Serious declines in populations have occurred historically throughout Western Europe, particularly in the latter half of the twentieth century. Protection of bats and investment in their conservation has led to the stabilisation of population trends for some species more recently, but bats remain vulnerable to roost loss and habitat change in several EU Member states (MS). Some other species continue to decline.

Bats are an essential component of the great variety of natural and semi-natural ecosystems in the European Union. From an ecological perspective, this group is a good ecological indicator since bats respond to very slight changes in their environment. Such responses can be useful in revealing habitat fragmentation, ecosystem stress, intensification of agriculture or forestry as well as various human activities.

The European landscape has been and continues to be affected by intensive and varied human influences that have had widespread and sometimes devastating effects on bat populations. In addition, there are continued misunderstandings and prejudices arising from ignorance about bats and their lives and habits. As a result of these impacts, many species are considered threatened; some have even become extinct in a number of countries.

The aim of this EU Species Action Plan (SAP) for all bat species is to support the development of national or local action plans and conservation measures as appropriate[1].The objectives of this EU SAP are as follows:

- To provide baseline data about species status;
- To provide scientifically-based recommendations to those who can promote and support species conservation;
- To establish priorities in bat species conservation;
- To provide a common framework and focus for a wide range of stakeholders.

The information and proposed conservation actions presented in this EU SAP have been prepared in consultation with EUROBATS and a group of experts from all EU countries as well as through a review of available literature as in 2013. An attempt has been made in this EU SAP to summarize the literature most relevant to bats conservation. Ecology, distribution, status and threats are outlined.

Finally, the conservation actions proposed for the bat species are presented and recommendations are provided regarding stakeholder participation and the monitoring and review of this Plan.

Within the frame of this Multi-Species Action plan, a meeting with bats experts was held (18/11/2013) in order to analyze the threats facing the species, develop a conservation strategy and identify the most important actions.

This plan is intended to be implemented in all the EU MS unless an action plan is already implemented. For these states, amendments may be made when they will be reviewed.

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[1] The EU Species Action Plans are not of a binding nature; species action plans are drafted and implemented at the discretion of MS.

1 - FOCUS SPECIES AND THEIR NATURAL HISTORY

1.1 - Focus species and their IUCN Red list status

Bats (order Chiroptera) are the only mammals that can fly. There are 45 species in the European Union from 5 families and 12 genera as presented in Table 1. The International Union for the Conservation of Nature (IUCN) red list statuses were published in 2007 for terrestrial Europe and for EU (only 25 Member States then, 28 in 2013) (1), and the latest world statuses were extracted from www.iucnredlist.org.

Table 1 – European species and their conservation status

IUCN red list categories:

- *EN: endangered – Very high risk of extinction in the wild;*
- *VU: vulnerable – High risk of extinction in the wild;*
- *NT: near Threatened – Likely to become threatened in the near future;*
- *LC: Least Concern – Does not qualify for a more at risk category. Widespread and abundant taxa are included in this category;*
- *DD: Data Deficient – Inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status;*
- *N/A: not assessed.*

SPECIES		IUCN Red list status			HD[2] Annex IV	HD Annex II
		World	Europe	EU 25 terrestrial		
Rhinolophidae (Horseshoe bats)						
Blasius's horseshoe bat	*Rhinolophus blasii*	LC	VU	DD	x	x
Mediterranean horseshoe bat	*Rhinolophus euryale*	NT	VU	VU	x	x
Greater horseshoe bat	*Rhinolophus ferrumequinum*	LC	NT	NT	x	x
Lesser horseshoe bat	*Rhinolophus hipposideros*	LC	NT	NT	x	x
Mehely's horseshoe bat	*Rhinolophus mehelyi*	VU	VU	VU	x	x
Vespertilionidae (Evening bats)						
Western Barbastelle bat	*Barbastella barbastellus*	NT	VU	VU	x	x
Anatolian Serotine	*Eptesicus anatolicus*	N/A	N/A	N/A	x	
Northern bat	*Eptesicus nilssonii*	LC	LC	LC	x	
Isabelline Serotine bat	*Eptesicus isabellinus*	LC	N/A	N/A	x	
Common Serotine	*Eptesicus serotinus*	LC	LC	LC	x	
Savi's pipistrelle	*Hypsugo savii*	LC	LC	LC	x	
Alcathoe whiskered bat	*Myotis alcathoe*	DD	DD	DD	x	
Steppe whiskered bat	*Myotis aurascens*[3]	LC	LC	LC	x	
Bechstein's bat	*Myotis bechsteinii*	NT	VU	VU	x	x
Lesser mouse-eared bat	*Myotis blythii oxygnathus*	LC	NT	NT	x	x

[2] Annexes of the Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. 1992 (Consolidated version 1. 1. 2007). http://ec.europa.eu/environment/nature/legislation/habitatsdirective

[3] Formerly in *Myotis mystacinus*, probably more studies needed (very poorly known), sometime questioned.

SPECIES		IUCN Red list status			HD[2] Annex IV	HD Annex II
		World	Europe	EU 25 terrestrial		
Brandt's bat	*Myotis brandtii*	LC	LC	LC	x	
Long-fingered bat	*Myotis capaccinii*	VU	VU	VU	x	x
Pond bat	*Myotis dasycneme*	NT	NT	NT	x	x
Daubenton's bat	*Myotis daubentonii*	LC	LC	LC	x	
Escalerai bat	*Myotis escalerai*[4]	N/A	N/A	N/A	x	
Geoffroy's bat	*Myotis emarginatus*	LC	LC	LC	x	x
Greater mouse-eared bat	*Myotis myotis*	LC	LC	LC	x	x
Whiskered bat	*Myotis mystacinus*	LC	LC	LC	x	
Natterer's bat	*Myotis nattereri*	LC	LC	LC	x	
Maghreb mouse-eared bat	*Myotis punicus*	NT	NT	NT	x	
Azorean bat	*Nyctalus azoreum*	EN	EN	EN	x	
Greater noctule bat	*Nyctalus lasiopterus*	NT	DD	DD	x	
Leisler's bat	*Nyctalus leisleri*	LC	LC	LC	x	
Common noctule	*Nyctalus noctula*	LC	LC	LC	x	
Kuhl's pipistrelle	*Pipistrellus kuhlii*	LC	LC	LC	x	
Hanaki's Dwarf Bat	*Pipistrellus hanaki*	DD	N/A	N/A	x	
Madeira pipistrelle	*Pipistrellus maderensis*	EN	EN	EN	x	
Nathusius's pipistrelle	*Pipistrellus nathusii*	LC	LC	LC	x	
Common pipistrelle	*Pipistrellus pipistrellus*	LC	LC	LC	x	
Pygmy pipistrelle	*Pipistrellus pygmaeus*	LC	LC	LC	x	
Brown long-eared bat	*Plecotus auritus*	LC	LC	LC	x	
Grey long-eared bat	*Plecotus austriacus*	LC	LC	LC	x	
Kolombatovic's Long-eared bat	*Plecotus kolombatovici*	LC	NT	NT	x	
Mountain long-eared bat	*Plecotus macrobullaris*	LC	NT	VU	x	
Sardinian long-eared bat	*Plecotus sardus*	VU	VU	VU	x	
Tenerife long-eared bat	*Plecotus teneriffae*	EN	EN	EN	x	
Parti-coloured bat	*Vespertilio murinus*	LC	LC	LC	x	
Miniopteridae						
Schreiber's bat	*Miniopterus schreibersii*	NT	NT	NT	x	x
Molossidae (Free-tailed bats)						
European free-tailed bat	*Tadarida teniotis*	LC	LC	LC	x	
Pteropodidae						
Egyptian fruit bat	*Rousettus aegyptiacus*	LC	N/A (EN?)	N/A (EN?)	x	x

[4] Formerly in *Myotis nattereri.*

1.2 - Natural history of bats

1.2.1 - Evolution and Biogeography

1.2.1.1 - Evolution

The earliest existing bat fossils are tens of millions years old, even though bats bones are very thin and fragile. It seems that the earliest fossil insect-eating bat found to date is 50 million years old and is very similar to the species of bats that exist today (2). The origins of insect-eating bats and fruits bat differs. The shape of the skulls and teeth, the neck vertebrae and the bones in the hands are very different (2).

1.2.1.2 - Biogeography

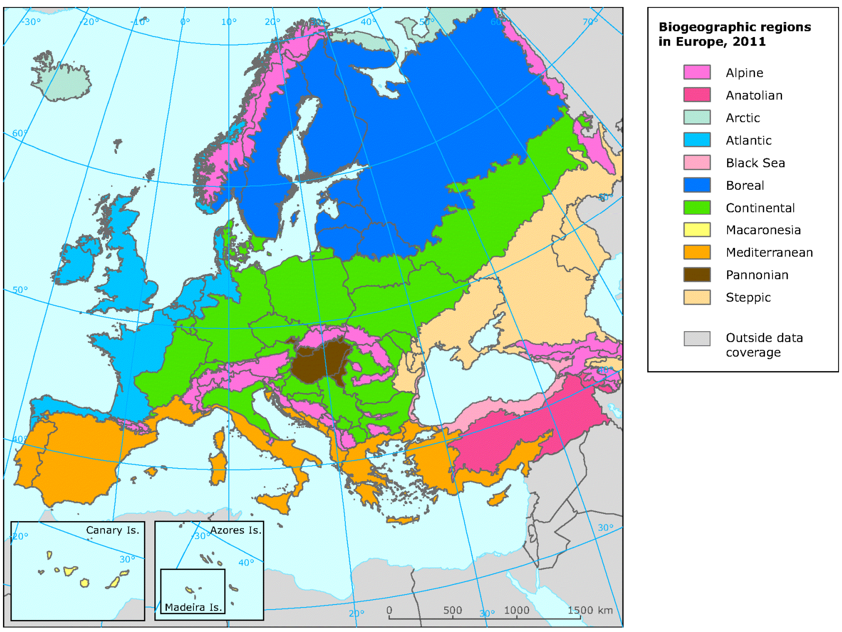
Flight gives bats the opportunity to go almost anywhere. Mountain ranges, seas or similar barriers that are obstacles to land-based mammals restrict them far less. This feature enables bats to reach new environments and after many generations, the survivors are gradually changed by the process of natural selection into new species (3). Bats are found in most terrestrial habitats, except in colder parts of the northern and southern hemispheres beyond the limit of tree growth or on some oceanic islands. The number of species increases towards the equator, where there is more food of more varied types than in temperate regions. Bats constitute the second most diverse mammal group in Europe (4). Three environmental characteristics (latitude, area and temperature) are the main predictors of bat species richness in Europe. These attributes act in an additive manner (5).

1.2.1.3 - Endemism

Each species is restricted in its range due to the ecological niche it has filled, governed by food supplies, temperature and roosting site availability. Some species have an extensive range, particularly those on large land masses. Other species, by contrast, have very small ranges. When they become geographically isolated over a very long period of time, bats evolve into new and unique species that can only be found in a single place – this is called endemism. Endemic species are especially likely to develop on biologically isolated areas such as islands. The endemic bat species of Europe are the Tenerife long-eared bat (*Plecotus teneriffae*), the Sardinian long-eared bat (*Plecotus sardus*), the Madeira's pipistrelle (*Pipistrellus maderensis*) and the Azorean bat (*Nyctalus azoreum*).

1.2.1.4 - EU Biogeographic regions

European bat species comprise several biogeographic groups with a widespread distribution in Europe (6), covering all the major biogeographic regions from the warmer Mediterranean to the colder Boreal and Alpine regions as shown in the map below.



Map 1 - Biogeographic regions in Europe (2011)

Using a spatial principal components analysis, the following plot was produced for 28 European bat species in which the three biogeographic groups can be distinguished (7). Four species were grouped in the Boreal biogeographic zone, 10 in the Temperate Humid Zone and 14 in the Mediterranean Zone (Fig. 1).

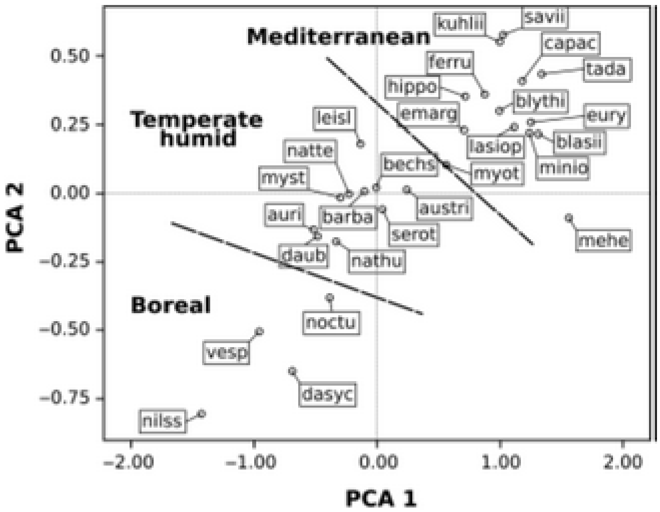


Figure 1 - Principal Components Analysis plot of the 28 bat species using three climatic variables (from (6)). The dashed lines separate each biogeographic group

Furthermore, there is a north-south gradient with the number of species increasing going southward (see chart 1 below).

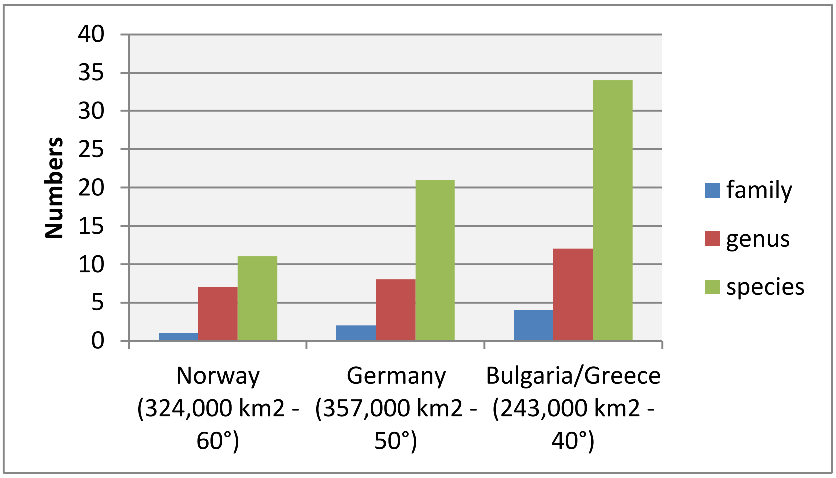


Figure 2 - Numbers of families, genera and species of European bats from north to south (from (7)).

1.2.1.5 - Influence of climate change

Biogeographic patterns exert a great influence on a species' response to climate change, with expected responses including range and population change (7). Bat species more associated with colder climates are most likely to be affected by current climate change prediction scenarios, while Mediterranean and Temperate groups may be more tolerant. However, the projections can vary considerably under different climate change scenarios (7).

1.2.2 - Life cycle

1.2.2.1 - General description from winter to autumn

In winter, the cold weather limits the numbers of active insects so there is little available food for insectivorous bats. Therefore, bats have developed a remarkable energy-saving strategy by hibernating – sleeping over a long period (many weeks) and cooling down their body temperature to approximately the same temperature as the surroundings. They also slow down their heart-beat and their breathing.

In spring time, as the ambient temperature rises up, they warm up their body to be able to fly and hunt for prey. While building up their reserves, they explore new areas and new roosting sites. The embryo of females, which have mated the previous autumn, starts to develop.

In summer, pregnant females gather together to give birth in maternity roosts – these are warm hidden and sheltered places. A female usually produces a single baby per year, but a few species, such as the ones belonging to the genera *Nyctalus* and *Pipistrellus* but also *Eptesicus,* occasionally produce twins. Males are usually not very active at this time of the year apart from feeding and exploring sites. Females spend several weeks weaning their babies which are born around June and July.

The juveniles may be able to fly out at one-month old only with the adults. By the end of summer, the offspring are almost independent but fly with the adults to learn the good feeding areas and roosting sites.

At the end of summer, the maternity colonies begin to move and split into smaller groups. Males become more active in courting females for mating. Some roosts are used for social gatherings called 'swarming sites' where up to a thousand bats seem to interact and build up various degrees of relationships with others.

By winter, the bats have sought out hibernation sites either individually or in small groups.

This is a general description (8). Close study of a single species will show up a number of variations in this basic pattern. Indeed, some species in warmer European countries may not hibernate and that a number of bats may be active during hibernation.

1.2.2.2 - Roosts

Bats do not make nests like birds but rather roost in a great variety of sites using overground structures like buildings, bridges, trees, or underground sites like caves, tunnels, mines, cellars - without bringing any kind of material. They often change site from one period of the year to another following the changes in weather and temperature patterns and to get closer to areas rich in prey. Being warm-blooded animals, they need to keep warm when they are resting or asleep during the active period (March to November in general). During winter, they need to find sheltered places with the right conditions of humidity and temperature as to be safe for hibernating over several months (8).

Depending on their functionality, the different types of roosts are classified as follow:

A HIBERNATION ROOSTS

These roosts are places where bats hide for safety when hibernating over winter because they are not capable to react from any danger (disturbance or predation) that may occur in the outdoors. Each species has its own requirements or habits, thus bats can be found in caves, mines, rock crevices, buildings but also in trees in winter.

B MATERNITY ROOSTS

These roosts are gatherings of female bats ready to give birth. Being together in numbers helps keeping the babies warm and safe. Males roost elsewhere (transitional roosts) most of the time; with some noticeable exceptions for *Plecotus* spp. bats, *Rhinolophus* spp. bats, *Miniopterus schreibersii*, *Myotis myotis*... These maternities or nurseries may contain many hundreds of females with their babies. Each species has its own requirements or habits, thus pregnant bats can be found in caves, mines, rock crevices and buildings or in trees.

C SWARMING SITES

These sites are roosts where a great number of bats gather in late summer for social interactions that are not fully understood to us. They were recently proposed as 'hot spots' for gene flow among populations – they seem to meet at swarming sites across colonies to start mating and, in addition, to renew information about suitable hibernacula (10). These roosts are usually found in caves, mines, tunnels or buildings, but also in deep forest areas and reed beds.

D TRANSITIONAL ROOSTS

These are all the other types of roosts where bats do not stay for long or have a special activity apart from resting. They may be used as an alternative for a better, but disturbed, roost or as a stopover while migrating or dispersing.

Table 2 below describes which species uses what type of roost at a certain period of the year.

Table 2 – The different roost types for the European species of bats
A: attics and other roofing spaces; B: buildings; C: caves and other underground sites (mines, bunkers); I: infrastructures (bridges, tunnels); T: trees; R: rock crevices or fissures; (A, B, C, I, T or R): means possible but not typical

SPECIES	Hibernation	Maternity	Transitional	Swarming
Rhinolophus blasii	C	C	C	
Rhinolophus euryale	C	C, A, (B), (I)	C, A, (B)	
Rhinolophus ferrumequinum	C	C, A, B	C, A, B	
Rhinolophus hipposideros	C	C, A, B, I	C, A, B, I, (T)	
Rhinolophus mehelyi	C	C	C	
Barbastella barbastellus	C, R, I, (T)	T, B, (R)	T, B, R	
Eptesicus anatolicus	R, B, (I)	B, R ?, (T)	B, R, I, (T)	
Eptesicus nilssonii	C, B, (R), (I)	B, (T), A	B, I, (T)	
Eptesicus isabellinus	B, R, I	B, R ?, (T)	B, I, (T)	
Eptesicus serotinus	B, I, (C)	B, A, I, (T)	B, (R), (T)	
Hypsugo savii	R, C	R, B	R, T, B, (I)	R, C
Myotis alcathoe	C, (T ?)	T	T, C	T, C
Myotis aurascens	C	R, I	R	R, C
Myotis bechsteinii	C, (T)	T, (B)	T	C
Myotis blythii oxygnathus	C	C, A, (I), (B)	C, A, I, (B)	C
Myotis brandtii	C, I	T, B	T, B	C, B
Myotis capaccinii	C, (B)	C	C, (I), (R)	C
Myotis dasycneme	C	B, A, (T)	B, T, C	B, C
Myotis daubentonii	C, I, (T)	I, T, C, B	I, T, B	C, I
Myotis escalerai	C	T, B, C	T, B, C	C, B
Myotis emarginatus	C	B, A, C, I	B, A, C, T, I	B, A, C
Myotis myotis	C, R	C, A, I, (B)	C, A, B, T, R	C, A
Myotis mystacinus	C	T, B, I	C, B, T	C, B
Myotis nattereri	C	T, B, (C), (I)	T, B, R, I, C	C, R
Myotis punicus	C	C, B,(I)	C, B, A, I	C, B, I
Nyctalus azoreum	T, R	T, B	T, R, B	
Nyctalus lasiopterus	T, R	T, (B)	T, R, I	
Nyctalus leisleri	T, R	T, (B)	T, R, I	
Nyctalus noctula	T, R, B, (C)	T, B	T, R, I, B	
Pipistrellus hanaki	B, R, C	T, B	T	C

SPECIES	Hibernation	Maternity	Transitional	Swarming
Pipistrellus kuhlii	B, R, (C)	B	B, T, R	B, C
Pipistrellus maderensis	B, R	B, A, R	B, A, R, I, T	B, A, R
Pipistrellus nathusii	T, R, (C)	T, B	T, B, R, I	T, B, R
Pipistrellus pipistrellus	B, C, I, (T)	B, T, A	B, T, A	B, A, C
Pipistrellus pygmaeus	B, T, C, I, (R)	T, B, A	B, T, A, I	B, A, C
Plecotus auritus	B, (C), (T)	T, B, A	B, T, A, I	
Plecotus austriacus	B, (C)	B, A, (C)	B, A, I	
Plecotus kolombatovici	C, R	B, A, I	R, B, C	
Plecotus macrobullaris	C, B	B, A	B, A	
Plecotus sardus	C, R, I	B	B, I, R	
Plecotus teneriffae	C, R	C, B, (R)	C, R, B	
Vespertilio murinus	R, B, I, (T)	B, A, R, (T)	B, R, (T)	
Miniopterus schreibersii	C	C, (A)	C, I, (B)	C, I, (B)
Tadarida teniotis	R, I	R, I	R, I, B, (T)	
Rousettus aegyptiacus	C	C, B, T	C, B, T	

1.2.3 - Foraging areas, commuting routes and ecological corridors

Bats are flying mammals which travel across the landscape using various features either natural or man-made, such as rivers, hedges, walls and bridges, to aid navigation and commuting to the principal foraging areas where they search for prey.

1.2.3.1 - Diet

A PREY ITEMS AND THEIR AVAILABILITY

In Europe, bats eat flies, moths, beetles, spiders and other insects (except *Nyctalus lasiopterus* which can hunt for small birds, *Rousettus aegyptiacus* which consumes large amounts of fruit such as wild dates, and *Myotis capaccinii* which can catch small fish). Each species is relatively specialised in the variety of insects it forages. For instance, moths are the bulk of the diet of *Miniopterus schreibersii* (9) throughout the year while the *Eptesicus serotinus* and *E. nilssonii* may hunt various types of swarming insects belonging to the Coleoptera, Lepidoptera, Hymenoptera and Heteroptera orders (10).

B HUNTING STRATEGIES

In Europe, bats forage at night to reduce competition with insectivorous birds. They emit calls in the dark and listen to the echoes of those calls that return from objects in their vicinity to avoid collisions and to catch insects. This capability is called echolocation or active sonar. All bats can also see; they are not blind (8).

Each species have developed their own strategy over millions of years to avoid competition and adapt to an ever-changing environment. Most species hunt in the air space from 0 to 30 m above ground level. Some species may fly and hunt higher especially in the *Nyctalus* genus. *Myotis daubentonii and M. dasycneme* are known to skim along the water surface of rivers and lakes, while *Tadarida teniotis*, the Noctule species (*Nyctalus* spp.*)* and the Serotine species *(Eptesicus/Vesperitilio* spp.) fly fast and high in the sky well clear of obstacles. Other species, such as the *Myotis bechsteinii*, favour dense deciduous woodland to glean insects from tree leaves, and *Myotis myotis* and *M. blythii oxygnathus* forages over pastures, steppes and meadows to catch beetles and grasshoppers off the ground (11).

A single bat may forage up to 20 different areas in a night to maximise its yield, especially the young mothers who need to feed their babies with their milk. A great variation occurs between species: certain species are used to forage not too far from their roosts like the *Rhinolophus* spp. bats and others do not hesitate to travel up to 25-30 km away from it for a rich meal like *Miniopterus schreibersii*.

C ROLE IN THE ECOSYSTEM

Bats are top predators. Although there are few studies on the degree to which bats control insect populations, in some regions they have been found to be highly effective in the control of agricultural pests, providing a major economic benefit to farmers[5]. *Rousettus aegyptiacus* also serves as a pollinator and seed disperser of many plants that are important to humans. Bat populations have the potential to be robust natural indicators of the health of our environment (12; 13). This is because bats are sensitive to pressures which affect other species and habitats (such as climate change, agricultural intensification, pesticides, land-use change) and also complement other taxonomic indicators by providing information on the night-time environment.

1.2.3.2 - Dispersal and Migration

A POPULATION DYNAMICS

Bats are small mammals but live a relatively long life compared to mice for instance - there are records of individuals of 20 and even more than 40 years old (14). Most of the species tend to have K-selected traits[6]: long life expectancy and the production of fewer offspring which often require extensive parental care until they mature.

A pregnant female will gather with other females to give birth a particular year but may not be able to do it every year for different reasons, and so it will live with her youngsters from previous years and other siblings. A male may be close to a particular group over winter but more solitary in summer. Therefore, a single bat may live in a variety of groups or families during its whole lifespan (8).

A typical situation is the gathering of a large number of individuals coming from the same local population (i.e. of close genetic distance) for hibernation in winter. These individuals will then split into smaller groups at spring time. Females and males live separately until autumn when they mate (11).

Particularities also occur: some species such as *Myotis bechsteinii* have very few exchanges between colonies. By studying the mitochondrial DNA of several maternity colonies it has been shown that all females share a common genotype (15).

In general, bats seem to have a typical population dynamic because the mortality rate is constant, independently of the age of adult individuals (10). In Europe, they have no major natural predators unlike many other animals since they are mostly active at night. A few are caught by opportunistic birds of prey (kestrel, sparrowhawk, owls) or other mammals (beech marten, weasel and stoat), but it is rather the domestic cat that has a significant impact on bat populations (16).

Thus, the small numbers of bats in a colony which reach sexual maturity and successfully rear a youngster each year makes long life essential if the population is to be maintained.

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[5] A two-year study on the diet of one individual of *Plecotus austriacus* at Mdina (Malta) resulted in 23 different species of moths, some of which are known to be pests on agricultural products (167).

[6] In ecology, the r/K selection theory relates to the selection of combinations of traits in an organism that trade off between quantity and quality of offspring. The terminology was coined by the ecologists Robert MacArthur and E. O. Wilson based on their work on island biogeography (165).

Table 3 - Different population parameters for 5 species from Central Europe (from (10)).

	Nyctalus noctula	*Pipistrellus pipistrellus*	*Pipistrellus nathusii*	*Myotis myotis*	*Myotis mystacinus*
Adult mortality (per annum)	0,44	0,31 - 0,37	0,32 - 0,34	0,21 - 0,24	0,19
Average life expectancy (in years)	1,7	2,1-2,6	2,4-2,7	3,6 - 4,2	4,6
Average recorded age for individuals at least 1-year old (in years)	2,2 - 2,3	2,7 - 2,9	2,6 - 2,9	3,9 - 4,0	4,5
Maximal recorded age (years)	12	16	14	25	23
Nativity rate required for maintain the population (per annum)	1,5 - 1,6	0,9 - 1,2	0,9 - 1,05	0,54 - 0,64	0,48

B MIGRATORY SPECIES

Many of the European species of bats perform seasonal long distance migrations and use geographically widely separate habitats during their life cycle. Some of them migrate over distances over 1,000 km long, e.g. all *Nyctalus* species and *Pipistrellus nathusii*.

Data on bat migrations in Europe were compiled in a book published in 2005 by the German Federal Agency for Nature Conservation (17). The terminology that describes the observed migrating behaviour of bats is still inconsistent. Fleming & Eby (2003) in (17) suggested defining migration as a seasonal, usually two-way, movement from one place or habitat to another to avoid unfavourable climatic conditions and/or to seek more favourable energetic conditions.

Dispersal usually involves movements away from an animal's place of birth – but not always (18). Because it is often difficult to distinguish between dispersal and incompletely documented migrations, the three widely established though artificial categories of spatial behaviour in bats – long distance, regional and sedentary, were provisionally adopted and are shown in Table 4 for all species. Data available indicate that most of the long-distance migratory bats move into a northeast-southwest direction, while the movements of regional migrants present a typical star-like pattern.

Population dynamics are slightly different for migratory species: young females are very faithful to their place of birth based in northern Europe; while males select their mating roosts in areas close to the migratory routes used by females and connecting summer maternity colonies and hibernation roosts based in southern Europe.

Migration is still understudied in bats and much less understood than for example in birds. It is technically challenging to study but advances in science and technology should lead to major knowledge advances in future.

Table 4 – Spatial behaviour of European bat species (from (17)).
"(x)": means possible but not typical.

SPECIES	Long-distance (> 100 km)	Regional (10-100 km)	Sedentary (<10 km)
Rhinolophus blasii			x
Rhinolophus euryale		(x)	x
Rhinolophus ferrumequinum		(x)	x
Rhinolophus hipposideros		(x)	x
Rhinolophus mehelyi		(x)	x
Barbastella barbastellus		(x)	x
Eptesicus anatolicus			
Eptesicus nilssonii		x	
Eptesicus isabellinus		(x)	x
Eptesicus serotinus		(x)	x
Hypsugo savii	(x)	x	
Myotis alcathoe			x
Myotis aurascens			x?
Myotis bechsteinii			x
Myotis blythii oxygnathus		x	
Myotis brandtii		x	
Myotis capaccinii		x	
Myotis dasycneme		x	
Myotis daubentonii		x	
Myotis escalerai			
Myotis emarginatus		(x)	x
Myotis myotis		x	
Myotis mystacinus		x	
Myotis nattereri		(x)	x
Myotis punicus		x	(x)
Nyctalus azoreum		x	
Nyctalus lasiopterus	x?	x	x
Nyctalus leisleri	x		
Nyctalus noctula	x		
Pipistrellus hanaki			x?
Pipistrellus kuhlii		(x)	x
Pipistrellus maderensis			x
Pipistrellus nathusii	x		
Pipistrellus pipistrellus	x?	x	
Pipistrellus pygmaeus	x	x	
Plecotus auritus			x
Plecotus austriacus			x
Plecotus kolombatovici			x
Plecotus macrobullaris			x
Plecotus sardus			x
Plecotus teneriffae			x
Vespertilio murinus	x	(x)	(x)
Miniopterus schreibersii	(x)	x	
Tadarida teniotis			x
Rousettus aegyptiacus			x

2 - BAT CONSERVATION IN EUROPE

2.1 - Conservation through the Habitats Directive and EU policies

The Birds Directive (BD)[7] and Habitats Directive (HD)[8] are the cornerstones of the EU's biodiversity policy (19). They enable all 28 EU Member States (MS) to work together within a common legislative framework to conserve Europe's most endangered and valuable species and habitats across their entire natural range within the EU, irrespective of political or administrative boundaries.

The overall objective of the HD is to maintain and restore to a favourable conservation status natural habitats and species of wild fauna and flora of Community interest. This directive does not cover every species of plant and animal in Europe (i.e. not all of the EU's biodiversity). Instead, they focus on a sub-set of around 2,000 (out of ca 100,000 or more species present in Europe) which are in need of protection to prevent their extinction. These are often referred to as species of Community interest or EU protected species.

All bat species found in Europe have been considered to be of Community interest:

- **14 bat species** are included in **Annex II** of the HD, and hence require site designation (Special Areas for Conservation) and special management measures aiming at conserving core areas for these species ;
- **All bat species** are included in the **Annex IV** of the HD. This means that they benefit from the general species protection provisions *across their entire natural range* and therefore also outside protected sites. The deterioration or destruction of breeding sites or resting places is prohibited all over Europe (apart from the implementation of the derogation system foreseen by article 16 of the HD).

The directive requires that MS do more than simply prevent the further deterioration of the listed species. They must also undertake positive management measures to ensure their populations are maintained and restored to a ***favourable conservation status*** throughout their natural range within the EU.

Favourable conservation status can be described as a situation where a species is prospering (extent/population) and has good prospects to do so in future as well. The fact that a species is not threatened (i.e. not faced by any direct extinction risk) does not necessarily mean that it is in favourable conservation status. The target of the directive is defined in positive terms, oriented towards a favourable situation, which needs to be defined, reached and maintained. It is therefore much more than just avoiding extinctions.

2.1.1 - The Natura 2000 network

A central element of the nature directives is that they require MS to designate sites for selected species and habitat types listed in the directives to be included into the Natura 2000 network. Once designated, these sites must be managed in a way that maintains or restores those species and habitats for which they have been designated in a good conservation condition.

There are 23,115 sites covering 602,000 km² that have been designated in 2013[9], and more than 700 new sites, including many caves (> 170), were designated for Croatia which has recently joined the EU.

At the end of 2010, around a third of sites designated in the framework of the HD were holding bat populations, including 4,015 sites designated for Annex II bat species (see table below). However, if foraging areas and commuting routes taken into consideration, the number of sites is greater (possibly most of the sites).

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[7] Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (http://ec.europa.eu/environment/nature/legislation/birdsdirective)

[8] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (http://ec.europa.eu/environment/nature/legislation/habitatsdirective)

[9] http://ec.europa.eu/environment/nature/info/pubs/docs/nat2000newsl/nat35_en.pdf

Table 5 - Data from the Natura 2000 database (end of 2010, excluding Population category D)

Bat species included in the Annex II of the Habitats Directive		**Number of sites designated for the species at the end of 2010**
Blasius's horseshoe bat	*Rhinolophus blasii*	82
Mediterranean horseshoe bat	*Rhinolophus euryale*	524
Greater horseshoe bat	*Rhinolophus ferrumequinum*	1,475
Lesser horseshoe bat	*Rhinolophus hipposideros*	1,504
Mehely's horseshoe bat	*Rhinolophus mehelyi*	129
Western Barbastelle bat	*Barbastella barbastellus*	1,129
Bechstein's bat	*Myotis bechsteinii*	992
Lesser mouse-eared bat	*Myotis blythii*	551
Long-fingered bat	*Myotis capaccinii*	237
Pond bat	*Myotis dasycneme*	359
Geoffroy's bat	*Myotis emarginatus*	798
Greater mouse-eared bat	*Myotis myotis*	2,266
Schreiber's bat	*Miniopterus schreibersii*	744
Egyptian fruit bat	*Rousettus aegyptiacus*	26

These sites have to be managed and protected in accordance with the provisions of Article 6 of the HD. These provisions are briefly described hereby as they have a direct relevance for the conservation of bats. The first two paragraphs of Article 6 require MS to:

- establish the necessary conservation measures which correspond to the ecological requirements of the relevant bat species on the sites (Art 6.1);
- prevent any damaging activities that could significantly disturb the relevant bat species or deteriorate their habitats (Article 6.2).

To facilitate this task, MS are encouraged to develop **conservation objectives for each Natura 2000 site**. As a minimum, the conservation objective will be to maintain the conservation condition of bat species for which it was designated and not to allow this to deteriorate further. However, as the overall objective of the directive is for all bat species to reach a favourable conservation status, more ambitious conservation objectives may be set to improve the conservation condition of these species on a site. **Natura 2000 management plans,** where they exist, often outline the conservation objectives for the site and the measures needed to achieve these objectives.

Whereas Article 6(1) and 6(2) of the HD concern the day-to-day management and conservation of Natura 2000 sites, Articles 6(3) and 6(4) lay down the procedure to be followed when planning new developments that might have adverse effects to a Natura 2000 site.

Basically, it requires that any plan or project that is likely to have significant negative effect on a Natura 2000 site undergoes **an 'Appropriate Assessment'** to study these effects in detail and in view of the site's conservation objectives.

Depending on the findings of the appropriate assessment, the competent authority can either agree to the plan or project as it stands if it has ascertained that the project will not have adverse effects to the integrity of the site. Alternatively, depending on the degree of the identified impacts, the competent authority may require:

- the plan or project to be redesigned to prevent adverse effects on the Natura 2000 site;

- mitigation measures to be introduced to remove the negative effects; or certain conditions to be respected during the modification, upgrading and maintenance of the river ecosystems or the construction of associated infrastructures, again to remove the likelihood of negative effects;
- alternative less-damaging solutions to be explored instead.

In exceptional circumstances, a plan or project may still be approved in spite of it having an adverse effect on the integrity of one or more Natura 2000 sites provided the procedural safeguards laid down in the HD are followed (Article 6(4)). Thus, if it can be demonstrated that there is an absence of alternatives and the plan or project is considered to be necessary for ***imperative reasons of overriding public interest,*** then the project may still be approved provided adequate compensation measures are put in place to ensure that the overall coherence of the Natura 2000 network is protected.

2.1.2 - Species protection provisions

In addition to protecting core sites through the Natura 2000 network, the Habitat directive also requires that MS establish a general system of protection for species listed in Annex IV of the HD including all bat species found in Europe. These provisions apply both within and outside protected sites.

The exact terms are laid down in article 12 of the HD[10]. They require MS, amongst others things, to prohibit:

- the deliberate disturbance during breeding, rearing, hibernation and migration;
- the deterioration or destruction of breeding sites or resting places;

The number of derogations issued under article 16 of the HD is not precisely known but there are a number of them.

As some of the protected bat species are potentially vulnerable to long distance interferences with their habitats, these provisions must be taken into account when considering building traffic infrastructures or wind farms only a few kilometres around roosting sites or resting places.

However, the case of "accidental killing" has to be clarified. In view of the impact of roads and wind farms on bats (see below), it is difficult to determine whether the article 16 derogation system has to be applied or if the article 12.d) should be used. Referring to this article, MS shall establish a system to monitor the incidental capture and killing of the bat species listed in Annex IV. In the light of the available information reviewed, MS shall take further research or conservation measures as required to ensure that incidental capture and killing does not have a significant negative impact on the species concerned. It seems that these monitoring systems do not currently exist in most of the MS.

2.1.3 - EU biodiversity strategy

On the 3rd May 2011, the European Commission adopted a new strategy to halt the loss of biodiversity and improve the state of Europe's species, habitats, ecosystems and the services they provide over the next decade. The EU Biodiversity strategy to 2020 includes a vision for 2050 and a 2020 headline target.

In addition, or in coherence with the new focus on ecosystem services, two specific targets will directly benefit to bat populations:

- The full implementation of the EU nature legislation (Actions: complete the establishment of the Natura 2000 Network and ensure good management; ensure adequate financing of Natura 2000 sites; increase stakeholder awareness and involvement and improve enforcement ; improve and streamline monitoring and reporting);

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[10] See the guidance document on the strict protection of animal species of Community interest under the Habitats Directive: http://ec.europa.eu/environment/nature/conservation/species/guidance/index_en.htm

- More sustainable agriculture and forestry (Actions: enhance direct payments for environmental public goods in the EU Common Agricultural Policy; better target Rural Development to biodiversity conservation; conserve Europe's agricultural genetic diversity; encourage forest holders to protect and enhance forest biodiversity; integrate biodiversity measures in forest management plans)

A set of biodiversity indicators will help to determine whether there has been an overall improvement in the state of Europe's biodiversity. Two of them will use available data on bats:

- A reduction in the number of species threatened with extinction;
- An increase in the number of species and habitats protected under EU nature legislation that is in favourable conservation status.

An analysis was prepared for 20 MS11 to compare the situation in terms of conservation status from the article 17 report for the period 2007-2013 per "trinomial"[12] Species/Biogeographic Area/Member State/Species (sp/BA/MS):

- 606 sp/BA/MS have a known status in 2013, including 193 with a favourable conservation status only
- On this data set, 327 BA/MS/sp are comparable between 2006 and 2013;
  - The situation was **stable for 213 sp/BA/MS** (including 72 still with a favourable status);
  - The situation has **improved for 53 sp/BA/MS** (including 26 now in favourable status);
  - The situation **was worst for 34 sp/BA/MS** (including 16 now in bad status);
  - For 6 sp/BA/MS, the species was not known in 2006, but is present in 2013 with a new conservation status;
- For 3 sp/BA/MS, the species was present in 2006 and is now absent in 2013 (temporarily?): *M. blythii* in the Mediterranean region of Malta, *N. noctula* in the Alpine region of Spain and *V. murinus* in the Atlantic region of Belgium ;
- The situation was unknown in 2006 and has been assessed in 2013 for 147 sp/BA/MS (including 10 for which the species is now considered as absent).

These figures have to be taken with caution because improvement or deterioration of conservation status may be related mostly to a better knowledge.

2.1.4 - Green infrastructures

On 5th May 2013, the European Commission published a new Strategy to promote the use of Green Infrastructure across Europe (20). Green Infrastructure is a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. The new Strategy calls for Green Infrastructure to be fully integrated into policies, and to become a standard part of spatial planning and territorial development.

The Natura 2000 Network forms the backbone of Europe's Green Infrastructure which will help reduce the fragmentation of the ecosystems, improving the connectivity between sites in the Natura 2000 Network and thus achieving the objectives of Article 10 of the HD.

In addition to designating core sites under the Natura 2000 Network, Article 10 of the HD also requires MS to endeavour to improve the ecological coherence of the network across the broader countryside by maintaining and, where appropriate, developing features of the landscape which are of major importance for wild fauna and flora, such as wildlife corridors or stepping stones which can be used during migration and dispersal.

Bats are very good indicators for this Green Infrastructure and the ecological network present in the countryside because most of them are using commuting routes between their roosts and their

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[11] It was not possible to include other MS (IE, SE, AT, SI, NL, DE) because of encrypted data. Greece is still in preparation at the date of 22/01/2014 and Croatia had no obligation in 2013.

[12] Trinomial = one species in one biogeographic area from one Member State (combinations - BA/MS/sp)

foraging areas, up to 40 km for some species (21). Landscape features such as hedges, rivers and cliffs are indeed particularly well used by bats.

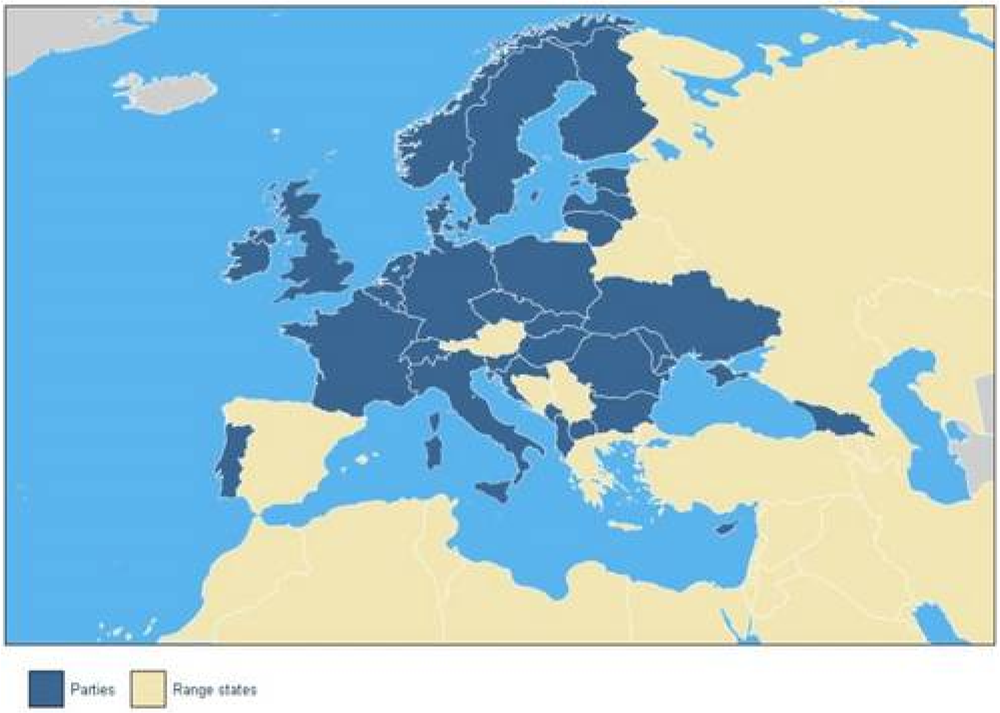
2.2 - UNEP/EUROBATS

The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention[13]) aims to conserve terrestrial, aquatic and avian migratory species throughout their range. It is an intergovernmental treaty concluded under the aegis of the United Nations Environment Programme (UNEP).

As the only global convention specialising in the conservation of migratory species, their habitats and migration routes, CMS complements and co-operates with a number of other international organisations, NGOs and partners in the media as well as in the corporate sector.

Migratory species threatened with extinction are listed on Appendix I of the Convention. However, none of the European bats are listed in this Annex. Migratory species that need or would significantly benefit from international co-operation are listed in Annex II of the Convention. For this reason, the Convention encourages the Range States to conclude global or regional Agreements. In this respect, CMS acts as a framework Convention. The Agreements may range from legally binding treaties (called Agreements) to less formal instruments, such as Memoranda of Understanding, and can be adapted to the requirements of particular regions. Such agreements have the great advantage that the Range States themselves decide on a tailored and structured action plan that includes the organization of joint research, monitoring activities and harmonisation of legislation.

Several Agreements have been concluded to date under the auspices of CMS including an Agreement on the Conservation of Populations of European Bats (EUROBATS[14]) dating from December 1991[15]. All the European bats are included in the Annex II of the CMS apart from *Rousettus aegyptiacus* which is however taken into consideration by EUROBATS.



Map 2 - Parties and Range States of the UNEP/EUROBATS Agreement

[13] www.cms.int/index.html

[14] www.eurobats.org

[15] Apart from *Rousettus aegyptiacus*, all the European bats are included in the annex II of the CMS.

2.2.1 - The UNEP/EUROBATS Agreement

The Agreement on the Conservation of Populations of European Bats entered into force on 16th January 1994. As of December 2012, 35 of 63 Range States are Parties to the Agreement. In the EU, Austria, Greece and Spain are not parties but they may participate to common work.

The Bat Agreement aims to protect all the European bat species[16] - whether migratory or not - occurring in Europe and non-European Range States. The aim of EUROBATS is to conserve these bats through legislation, education, conservation measures and international co-operation amongst Agreement Parties and with those countries that have not yet joined.

EUROBATS sets up legal protection standards, while developing and promoting transboundary conservation and management strategies, research and public awareness across the Agreement area. It also assists in finding financial support for mainly cross-border oriented projects. EUROBATS has developed a wide-ranging Conservation and Management Plan, which is the key instrument for the implementation of the Agreement.

2.2.2 - Working within the framework of EUROBATS

2.2.2.1 - Meeting of Parties (MoP) and Secretariat

Since the first one in 1995, there are periodic Meetings of Parties (MoP) to this Agreement (in average every 3 years). This is the key governance place for any matter related to the Agreement. In 1995, during its first session, the MoP took the following key decisions:

- Establishment of a permanent **Secretariat** in Bonn in collocation with the CMS Secretariat ;
- Establishment of an **Advisory Committee,** which may establish working Groups, to provide expert advice and information to the Parties and the Secretariat;
- Adoption of priorities for Bat Conservation through the first **Conservation and Management Plan**.
- Proposal of guidelines for **national report** to the Parties;

Furthermore, since 2006 a **Standing Committee** was established to act on behalf of the MoP mainly with administrative matters, finance and representation.

The core functioning of the Agreement remains the same today but, as described below, the Conservation and Management plan is amended during the MoP.

The EUROBATS **Secretariat's** particular tasks are to:

- exchange information and co-ordinate international research and monitoring initiatives;
- arrange the Meetings of the Parties and the Advisory and Standing Committee meetings;
- stimulate proposals for improving the effectiveness of the Agreement, and attract more countries to participate in and join the Agreement;
- stimulate public awareness of the threats to European bat species and what can be done at all levels to prevent their numbers dwindling further.

2.2.2.2 - Advisory Committee and Intersessional Working Groups (IWG)

To advice the Parties and prepare technical resolutions for the MOP and the revision of the Conservation and Management Plan, there are regular (annual) meetings of the Advisory Committee. The work is prepared with working groups which organise meeting more or less regularly depending on the subjects. Even if they meet quite often during institutional meetings, they are named intersessional working groups (IWG).

[16] www.eurobats.org/about_eurobats/protected_bat_species

In the ongoing quadriennium 2011-2014, there are 16 IWG[17] working on different bat conservation issues in order to fulfil the requirements of the last MoP resolutions including the 2011-2014 Conservation and Management Plan.

- 1. Conservation of Key Underground Sites
- 2. Bat Conservation and Sustainable Forest Management
- 3. Monitoring and Indicators
- 4. Monitoring of Daily and Seasonal Movements of Bats
- 5. Autecological Studies for Priority Species
- 6. Wind Turbines and Bat Populations
- 7. Light Pollution
- 8. Conservation and Management of Critical Feeding Areas and Commuting Routes
- 9. Man-made Purpose-built Bat Roosts
- 10. Impact of Roads and other Traffic Infrastructures on Bats
- 11. Lethal Fungal Infections
- 12. Implementation of the Agreement
- 13. Review of the Format of National Reports
- 14. Bat Rehabilitation
- 15. Bats and Insulation
- 16. Eurobats Projects Initiative Selection Working Group

The minutes and resolutions taken during the annual Advisory Meeting and documents produced by the IWGs are published on the EUROBATS website (www.eurobats.org) and on an extranet platform for members of the working groups. This published material was a key source for the preparation of this EU Action Plan and relevant information is presented in the corresponding chapters.

2.2.3 - Conservation and Management Plan

The fundamental obligations of the Agreement are described in its article III. To help apply article III and set up priorities, a **Conservation and Management Plan** is endorsed by the Parties during the MoP.

Some **resolutions** concerning conservation issues and priorities are also voted during the MoP to be integrated in the Conservation and Management Plan. MoP after MoP, the Conservation and Management Plan is updated and makes reference to past endorsed resolutions. It may also make reference to other official papers as those prepared by the Advisory committee.

The **current Conservation and Management Plan** was adopted in September 2010 for the period 2011-2014. Apart from institutional matters[18], it encompasses 7 main topics that will be better described in the conservation chapters further down in this document:

- Population survey and Monitoring (8 items)
- Roosts (2 items)
- Habitats (4 items)
- Promoting Public Awareness of Bats and their Conservation (3 items)
- Pesticides
- Diseases
- EUROBATS Projects Initiative (EPI)

Details of the outcome of each IWG can be consulted on the EUROBATS workspace website[19].

As foreseen in the article VI of the Agreement, each Party has a duty to provide regularly updated **National Reports** on the implementation of the Agreement. A number of non-party Range States also provide Eurobats with a national report. For the 6th Session of the meetings of the parties, 30 Parties provided national reports and 3 non-parties as well. Furthermore, some oral presentations also occur

[17] http://workspace.eurobats.org/node/257

[18] Legal requirements & International co-operation

[19] http://workspace.eurobats.org/node/257

during the meeting. The two main parts of these reports concern the status of bats within the territory and the measures taken to implement the key article III of the Agreement.

In relation to the Conservation and Management Plan or to the work undertaken by the Advisory Committee and the IWGs, EUROBATS has already published several key documents dealing with various aspects of bat conservation. There are 3 main categories of publications:

- The EUROBATS Publication series that are sometimes reporting on the implementation of the EUROBATS Agreement in the Range States, and sometimes providing guidance on the best practices to protect bats and their habitats. It includes:
  - ✓ "*Conservation of Key Underground Sites*" (2010)
  - ✓ "*Guidelines for Surveillance and Monitoring of European Bats*" (2010)
  - ✓ "*Protection of overground roosts for bats*" (2nd edition, 2010)
  - ✓ "*Guidelines for consideration of bats in wind farm projects*" (2008)
  - ✓ "*Protecting and managing underground sites for bats*", (3rd edition, 2010)
- The EUROBATS Leaflets such as the one on "*Bats and Forestry*" published in 2009 after the work undertaken by the Advisory Committee and its IWG.
- Other specific publications prepared by partners :
  - ✓ "*Building Bat Friendly*" (Landschapsbeheer Flecoland, 2011)
  - ✓ "*Investigating the role of bats in emerging zoonoses - balancing ecology, conservation and public health interest*" (FAO, 2011)
  - ✓ "From *a Plattenbau block of flats into a tower for bats - a report with hints for planning*" (Institut für Tierökologie und Naturbildung, 2008).
  - ✓ "*Bats in Forests - Information and Recommendations for Forest Managers*", (Deutscher Verband für Landschaftspflege – DVL, 2001).

2.3 - NGOs and BatLife Europe

In 2003, the 4th EUROBATS Meeting of Parties recognized in its resolution n°4.11 the important role of Non-Governmental Organizations (NGOs) in bat conservation. Bats benefit highly from their voluntary monitoring and data collection work and their enormous and most successful efforts in raising public awareness. NGOs' expertise and activities represent a substantial contribution to the successful implementation of the EUROBATS Agreement and to bat conservation. There are tens of NGOs at national or local level, sometimes specialised or with a broader approach (mammals or fauna). The resolution encouraged activities of NGOs to collaborate in their activities and to share their experience in ways that have the potential to substantially improve transboundary co-operation and exchange of information as well as mutual assistance, including, where appropriate, the establishment of a pan-European umbrella organisation.

In 2006, the Bat Conservation Trust (BCT) UK was invited to establish BatLife Europe[20] and accepted. In 2010, BCT united with 5 other NGOs[21] to found BatLife Europe and invite others to join them.

BatLife Europe was launched as an international NGO in 2011 at the European Bat Research Symposium in Lithuania and currently (2013) has 33 partner NGOs in 30 countries and a part time secretariat based in London (currently in progress of registering as a UK charity).

BatLife Europe follows a membership model based on that of Birdlife International, which allows NGOs from across Europe and beyond to contribute. The trustees have decided that only national conservation NGOs should be able to become partners in BatLife Europe. However, other types of organisations such as state-owned museums and academic institutions can also work closely with BatLife Europe, as collaborating organisations.

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[20] www.batlife-europe.info

[21] The Dutch Mammal Society (DMS), Nature and Biodiversity Conservation Union (NABU), Romanian Bat Protection Association (RBPA), StiftungFledermaus and the French Society for Study of Mammals and their Protection (SFEPM).

BatLife Europe aims to conserve bats and their habitats and provide a stronger international voice for bat conservation in Europe by:

- Facilitating international communication and knowledge sharing
- Identifying European conservation priorities
- Developing pan-European projects
- Fundraising for international projects
- Developing best practice guidelines
- Assisting in capacity building
- Providing support and technical advice for EUROBATS initiatives
- Coordinating action in relation to special threats
- Collecting / managing data
- Assisting national bodies in developing / implementing national conservation plans /strategies
- Giving international status to national NGOs
- Providing international support for national matters of concern

BatLife Europe is active within the Eurobats Agreement and has been a partner in the development of the pan European bat indicator, BatLife Europe is also a member of the European Habitat's Forum, a partnership of over 20 environmental NGOs working together collaboratively at the European level, and is linking up with bat conservation networks in other continents to share knowledge and best practice.

In 2012, BatLife undertook a survey of the priorities and capacity building needs of its NGO members and 25 took part. The survey showed there is a big range of types and size of NGOs involved in bat conservation in Europe, some with staff, others entirely run by expert volunteers, and carrying out a range of activities from projects on bat research to conservation and education. Most NGOs are active in engaging people, carry out conservation activities, hold a database of bat records and monitor at population trends (to varying levels) and are engaged in some kind of political work. Some NGOs also carry out consultancy work or undertake practical work at roosts or nature reserves or by caring for injured bats or engage in fundraising. The survey identified the bigger barriers to bat conservation perceived by NGOs is lack of funding, followed by lack of people, the economic and political situation and lack of data. In terms of capacity building needs, the survey generated a large number of requests for help but also offers of help in sharing expertise in these areas:

- Engaging new members and volunteers
- Increasing public awareness about bat conservation
- Fundraising techniques
- Setting up a national bat monitoring programmes
- Storing and handling bat data
- Bat reserve/roost creation and management
- Lobbying for change
- Investigation of bat crime and persecution

BatLife Europe is now working to share knowledge and experience through sharing guidance and documents, by personal contacts and through twinning of NGOs and in due course aim to run capacity building workshops at existing international bat conservation and research events.

2.4 - Bat Action Plans

Many MS have monitoring programmes or site management plans including bat conservation objectives (e.g. for Natura 2000 sites). In addition, specific "Species Action Plans" or Conservation or Restoration Plans for species were also set up in a number of MS (national and/or regional level). These plans are be based on expert knowledge and implemented according to national specificities. They include specific measures or general ones as the adoption of measures (e.g. codes of best practice), to minimize damage to bats.

Some specific examples are presented below. Quite all the other MS are nevertheless implementing conservation actions concerning bats. National reports to EUROBATS present good illustration of the actions undertaken[22].

2.4.1 - National Action Plans

- Bat conservation action plans were included in the new Strategy and Action Plan for the Protection of Biological and Landscape Diversity of the Republic of **Croatia** from 2008, especially in regard to wind farms. However, management plan for bat species have not yet been prepared.
- **Estonia** has an Action Plan for the protection of bats. The first plan[23] covered the period 2005-2009. This plan identifies the main threats and important actions to improve the conservation status of bats. The compilation of a new action plan was contracted with NGO-organization after a successful public tender and is ongoing
- In **Finland**, a species action plan is considered for *Myotis nattereri*, as it is a species under strict protection.
- In **France**, after a first restoration plan implemented from 1999 to 2004 by the French Society for the Mammals Study and Protection (SFEPM), a new National Action Plan is currently implemented under the auspice of the French Ministry of Environment and with the support of a new legislation. This national action plan 2009-2013 involves numerous NGOs, local administrations and public bodies. 26 actions covers all aspects needed for bat conservation are included: protection and monitoring of roosts, forestry, transport infrastructures, wind energy, populations monitoring of all bat species present in the country, bat workers networking and raising public awareness…
- In **Germany** a Species Action Plan for the Lesser Horseshoe Bat has been drafted in 2013.
- In **Hungary**, the Minister for environment and water adopted a Species Protection Plan for *Nyctalus lasiopterus*.
- An “All-**Ireland** Species Action Plan – Bats” was published in 2008[24]. This Action Plan targets the maintenance of the populations of all bat species in Ireland and of their present range. It suggests a number of actions to be carried out in the interest of bat conservation by the lead agencies (NPWS, EHS, BCIreland, etc.). It also sums up all the current actions being carried out in favour of bats in Ireland.
- In **Lithuania**, a Ministerial order approved the project “*Preparation of Action Plans for Protection of Rare Species and Action Plans for the Control of Invasive Species*”. This project includes three conservation plans for *Myotis dasycneme, Pipistrellus nathusii* and *Plecotus auritus*. Additional plans are also planned for other species.
- In **Luxembourg**, a five-year nature protection plan was established for bats in May 2007 by the Ministry of Environment. Three species are currently in the national nature protection plan and benefit from a species action plan since 2009[25]: *Barbastella barbastellus*, *Myotis emarginatus* & *Rhinolophus ferrumequinum*. Management targets are listed for each of these species, most of them for the conservation and restoration of habitats.
- In **Portugal**, a conservation plan for cave-dwelling species was published in 1992 (22).
- An action plan has been built in order to implement the EUROBATS agreement in **Sweden**. This action plan was published in 2006 under the name **“***Conservation and management of the bat fauna in Sweden - Action plan for implementation of the EUROBATS agreement*”. It was written by a group of scientists and officials at Swedish Environmental Protection Agency (SEPA). In this report are discussed the following points:
  - ✓ importance of protection and management of important bat habitats

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[22] http://www.eurobats.org/official_documents/national_reports

[23] http://envir.ee/498230

[24] www.npws.ie/publications/speciesactionplans/2008_Bat_SAP.pdf

[25] www.environnement.public.lu/conserv_nature/dossiers/Plans_d_actions/Plans_d_actions/index.html

- ✓ Implementation of available knowledge on bat ecology in several field activities
- ✓ Impact assessments

A central coordinator, a reference group of experts and contact persons at regional authorities were suggested. Other subjects are approached, such as public awareness, information circulation, organisation of the work, etc.

The necessity of creating species-specific recovery plans is also pointed out in Sweden. The first priority is to establish an action plan for *Barbastella barbastellus* and coordinate the efforts to protect and manage this species. Other action plans are likely to follow, probably for *Myotis bechsteinii* and *Myotis dasycneme* and perhaps one or two more species.

- In the **UK**, *Barbastella barbastellus*, *Myotis bechsteinii, Pipistrellus pygmaeus, Plecotus auritus, Nyctalus noctula, Rhinolophus ferrumequinum and R. hipposideros* benefit from Species Action Plan updated in December 2010 by the Joint Nature Conservation Committee (JNCC)[26], a statutory adviser to the UK Government. This was done for the priority species (most threatened and requiring conservation action) in the framework of the UK Biodiversity Action Plan. However, as a result of devolution, and new country-level and international drivers and requirements, much of the work previously carried out by the UK BAP is now focussed at a country-level.

2.4.2 - Other regional action plans

- In **Belgium**, the LIFE+ project "*Bat action, Action plan for three threatened bat species in Flanders*"[27] may be considered as a regional action for bats for the period 2006-2010. It was a major driving force for all kind of initiatives relating to bat conservation and bat management in Flanders (**Belgium**): land acquisitions, management plan, census, awareness campaigns. This project was a collaboration scheme between the Flemish Agency for Nature and Forest and the NGO Natuurpunt. It included three targeted bat species (*Myotis bechsteinii, Myotis dasycneme, Myotis emarginatus*) and aimed to achieve a substantial increase in numbers of bats. A species action plan is also implemented for *Rhinolophus hipposideros* in the Walloon region for the relict maternity colonies.
- In **Germany,** there are numerous bat actions planned at regional level and some of them could be considered as Species action Plan. In Bayern (and in Berlin), local species-assistance programmes for bats have been built to implement conservation measures on threatened species[28]. In Thuringia and Bavaria, there are Coordination agencies for bat conservation (since 1996) that supports and develops bat conservation programmes.
- In **Netherlands**, an action plan for bats was launched in 2006 by the province of Noord-Brabant, which is still currently running.
- In **Romania**, the Life+ Project "*Bat Conservation in Pădurea Craiului, Bihor and Trascău Mountains*" has been contracted in 2009 by the regional Environmental Protection Agency of Bihor. This project plans to implement conservation actions for bats on 16 Natura 2000 sites. Management plans for 7 bat species (*Myotis myotis, Myotis oxygnathus, Myotis bechsteinii, Barbastella barbastellus, Rhinolophus ferrumequinum, Rhinolophus hipposideros, Miniopterus schreibersii*) are to be established.
- In **Spain,** two specific Action Plans are in place in the Autonomic region "comunitat valenciana" on *Myotis capaccini* and *Rhinolophus mehelyi* respectively.

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[26] http://jncc.defra.gov.uk/page-5170

[27] www.natuurenbos.be/~/media/Files/Projecten/BatAction/laymans%20report.pdf

[28] www.lfu.bayern.de/natur/artenhilfsprogramme_zoologie/fledermaeuse/index.htm

2.4.3 - Action Plans for the conservation of bats in Europe

- For conservation of *Rhinolophus ferrumequinum*, an Action Plan was prepared by R.D. Ransome, Anthony M. Hutson in 1999 (under the Bern Convention - Council of Europe). The Action Plan gives details about the status, ecology main threats of the greater horseshoe bat (23);
- The Action Plan for the Conservation of *Myotis dasycneme* in Europe was prepared by Herman Limpens, Peter Lina and Anthony Hutson in 1999 (Council of Europe). The document reflects the results of the surveys concerning the species ecology and conservation status at European level from that time (24).
- The Action Plan about Microchiropteran Bats includes a global status, survey and conservation actions of all bat species, complied by Anthony M. Hutson, Simon P. Mickleburgh, and Paul A. Racey (IUCN/SSC Chiroptera Specialist Group) in 2001 (25).

2.5 - EU and EUROBATS co-funded projects

There are many actions implemented for bat conservation by local NGOs with the support of local administration and sponsors. It is not the right place here to list them all. However EU or EUROBATS supported projects may well illustrate needs and possibilities.

The EUROBATS Project Initiative (EPI) was launched in August 2008 to provide appropriate funding for small to medium sized bat conservation projects (costs of up to 10,000 €). The following criteria are taken into account when assessing EPI projects (Details of each project are presented in Annexe 2):

- Predictable impact for bat conservation, in particular the implementation of the Conservation and Management Plan of the Agreement, other EUROBATS Resolutions, national conservation targets or public awareness,
- Degree of transboundary character,
- Contribution on the promotion of international cooperation of Parties and Range States,
- The ability of the project to provide innovative information and experience that can be shared with other parties and range states,
- Contribution on the education and motivation of newly established bat workers,
- European conservation concern of targeted species as defined by other EUROBATS Resolutions or the European Mammal Assessment,
- Envisioned outcomes of the project like publications, guidelines or follow-up programmes, educational outreach.

This approach focusing small projects does not exist as such in EU cofounded projects. However MS may use structural funds (Interreg) or EARDF funds (Leader) for small projects even if the competition is hard to access these funds. Annexe 2 lists the various projects (n=19) dedicated to bat conservation funded through European programmes. **Life** is the main financial tool used by these projects.

3 - SURVEILLANCE AND KNOWLEDGE ASSESSMENT

Good quality data are needed on the actual range of the species, on the size of colonies, populations and quality of habitats. The current conservation status of bats in the European Union means that information on changes in the distribution and abundance of bat species over time is still required. The size of population changes over years and has to be updated regularly (e.g. every 6 years as required by Art. 17 reporting). To help determining bat conservation status and preparing the article 17 reports, common methodologies or views on reference value and pressures are needed. Building capacity for monitoring in MS which do not currently have national monitoring schemes is needed.

In countries or regions with outdated or no data, basic surveys should start as soon as possible. In order to get comparable results, common standards for surveying need to be developed and agreed among countries (e.g. value given to acoustic data).

Population survey and monitoring is a key item of the EUROBATS Conservation and Management Plan and one the main activities of several IWGs aiming to develop common and transboundary approaches. The main results are publication of guidelines or recommendations and exchanges between experts and scientists to disseminate knowledge. There is a will, through pan-European observation frameworks, to identify national and European population trends, to better understand local and regional movements or to refine autecological data for representative key species.

The use of non invasive methods is preferred and two main guidelines were prepared by EUROBATS to reinforce ethical approaches in field studies:

- Guidelines for the Issue of Permits for the Capture and Study of Captured Wild Bats were issued in 2003[29] with some slight amendments later on.
- Guidelines on Ethics for Research and Field work practices were issued in 2010[30]

3.1 - Population survey

As stated in EUROBATS Publication series n°5, surveillance is defined as population surveys (range, abundance) over time, while monitoring is related to defined target involving species but also other factors surveillance.

3.1.1 - Surveillance methods

Preliminary general guidelines were published in 1998 ("Consistent monitoring methodologies"[31]) but the main current guidance document is the EUROBATS Publication series n°5 published in 2010: "**Guidelines for Surveillance and Monitoring of European Bats**". Guidelines should be reviewed regularly, every 3-5 years, to assess whether they need updating. The purpose of this manual is to recommend best practices to detect changes in distribution, range and abundance and provide long term population trends. The guidelines concentrates on the standardised methods required to produce indices of population change.

3.1.1.1 - Roosts counts

Surveillance activities are facilitated by the gregarious character of bats. Maternity and hibernation roosts are particularly useful for surveying numerous species. Counts of emerging bats or counts inside the roosts can be used for maternity roosts. At hibernation sites, the relationships between the number of bats seen and the number of bats present is not always clear because of numerous cracks and crevices in which bats may be hidden from view. The EUROBATS publication cites the example of a German cave in which about 300 individuals were visible when about 15,000 were present when counted with infrared detection

[29] www.eurobats.org/sites/default/files/documents/pdf/Meeting_of_Parties/MoP4_Res.6_Issue_of_Permits.pdf

[30] www.eurobats.org/sites/default/files/documents/pdf/Meeting_of_Parties/MoP6_Record_Annex8_Res_6_5_Ethics.pdf

[31] www.eurobats.org/sites/default/files/documents/pdf/Meeting_of_Parties/MoP2_Res.2.pdf

Other summer or transitional roosts are also interesting but interpretation of data, especially quantitative, is more difficult when there are regular changes of roosts. It is much more difficult to count forest species, apart from the individuals using bat boxes (e.g. *Pipistrellus nathusii*) in forests with specific monitoring programmes.

In a greater urban area, there are many types of buildings (e. g. prefabricated houses) with structures as various gaps, cracks, vents of attic roofs and crevices that enable to roost some species of bats. In some countries these structures represent important hibernation sites of *Nyctalus noctula*. Because of the inaccessibility of this roost sites, it is possible only estimate number of individuals in cavities. Observation of bats flying out their roosts sites at each suitable building before they start to hibernate seems to be an effective method.

At late summer/autumn, swarming sites seem to play a key role in the yearly cycle of bats (which may be related to mating event, checking of hibernation sites, or training young...). Swarming sites attract thousands of individuals, and may also be roosts sites but not always.

3.1.1.2 - Away from roosts counts

Away from roosts counts use bat detectors or Automatic Recording Devices (ARDs), whereas walked surveys with handheld bat detectors, using line-transects and/or point-counts are utilised to monitor variation in abundance and activity between years. They are also used to study bat foraging areas or to identify commuting routes. This approach was proposed in Germany to fulfil the EC HD reporting requirements (26). Another approach is bat detector transects along roads using moving vehicles which provide statistically robust conclusions on population trends of common species along roadsides. Such a project is implemented at national level in France with 146 road sections monitored in 2008[32] through a partnership between scientists and volunteers.

Remote automated recording was not emphasised much by the EUROBATS publication. Noting the huge progress made during recent years concerning this technology and the development of classification tools[33], the guidelines could be updated to capture these new opportunities. New devices become available every year and some studies are now using batteries of ARDs. There are even new approaches concerning algorithms to use automatic data to monitor specific impacts as in the wind farms projects (27).

The capture of bats is not recommended for the purpose of surveillance unless less invasive bat detectors, ARDs and roosts counts methods are not adapted (e.g. to confirm reproductive status or for radio tagging projects). A good example may be provided by *Myotis bechsteinii* or *Myotis alcathoe* for which radio-tracking is generally needed to locate roosts. In addition, monitoring scheme for some countries include mist netting as the only applicable method for some bat species.

The EUROBATS Publication series n°5 are well designed to address long term surveillance with different scales of stratification relevant to surveillance obligations under the HD. However, this is not suitable for use in Environmental Impact Assessment (EIA) or to Article 6.3 on Appropriate Assessment because these involve short term studies and inappropriate sampling methods. Bat detector surveys in the countryside, using line-transect or point-count methods, should be analysed with the last scientist results in mind: e.g. a study based on 257 hours of listening in forests habitats (28) has shown that the exhaustiveness, in terms of number of bat species, was only rating at 65 % after 45 min. Therefore, data analysis and its transcription of impacts from EIAs is sometimes difficult to interpret both before the project authorisation and after during BACI protocols.

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[32] http://vigienature.mnhn.fr/chauves-souris

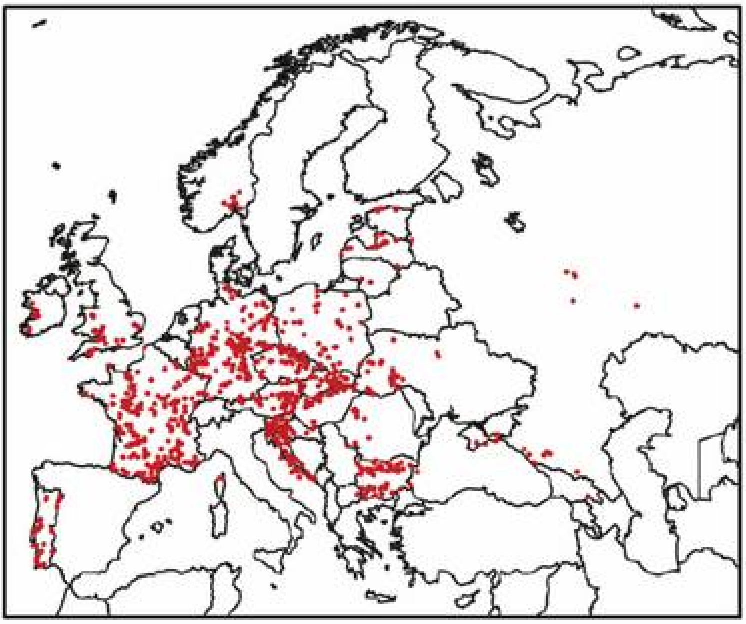
[33] As iBatsID, a free online tool developed by a network of European research worker, using ensembles of artificial neural networks to classify time-expanded recordings of bat echolocation calls from 34 European bat species https://sites.google.com/site/ibatsresources/iBatsID

3.1.2 - Data analysis and compilation for roosts

Because of the fidelity to the roosts and the gregarious nature of bats at roost sites, there is a great worth in compiling data from roosts counts to monitor their conservation status.

In 2010, EUROBATS collated a list of 1,487 internationally important underground sites for bats identified by Parties (1,402 for the EU). The current Conservation and Management plan envisaged to publish a new list in a suitable format accessible through the EUROBATS website.

It would be useful to analyse whether such sites are included within the Natura 2000 network (in the knowledge that some sites are may be important for Annex IV species only).



Map 3 - Underground sites important for bats in Europe as identified by EUROBATS Parties and Range States. The map shows the location of sites in the database at 1/11/06.

3.1.3 - Daily and seasonal movements - migration

The EUROBATS Conservation and Management Programme recommends collecting data on local and commuting movements among bat populations and identifying long distance migration routes. International-protection measures for bats are most important for those species which migrate furthest across Europe, crossing national boundaries. Possible dangers caused by barriers on the migratory routes of various species can then be identified and addressed by NGOs and MS. Furthermore, understanding migration is also important for understanding the potential spread of infections that can be harmful to bats and also to humans.

Among the transboundary approaches implemented by EUROBATS, a framework to study the status of *Pipistrellus nathusii* and especially its migration routes was launched in 1998 with specific recommendations including for banding. It seems that compilation of results was not specifically published apart from information presented in National reports and specific scientific papers or books published by scientists (17; 18).

Today, the use of modern methods (e.g. genetics and isotope analysis) will supplement classical methods (e.g. banding) to identify long distance migration routes which cross national frontiers (29).

A EUROBATS IWG is currently tasked with the collection of migration data of species within the range of the Agreement. The data was to be obtained from published literature and other specialists. However, there is a need to collects data from ‘grey literature’ and from publications in several languages. A questionnaire on all species known to undertake seasonal movements is to be developed by EUROBATS and circulated among scientific focal points.

3.1.4 - Prototype pan European indicator

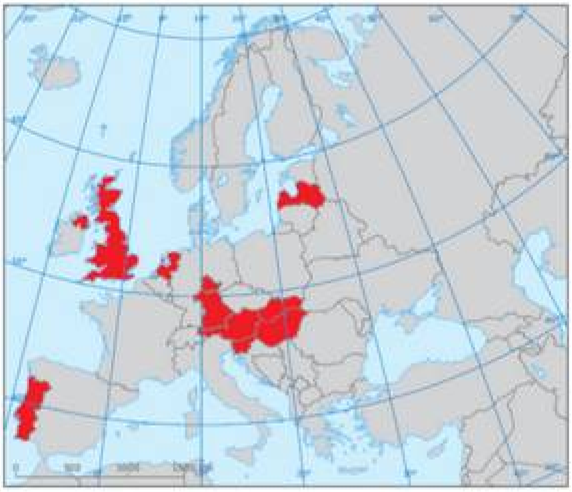
To improve the coordination of and streamline international biodiversity-related indicators, in line with the recommendation by Streamlining European Biodiversity Indicators (SEBI) 2010 to expand the suite of indicator taxa used to measure progress towards achieving biodiversity targets, EUROBATS seeks to develop indicators based on European bat monitoring data and conservation activities. This includes work towards the provision of standardised statistics in the national reports to EUROBATS.

The EUROBATS IWG on Monitoring and Indicators seeks to develop a bat indicator to summarize population trends at European scale. A first step towards this goal, developing a prototype indicator using hibernation data, has recently been possible through work commissioned by the European Environmental Agency (EEA) in 2011. This work has been published in the EEA technical report series[34] in early 2014.

The Bat Conservation Trust, the Dutch Mammal Society and Statistics Netherland led the work and established cooperation among 10 hibernation surveillance programmes in 9 countries.

The data contributing countries (see map 4) were UK, Netherlands, Bavaria and Thuringia (Germany), Austria, Hungary, Slovenia, Slovakia, Portugal and Latvia. The contributing hibernation surveillance schemes cover 6000 sites, 6 bio-geographic regions, 27 species and time series ranging from 6 to 26 years.

A **prototype** hibernating bat indicator, covering the period 1993-2011, incorporates data on 16 species from 10 schemes spread over 9 countries.



Map 4 - Data contributing countries for the prototype pan European indicator

Overall, the species included in the prototype indicator appear to have increased by 43% at hibernation sites between 1993-2011, with a relatively stable trend since 2003. The apparent population increase of some species may reflect the impact of national and European conservation legislation, species and site protection, targeted conservation measures, the improvement of volunteers' skills to survey bats and widespread awareness-raising towards the public and professional sectors, particularly under the EUROBATS agreement. However, due to the **preliminary nature** of this prototype indicator, the early conclusion that bats have increased at hibernation sites should be **interpreted with caution** until the indicator can be expanded to cover a more representative range of European countries and species, and elements of the methodology to do with how sibling species are amalgamated be further refined. One species, *Plecotus austriacus,* shows a significant decline.

34 www.eea.europa.eu/publications/european-bat-population-trends-2013

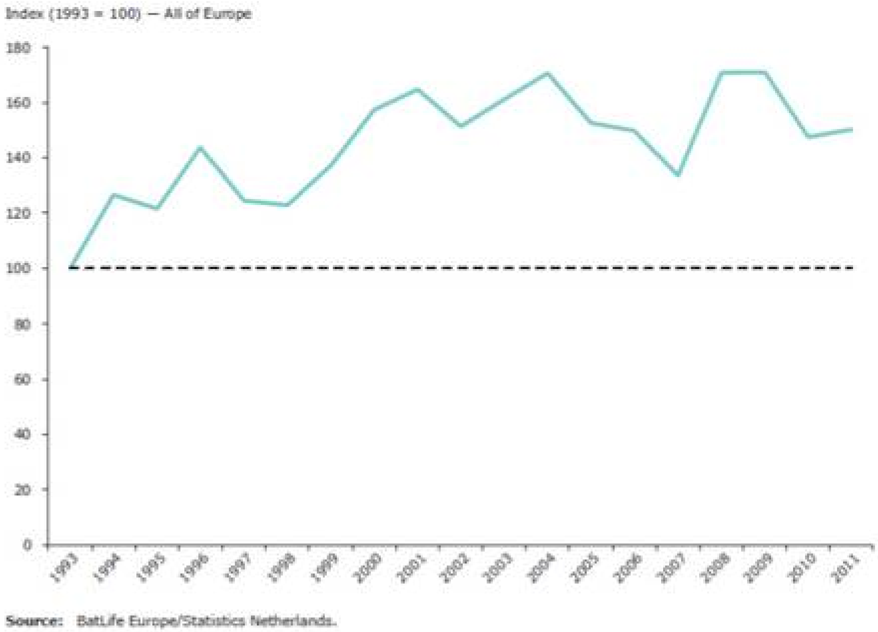


Figure 3 - The prototype European bat hibernating indicator (from (30))

Table 6 – Slope, error of slope and number of sites where the species occurred; trend of species and of the combined prototype European hibernating bat indicator

Species	Slope	Standard slope error	Number of sites	Trend classification
European hibernating bat indicator	**1.02**	**(*) -**		Increase
Rhinolophus euryale (Blasius, 1853)	1.08	0.03	37	Moderate increase
Rhinolophus ferrumequinum (Schreber, 1774)	1.04	0.01	272	Moderate increase
Rhinolophus hipposideros (Bechstein, 1800)	1.06	0.01	619	Moderate increase
Barbastella barbastellus (Schreber, 1774)	1.04	0.01	973	Moderate increase
Eptesicus nilssonii (Keyserling and Blasius, 1839)	1.03	0.02	309	Uncertain
Eptesicus serotinus (Schreber, 1774)	1.02	0.01	201	Stable
Myotis bechsteinii (Kuhl, 1817)	0.96	0.04	500	Uncertain
Myotis dasycneme (Boie, 1825)	1.00	0.01	230	Stable
Myotis daubentonii (Kuhl, 1817)	1.02	0.00	2 125	Moderate increase
Myotis emarginatus (Geoffroy, 1806)	1.08	0.02	111	Moderate increase
Myotis mystacinus/brandtii (Kuhl, 1879; Eversmann, 1845)	1.06	0.00	1 506	Strong increase
Myotis nattereri (Kuhl, 1817)	1.05	0.01	2 066	Moderate increase
Myotis myotis/(blythii) oxygnathus (Monticelli 1885)	1.02	0.00	1 748	Moderate increase
Plecotus auritus (Linnaeus, 1758)	0.99	0.01	3 655	Stable
Plecotus austriacus (Fischer, 1829)	0.91	0.03	399	Moderate decline
Miniopterus schreibersii (Kuhl, 1817)	1.00	0.01	44	Stable

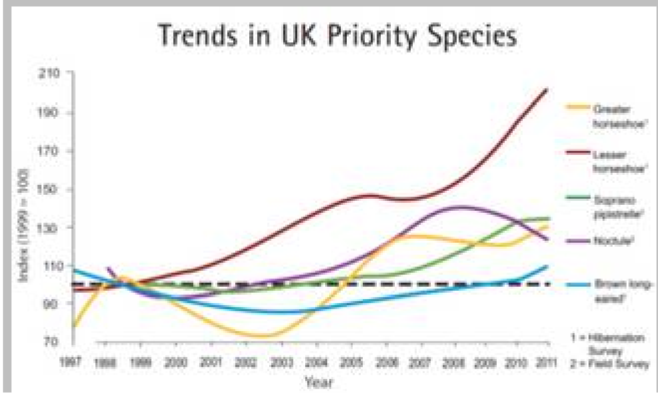
Note: (*) Trendspotter analyses differ from those of TRIM and do not result in standard errors of a slope.

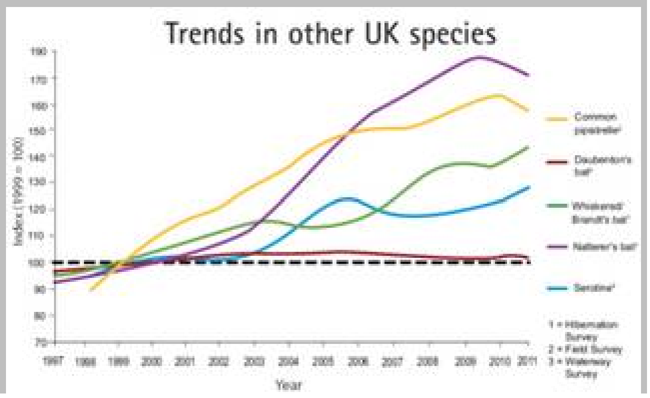
The future plan is to expand and update the indicator to incorporate data from at least 15 and ideally over 20 European countries at the earliest opportunity and to develop an additional trend line using data from maternity roosts. This is a realistic aim, given widespread pledges to participate from monitoring schemes in other countries, particularly from BatLife Europe partner organizations, but requires some funding to facilitate essential training in appropriate statistical techniques and coordination.

The working group would also like to develop a data sharing structure for census data to calculate pan-European and regional trends (which could be managed by BatLife Europe). This would also require specific funding.

National Bat Monitoring Programme in UK

Since 1996 more than 3,500 volunteers have taken part in surveys coordinated by Bat Conservation Trust (BCT) at over 6,800 roost or field sites around the UK. The data collected have already indicated population changes in some species but surveying needs to continue for many more years in order to ascertain whether these are long-term trends or simply short-term fluctuations. The figure above illustrates some of the results.





3.1.5 - Autecology / Population ecology- Specific action plan

In the framework of transboundary approaches implemented by EUROBATS, several species-focused approaches were developed

- In view of preparing an Action Plan for *Myotis dasycneme*, survey results have been collated in 1998/99. After all, the Action Plan for the Conservation of the Pond bat (*Myotis dasycneme*) in Europe was adopted by the Standing Committee of the Bern Convention (recommendation No. 73 on 3 December 1999) after consultation with EUROBATS. This action plan was published in 2000[35] (24).
- A working group on autecological studies has defined three priority species in 2004 (*Rhinolophus Euryale*, *Myotis capaccinii* and *Miniopterus schreibersii*) and a first state of the art was set up in 2006 and a more comprehensive one was prepared in 2010[36] (surveillance of populations and roosts, list of references and summaries, analysis of answers to the 2006 questionnaire).

3.2 - Gaps in biological knowledge

Good knowledge on bats ecology is needed to take the right decisions, address priorities and improve the management of priority areas. As in any action plan, filling the gaps in knowledge is a priority not only for biological and ecological aspects but also to assess the pressure of human activities.

- **Population ecology:**
  - ✓ The knowledge on regional meta-population is poor, even in countries with a long tradition on studying bats.
- **Behaviour:**
  - ✓ Several hypotheses have been produced to explain the gathering or swarming behaviour seen in late summer and autumn near cave or mine entrances. More research is required

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[35] Another one on *Rhinolophus ferrumequinum* was published at the same time (23). It seems that the results of both were never assessed.

[36] www.eurobats.org/sites/default/files/documents/pdf/Advisory_Committee/StC4_AC15_Doc_26_ReportIWG_PrioritySpecies.pdf

to fully explain the reasons of such phenomena (extension and importance in Southern Europe should be assessed).

- **Species knowledge:**
  - ✓ There is a strong lack of biological knowledge for the following species: *Myotis sclera*, *Myotis aurascens*, *Nyctalus azoreum*, *Plecotus kolombatovici, Nyctalus lasiopterus*.
  - ✓ Knowledge on cryptic species (*Pipistrellus*, *Myotis*...)
  - ✓ Why does *Nyctalus noctula* have a high nativity and mortality rate compared to the other species (10) ?
  - ✓ Natural wintering roost sites of *Nyctalus noctula*: Population size wintering in the structures of buildings (panel houses) in comparison with population size wintering in natural roost sites (tree or rock cavities);
  - ✓ For *Pipistrellus nathusii*, there is an urgent need of systematical studies about winter habitats of bats in the critical areas in coastal and mainland France, Italy, Slovenia, Croatia and the Balkans.
- **Migration:**
  - ✓ Migration mechanisms are still not well known and can have conservation implications (use of landscape features as spatial references, other environmental factors, memory or Earth magnetic field...);
  - ✓ Precise assessment of migration routes, including possible movements between Africa and Southern Europe ;
  - ✓ Lack of knowledge on migration pattern of *Pipistrellus pipistrellus*, *P. pygmaeus* and *Vespertilio murinus* in north-eastern part of species range ;
  - ✓ In spite of the study of *Pipistrellus nathusii* migration routes launched in 1998 by EUROBATS, migration is still not well understood. For instance, there is no detailed information about migration timing and important migration routes in east coast of Baltic Sea (Finland, Estonia, Latvia, Lithuania, and Poland). However, recent studies have provided evidence, that in some locations, *Pipistrellus nathusii* migration is very intensive and temporally concentrated. Recently, new wind farms have been erected and are planned in this coastal region without any intensive migration survey at all. There is also evidence that some species, which were thought to be mostly sedentary, are migrating distances greater than expected (e.g. *Eptesicus nilssonii*).
  - ✓ Do bats in the UK migrate?
  - ✓ Is there a migration through the Alps (because now wind farms are more and more planed in this area)?
- **Bats conservation:**
  - ✓ Impact of mortality due to human projects (wind farms, roads, insulation of buildings) on local bat population;
  - ✓ Role of compensation schemes and artificial roosts in population dynamics;
  - ✓ Effects of pesticides/biocides on bat survival / fitness (agricultural, forest and buildings);
  - ✓ Agriculture: impact of endectocides and farming practices.
  - ✓ Impact of building insulation on wintering and maternity roosts.
- **Bats and forestry:**
  - ✓ Assessment of direct mortality in bats due to forestry operations;
  - ✓ Evaluation on the density of “suitable” trees (e.g. dead trees for *Barbastella barbastellus*) to be left in order to sustain populations of forest species to provide foresters with appropriate guidelines to be put into practice rather than qualitative indications or “rules of thumb”;
  - ✓ Effects of forest fragmentation on movement / gene flow of forest bat species.

4 - THREATS AND CONSERVATION ISSUES

Many European bats are under threat and some have even become extinct in certain countries. The reasons for this are mainly:

- Loss of roosts and disturbances at roost sites;
- Habitat loss (commuting routes and foraging areas) and fragmentation;
- Mortality of individuals; and
- Prejudices against bats and misunderstandings arising from ignorance.

Bats are difficult to study (nocturnal, undetectable call for the human ear, hidden roost sites, lack of quantitative data, vulnerability to disturbance…) and there are strong gaps in knowledge that strongly hinder the assessment of the impacts especially at project level.

4.1 - Loss and disturbance of roosts

Bats make use of many different roosts, within a biological cycle. In Europe, the majority of bats hibernate in caves, buildings or in tree cavities to be protected from cold weather and predation. During other periods, some species prefer buildings or man-made structures, while others prefer caves or trees. But whatever the species, almost all of them use several roosts at a time. (31; 32; 33; 34; 35; 10).

Loss of roost, by destruction or by disturbance, has a significant impact on local populations. As explained by Bat Conservation Trust (36): "*Where there are limited alternative roosting opportunities locally, loss of a roost site would result in bats moving away perhaps to a site that is less suitable. In other cases there may be no suitable roosting sites nearby.*" Damage will be higher for maternity roosts as the "*loss of one maternity roost site may result in all the breeding females from an area being unable to rear young in that year, and possibly future years if there are no suitable alternative roosts nearby*" (36). Because of their reproduction strategy[37], the impact will be significant on local bat population.

It is possible to distinguish three main categories of roost sites:

- Underground sites: the word "*underground site*" is frequently reduced to natural caves. However all man-made structures that mimic the environmental conditions found in caves belong also to this category (37): abandoned mines, catacombs, tunnels, cellars, military installations and fortifications (war bunkers. …);
- Overground sites: generally man-made, they include bridges, castles, churches, houses, block of flats, stables and cowsheds, barns or even artificial roosts sites built for bats. Crevices in cliffs are also used;
- Tree dwelling sites: cavities, barks, cracks or even bat boxes established in forests.

4.1.1 - Underground sites

All man-made structures that mimic the environmental conditions found in caves belong to underground sites. This includes abandoned old mining systems and tunnels which share very similar conservation issues with caves. The case of cellars is slightly different because apart of airflow modifications, inhabitants have to accept to share their living space with bats (10). Unheated cellars in winter and/or heated cellars in summer may be used by *Rhinolophus ferrumequinum* and *R. hipposideros* bats and numerous questions on this case occur on the Internet.

Both humidity and temperature are buffered against rapid change in underground roost sites (37).This specific feature is fragile and modifications in airflow may alter the site value. Because of cave longevity, one single site can be used by many generations of bats. Thus, caves are long life roosts easily used by bats for hibernation and, in some places of EU, for maternity or transitional roosts. Bats are generally faithful to their roosts when they remain stable.

[37] Long-lived mammals but in general only one single baby per year in case of successful reproduction.

Since 1998, a EUROBATS IWG is working on underground sites, because they were defined as very important for the conservation of bats populations. A list of internationally important underground sites for bats was produced by EUROBATS experts in 2010 (1.487 sites) and is published on the EUROBAT Website. Currently, a review process in on the way and experts are working on criteria by biogeographic zones. Within the current list, 78.3 % of the important underground sites are composed of caves, mines, quarries or tunnels. However some EU countries are not included in this database as Spain or Greece.

The conservation of underground sites is done through legal protection and/or site management. Numerous legislation or regulation exist within MS, all of them being compatibles with the Article 6.1 of the HD which asks for establishing the necessary conservation measures at Natura 2000 sites. Preliminary guidance is provided in the EUROBATS Publication Series n°2 for restrictions within sites with site grading and conservation code examples (37).

4.1.1.1 - Issues

The two main issues to be considered for underground sites management are:

- Ecological modifications of cave features ;
- Excessive disturbance at underground sites;

A ECOLOGICAL MODIFICATIONS OF CAVE FEATURES

Many caves or subterranean sites have been closed for security reasons or concern over legal liability (37) and became unusable by bats. Other sites have been reused as storage sites, mushrooms cultures… or reopened for their original use. A cave may also be totally modified or even inundated with hard consequences on meta-populations.

The necessary ecological conditions for bats hibernating can be disturbed by preservation works and gating or grilling in an inappropriate way. The installation of an unfitted grille can modify airflows; then the inner temperature can increase or the humidity can vary, hence the desertion of the cave by bats (37; 38; 39; 40). An unfitted grille can also become an obstacle for some species as *Miniopterus schreibersii* (41; 37) or, in breeding season, *Rhinolophus euryale, R. mehelyi, Myotis myotis, M. blythii* (37) which are intolerant to any grilles.

The EUROBATS Publication Series n°2 provides advice and numerous examples concerning physical protection measures of caves (37).

B EXCESSIVE DISTURBANCE

Even if bats can tolerate a small amount of disturbance, important or regular ones can trigger desertion or mortality (37; 38; 42). Many people may visit caves: speleologists, inexperienced tourists, local people who can dump (toxic) wastes, light a fire or intentionally kill bats as it was reported in one French cave, where people used hibernating bats as paintball targets (43). EUROBATS highlights the fact that the increasing use of a growing number of sites outdoor leisure centres, adventure holiday groups and unregulated tourism is a cause for concern as members such parties generally have a poor understanding of the impact of humans on these sites (37).

Excessive disturbance can be illustrated with the case of the Bulgarian Devetashka cave, one of the most important bat caves in Europe. In 2011, after the filming of the movie "Expendables 2" with star movie actors, the bat population in the cave has been reduced to around a ¼ (8,000 bats hibernating compared to 30,000 the year before). Numerous bats have come out of hibernation much earlier than usual and dead bats seem to occur. The impact will remain for a long period because a bridge was built which now provides now easy access to the cave entrance attracting visitors.

"Mineral mines" state companies systematically apply a total closure (by demolition or filling of entrance sections) of the old abandoned mines in the mining areas (e. g. in Slovakia). They follow mining law about protection and utilisation of mineral richness to eliminate consequences of mining activities, because the most of old abandoned mines are dangerous to residents.

4.1.1.2 - Bat-friendly management of artificial underground sites

To take part in an appropriate management of underground sites, local authorities have to be made aware of bat needs (raising awareness). The priority is to develop and support strict protection of the sites of international importance within the Natura 2000 network and to include other sites of international importance lacking in this EU network.

Habitat conservation measures can only be implemented if bat requirements in underground roosts are correctly taken into consideration as in the examples below.

There are thousands of military installations from the 20th century which are now unoccupied in the EU: war bunkers, pillboxes and blockhouses, others fortified buildings or even older military fortifications. In some areas, this creates a key network of artificial sites for bats. One of the first LIFE project dedicated to bats was the "*Transboundary program for the protection of bats in Western Central Europe*" (LIFE95 NAT/D/000045) implemented in Belgium, Germany, France, Luxemburg.

The project secured a total of 143 sites and indirectly 22 other ones. This work includes purchase and lease of several forts, blockhouses or other military buildings as powder storage blocks. All sites were subsequently managed for the bats' benefit (bat-doors, grills and other devices).

In Germany, around 22.000 bunkers were built between 1936 and 1940 between Bale and Kleve to form the Western Wall. After the war most of the fortifications were blown up by the occupying powers, and then became largely forgotten. The undestroyed and partially destroyed bunker systems have evolved over the decades into valuable habitats and place in the densely populated and intensively cultivated cultural landscape. In the bunker ruins of the Western Wall numerous bats were detected with at least 10 species of bats using bunkers including *Myotis dasycneme*, *Myotis myotis*, *Pipistrellus spp*., *Eptesicus serotinus*... The NGO Bund is committed to the preservation of the remaining residues and the further improvement of the ecological network along this Western Wall strip[38].

In Poland, an extensive subterranean system of defences, often referred to as the Miedzyrzecz fortifications (Ostwall), were built for German troops from 1933 through to the end of the second world war in 1945[39]. Today, sections of this underground bunker complex serve as perhaps the most important winter hibernation roost in Europe, for at least 12 species of bats. True bat numbers are almost impossible to ascertain because the entire system cannot be investigated thoroughly. However, most researchers agree that the number of bats present here during the winter months number between 20,000 and 30,000. Many of these bats are rare or endangered species such as the *Barbastella barbastellus* and *Myotis myotis*. The bats travel from as far away as western Germany, the Czech Republic and throughout Poland to this unique hibernation roost in October each year.

In the UK, several local NGOs are converting pillboxes from the World War II into bat hibernacula with sometimes good results for species e.g. *Plecotus auritus* or *Myotis nattereri*. The gun ports are bricked up, leaving just a single small entrance for bats to fly through and bat bricks are cemented to the ceiling. Finally, a steel door is fitted to each pill box and secured with a padlock to prevent disturbance to any bats that might use the sites[40]. The EUROBATS Publication Series n°2 provides examples of this conversion (37).

Slovakia is a state rich in mineral resources. There are many mining areas with thousands of old mines. It means a great potential for occurrence of bat populations in the underground roost sites (e. g. *Rhinolophus euryale* or *Miniopterus schreibersii* maternity colonies). The method of their protection is based on cooperation with the Mineral Mines State Company to ensure maintenance of them. A

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38 www.gruenerwallimwesten.de

39 http://polandpoland.com/nietoperek_bats.html

40 www.essex-batgroup.org.uk/reports.html

good example[41] can be construction of protective walls around dangerous entrances to the old mines which will solve the threat of entry or fall and retains access for the bats.

A new option is developed today with mitigation and biodiversity offsets: totally artificial underground buildings are built specifically for bats. This was done in the context of the construction of large reservoirs in north-east Portugal where two artificial galleries were built in 1995 and 2005. Good results occurred in the first one for *Myotis myotis*, *Rhinolophus mehelyi* and *Miniopterus schreibersii*. More recently, a motorway company built two artificial concrete bat shelters along the motorway A89 in France in the framework a partnership with a local NGO (see also chapter on overground sites) However time is needed to assess the results of this kind of project. Furthermore there is today no clue that they could shelter thousands of bats as it is the case in some natural caves.

4.1.2 - Overground roosts in buildings

Man-made overground structures regularly used by bats across Europe include bridges, castles, churches, houses, blocks of flats, stables and cowsheds, barns or even artificial roosts sites built for bats. These roosts can be found in such buildings all year round. In late spring, maternity roosts are formed in the roofs of buildings to take advantage of the heat provided by the sun. This is because breeding females seek warm areas during this phase in their life-cycle to minimise the energy cost of maintaining a high body temperature. In winter, bats of most species have been recorded hibernating in various parts of buildings such as inside cavity walls, around window frames, under ridge tiles and in cooler areas with stable temperatures such as cellars and basements.

A high percentage of the bat fauna rely on roosts in buildings in northern European countries, compared to the percentage seen in the southern countries (44). A survey carried out by Eurobats showed that in Europe, for their roosts:

- At least 33 species depend on castles and fortifications;
- At least 32 species depend on church, buildings and houses;
- 27 species depend on stables;
- 23 species depend on bridges.

However, there is a true diversity within MS, may be related to differences in construction (barns, bridges...) with all over EU churches and houses being key places. Some species such as *Rhinolophus hipposideros* shows a great variability in its roost choice across Europe (44): churches are highly important in Austria, Slovenia and Slovakia and are of medium importance in neighbouring Hungary, Czech Republic, Germany and France.

4.1.2.1 - Issues

A Problems caused by bats roosting in buildings

On occasion, bats roosting in buildings can cause a number of nuisances that have to be taken into consideration for bat conservation (44):

- A serious smell of bats or the noise from the roost can keep family members awake;
- Droppings, over a protracted period of time, may cause pitting, long-term staining and etching to porous materials such as painted wall surfaces, wooden monuments and stone sculptures;
- Bat urine (which is 70% urea) is chemically aggressive and therefore of even greater conservation concern. It can cause spotting and etching of wooden, metal and painted surfaces;
- The presence of these protected species requires consideration when planning work such as remedial timber treatment or reroofing for repair or refurbishment in a private house or other buildings.

41 www.netopiere.sk/aktuality/2013/10/15/Grafity_v_lesoch_Revuckej_vrchoviny_upozornuju_na_vyskyt_netopiero

B POISONING BY TIMBER TREATMENT DURING RENOVATION OF BUILDINGS

Bat populations are very sensitive to chemicals because of their long lifetime and their low reproductive rate. Species roosting in roofs are exposed to frame treatment products. Because of their large naked wings, bats are more exposed than other species of mammals. They also ingest directly these chemical substances by licking their wing membranes and their fur or by grooming others members of the colony. Some substances can also be transmitted by lactation.

A recent study (45) compiled data on different toxics substances. Three mains types of chemical substances are used to treat wood:

- Chlorinates (organochlorine pesticides, DDT, dieldrine, lindane, chlordane): they cause severe and chronic poisoning, by storage in brain entailing death. Other effects are known on reproduction and fertility. These substances can increase bat metabolism, and can induce death by precocious exhaustion of fat reserves. Chlorinates are stocked in fat, then they can be mobilised to the brain during hibernation, or they can be transmitted by lactation to juveniles by lactation which are more sensitive than adults. These substances are persistent in the environment, and studies show that recent bat corpses can present a high level of forbidden toxic substances since 40 years.

- Pyrethrinoide pesticides (cypermetrine and permethrine): these products present a lower toxicity for mammals but are still neurotoxins. They can affect reproduction (more abnormal spermatozoids, decrease of weight of juveniles at birth, increase of prenatal death, delay of growth…). These substances can be lethal, but it seems that they don't have noticeable effects in doses of normal use.
- Metals and metalloids (TBTO, Boron salt and Zinc): these products are concentrated in different organs. The accumulation rate depends on species, age and sex of animals. They can also be transferred to the juveniles by lactation and by placental transfer. Some scientists have noticed a significant mortality with TBTO use, but not with Bore salt or Zinc salt (46) (45).

Because of these toxic effects, a large number of these types of chemicals are not permitted anymore for use in many countries because of the hazard to human health.

Treatment should take place at a time when no bats are present. In most situations, where bats are only present seasonally, this is fairly straightforward. Certain species, however, may be present in buildings all year round and there is no ideal solution in these cases (44). The local Bat Conservation Organisation may provide some help.

Tree species which don't need much treatment are sweet chestnut, oak, arch, Douglas pine. A number of fungicides and insecticides available on the market have been granted the European Ecolabel[42] due to their less toxic chemical composition (47).

C BUILDING INSULATION

Bats roost in cavity walls during all seasons. There are currently many European level and national initiatives to encourage building insulation to reduce carbon footprint. Although in theory, as part of these schemes, protected species should be surveyed for and their needs taken into account, in practice this rarely happens. Insulation schemes are damaging and destroying bat roosts in cavity walls in buildings, and at times killing whole roosts of bats where they become entombed within the cavity when the insulation is injected.

Another problem is breathable roofing membranes (BRMs) which have become widely used in buildings in recurrent years. Although originally designed for use as part of a continuous breathable/airtight barrier, they are also used in conventional ventilated buildings. There are a wide range of breathable membranes available but it has become apparent, through research undertaken at the University of Reading (UK)[43], that most of these membranes are detrimental to bats.

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[42] http://ec.europa.eu/environment/ecolabel/index_en.htm

[43] http://www.bats.org.uk/data/files/Entanglement_StaceyWaring.pdf

The issue is widespread across Europe:

- In Slovakia and Poland, some of the worst examples come from apartment blocks being upgraded, especially insulation of accessible roof voids that encouraged swift and bat occupation in apartment blocks. Financial support for insulation has been gained from the EU through program "Jessica";
- In the Netherlands, a 2013 workshop on urban bat ecology highlighted many problems with post-build isolation of wall cavities;
- In the UK, there are many examples of cases where insulation and refurbishment of buildings have had a similar impact on bats.

4.1.2.2 - Renovation works and mitigation measures

There are many examples from throughout Europe to show how bats need not be impacted during building works. Indeed, with some careful planning, the status of bats in a building can often be enhanced during such operations. Equally, it has been shown that if bat expertise is involved from the early planning stages of a restoration project, and a flexible approach is taken to the scheduling of the works, the bats can be satisfactorily accommodated throughout the project at little or no additional cost and without compromising the aims of the works.

Table 7 - Optimal period for carrying out works

Bat usage of site	Optimal period for carrying out works (some variation between species, and geographical regions)
Maternity	1 October – 1 April
Summer (not a proven maternity site)	1 September – 1 May
Hibernation	1 May – 1 October
Mating / swarming	1 November – 1 August

A BUILDINGS OF CULTURAL HERITAGE

UNESCO's Convention Concerning the Protection of the World Cultural and Natural Heritage[44], signed in Paris in 1972, recognised the dual need for protection of both natural and built heritage elements. However, conflicts arising between these two objectives have their origin in two opposite issues: either restoration / renovation works are planned for the building that will impact on the bats, or the bats themselves are causing a disturbance or damage within the building (44). Stakeholders of both side need to exchange at technical level to find appropriate solutions.

Lots of cultural heritage buildings tend to be illuminated at night with some impacts for certain species such as *Rhinolophus* and *Myotis spp*. Lighting can limit bat colonies installation or can disturb the schedules of exit and by the way increase prey availability at the beginning of the night (48).

Some public buildings, particularly churches, are closed to avoid settlement by pigeons. Belfries are fenced by wire netting and the access for bats is forgotten. When there is an established colony, bats can be trapped in these belfries and die.

A specific issue with some older buildings is the existence of lead based paints on girders or other metal structures. Bats can develop lead poisoning by ingesting flakes of this paint during grooming. Such a situation arose in the Château de Trévarez in north-west France. The chateau contained a

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[44] Further information on this agreement can be found at http://portal.unesco.org/culture/en/ev.php-URL_ID=8453&URL_DO=DO_TOPIC&URL_SECTION=201.html

nursery roost of 300 *Rhinolophus ferrumequinum*. Lead and pentachlorophenol poisoning was found to be the cause of high juvenile mortality at the site and in this case it was decided that the best solution was to build a new roost for the bats (49).

Case study: Ratková Church, Slovakia (44)

The loft of the Lutheran church in the village of Ratková, Slovakia, is occupied by a nursery colony of *Myotis myotis* and *Myotis blythii* in summer. The colony was discovered in 1992 and is the biggest colony of this type known in Slovakia, with up to 5,000 individuals present. A thick layer of bat guano had accumulated below the colony over the years; in places the layer of guano exceeded 1 m. The weight of the guano was about 10 tonnes, giving rise to concerns about the ceiling of the church.

On 3 - 4 December 2004, the loft of the church was cleaned with the help of the employees of the Muránska Planina National Park and Slovak Bat Conservation Society (SON) members. The guano was bagged and distributed to members of the local community as fertiliser. The colony continues to thrive and the ceiling of the church is no longer threatened with collapse. See SON website for further details of this work: http://www.netopiere.sk/aktuality/2004/12/03/cistenie-kostola-v-ratkovej.

Case study: Grad na Goričkem, Slovenia (44)**.**

Grad na Goričkem lies in northeastern Slovenia, close to Austria and Hungary. It is a castle of cultural heritage importance dating from the middle ages. When plans were developed to transform the castle into a visitor centre for cross-border landscape parks, it provided an opportunity to improve the roosting habitat of the castle's bats. Bats were first discovered in the castle in 1999. Intensive research followed on the composition of the bat fauna, seasonal dynamics of species and the microclimates of the areas being used by bats. Volunteer involvement was also important in developing an understanding of the importance of the building for bats. Conservation work was then undertaken to protect the bats from disturbance. Funding was provided by the State and also through an INTERREG IIIA project (Conservation of amphibians and bats in the Alpine & Adriatic region).

Ten bat species (one third of all Slovenian species) were found to use the site; the cellars provide hibernation sites for *Rhinolophus hipposideros*, *Myotis myotis*, *Barbastella barbastellus* and even occasionally for *Myotis bechsteinii*. *M. myotis* use the cellars as mating quarters as well. Up to 100 *Miniopterus schreibersii* have been recorded in the castle, making it one of the biggest known roosts for this species in the north-western part of the Pannonian basin. *R. hipposideros* also forms a small nursery group in the attic of the castle. As underground habitats are generally rare in the region, the cellars are thought to be an important swarming site for bats in the wider area. The building works required the complete demolition and reconstruction of parts of the castle used by bats. On the basis of the research, mitigation measures were recommended during the renovation, including the designation of part of the cellars as a bat roost. Extensive discussion took place between nature conservation and cultural heritage officers to agree the position and size of a new entrance for bats (Figure 16). Follow up monitoring is now required to ensure that the conservation measures are effective, but it seems that the conservation efforts to date have been successful. For further details of this work see (50).

B Barns and attics

As detailed in EUROBATS Publication Series (44), old barns play a locally important role as roosts for some bat species and provide their own challenges when it comes to accommodating bats during renovation or restoration works. A study in the UK has shown that many old timber-framed barns, some dating back several centuries, are now being converted into dwellings. Briggs (51; 52) found that the vast majority (77%) of converted barns have not maintained their bat species and she questions whether barns with bats should ever be converted. She looked at how bats could best be accommodated in these conversions and provides details of mitigation measures that should be built into future barn conversion designs (Species specific design, light pollution, timing of the works...).

The same issue exist for attics that are transformed in rooms when old houses are rearranged (53).

C Bridges

Bridges are known to be of particular importance for at least 13 species of bats across Europe (44). For example, out of 328 inspected bridges in Austria, 30% were used by bats (54). A survey of 200 known bridge roosts of *Myotis daubentonii* in Ireland showed that 75% were occupied by 1-5 bats and only 5% held 20 or more bats (55). Individual bats will use crevices as small as 50 mm deep and 12 mm wide, but larger groups require bigger, deeper roosting sites. Large, concrete motorway bridges with big interiors can provide shelters for many bats (e.g. one of the biggest known maternity roosts of *Rhinolophus hipposideros* in Austria is found in such a bridge). In Southern Spain, there are also modern bridges which support colonies of several thousand *P. pygmaeus* or hundreds of *E. isabellinus*

Old bridges, often made of stone, are subject to different types of disturbance and require different forms of maintenance or restoration works (redo joints, roughcast...). Crevices-dwelling species are very concerned by this issue. Some guidance documents provide helpful advice on how to accommodate bats in both old and new structures[45]. Again, careful timing of the works is a determining factor as well as preserving individual roosting spaces wherever possible.

D Modern buildings

All types of modern buildings (houses, flats, offices…) may be colonized by a number of species of bats, since they provide roosting opportunities which are becoming less and less available in more natural habitats. These modern buildings are often subject to renovation, reroofing, thermal insulation in the attic or elsewhere, or even demolition works at shorter periods than the buildings of cultural heritage. Simon et al. (56) provide detailed information on the construction of artificial roosts within buildings. Mitchell-Jones (57) and Schofield (58) provide extensive advice on the design and construction of roosts in dwellings. For other practical examples of mitigation measures and alternative roosts see Reiter & Zahn (59).

[45] See the leaflet produced by SFEPM that can be downloaded from www.sfepm.org/NuitChauveSouris/images2/Savoirplus/plaqponts.pdf.

Case study: Morcegário, Portugal (44)

In 2000, bats were discovered during the environmental impact study for the destruction of a 15-storey building in Portugal. Up to 100 *Tadarida teniotis* and some *Eptesicus serotinus* and *Pipistrellus pygmaeus* were hiding in crevices below concrete plates covering the walls.

Detailed monitoring showed that bats were present in all seasons and favoured walls with higher sun exposure. Bats were present at various heights, but were most abundant above 21 m, where temperatures were warmest. 75% of the bats were found inside crevices less than 3 cm wide.

Old and new Tadarida roosts, Portugal. © M. Carapuço © J. Palmeirim

The developer built a new roost in 2003, 150 m from the original. It was designed, in consultation with the statutory nature conservation organisation, to replicate the original building, although it is only 12 m high. In order to ensure that the thermal characteristics of the crevices were replicated the concrete plates of the original building were re-used. Follow-up monitoring confirmed that the thermal behaviour of the new roost was quite similar to the original one. To encourage colonization of the new roost, 50 bats were captured and released there when it was finished. The old building was knocked down in 2005. In 2006, 22 *Tadarida teniotis*, 12 *Eptesicus serotinus* and 4 *Pipistrellus pygmaeus* were recorded in the new roost. In 2007, the maximum numbers seen were 11 *Tadarida teniotis*, 11 *Eptesicus serotinus* and 7 *Pipistrellus pygmaeus*. Monitoring of the new roost is continuing.

Case study: Prefabricated panel houses and blocks of flats, Slovakia

Efforts for the procedure in conservation of bats and other protected species applied in Slovakia:

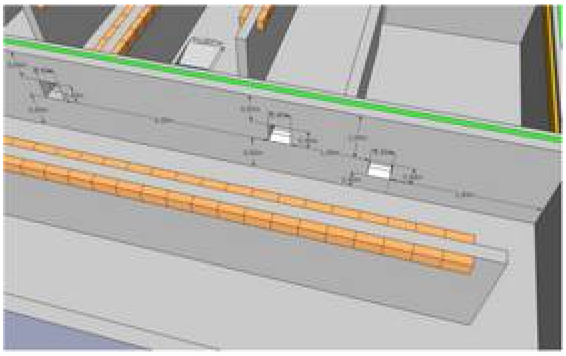
During planning of thermal insulation of blocks of flats the investor asks for an expert´s statement on occurrence of protected species from the State Nature Conservancy or a specialist with relevant experience listed in the List of Experts for elaboration of expertise. This appraisal will become a part of the project documentation similar to other obligatory parts of the design (like from fire-fighters etc.). In the statement the expert proposes protective measures which will be necessary during construction works (e.g. evacuation of bats from rifts between panels) and proposes the extent of compensation measures for loss of roosts as a consequence of insulation of the building (it can be done in different ways – if the situation permits keeping of used roosts or installation of artificial bat houses on the building façade or directly to the insulation)[46]. These works are covered by investor (or after agreement by the construction company). - Photos © D. Lobbova

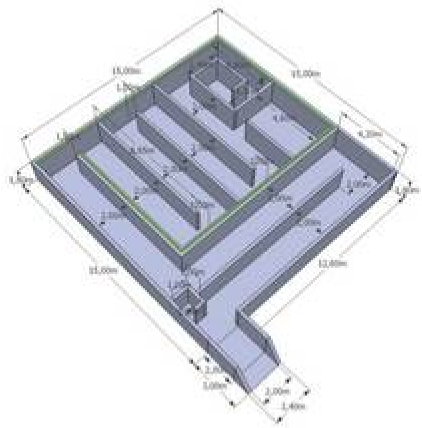
[46] www.bat-man.sk/netopiere/eshop/1-1-Budky-pre-netopiere/1-2-Polystyrenove

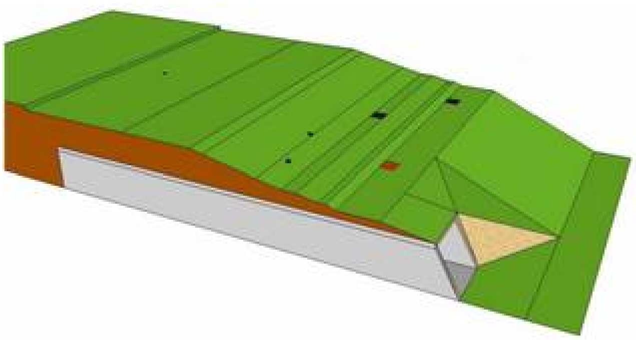
E ARTIFICIAL BAT HOUSES AS MITIGATION OR COMPENSATION MEASURES

Creation of new roosts – bat bricks or boxes - can be incorporated into bridges and buildings to replace lost crevices. This is done locally e.g. in relation with large infrastructure projects where this kind of measure become compulsory in the framework of compensation scheme or biodiversity offset projects. Some private or public bodies are building bat boxes for gardens, walls or other support and numerous NGOs or commercial catalogs are selling this equipment. However this is mainly proposed for some species (e.g. *Pipistrellus*) and transitional roosts.

In some cases artificial large bat houses are now proposed as it is already the case since many years in North America[47]. Such large bat houses have been proposed in some Environmental impact assessment studies as compensation measures and feasibility studies are now published (60). In some large projects, artificial bat houses imitating caves are proposed even in forest as in the figure below.







Different views of a proposed artificial roost in the forest of Belles-Forêts (France). This project is undertaken since 2012 by a public French company in the railway sector (RFF) in the framework of a compensation scheme (views extracted from the call for tender for the building operation published in 2012).

4.1.3 - Tree roosts

Trees are often used by bats as roosts with some species specialising in forest habitats (e.g. *Myotis bechsteinii*). They can use lots of different cavities: cracks, woodpecker tree holes, etc. Nevertheless, they prefer old and living deciduous trees (or more precisely indigenous trees which can be resinous in mountains) or forests with some great trunks and dead or broken trees. They also prefer a cavity high up into the trunk, a thin opening and tree cavities which are close to each other. Aged or ancient forests with enough dead wood are more often used by bats (35; 61). Also, orchards and isolated trees in hedges or in urban areas may also offer good roosting opportunities. Habitat requirements for each tree-dwelling species are detailed in (62; 63; 64).

In the town of Strasbourg (France), seven old plane trees were felled down in January 2013 as a measure for a new urban development project. In one of them, there was the second most important known tree-dwelling of *Nyctalus noctula* in Europe: 488 animals were found hibernating in the big internal cavity of the plane tree.

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[47] www.batmanagement.com/Ordering/condos/batcondo.html

Unfortunately, 24 of them died on the day of the felling; 464 were cared for by a local NGO and the animals were released in March-April. 118 to 145 were released at a time from the roof of the building next to the lost hibernacula. These releases were screened with infrared camera and few individuals were radio-tracked. This study allowed finding 4 other tree roosts distant from 1.8 to 14 km. All of these trees were found in old and big trees more than 100 years old (65; 66; 67).

The case of forest tree-dwelling is developed within the chapter on forestry practices (4.2.3). Roosting opportunities found in forested areas can be preserved by conserving standing dead trees, old and big trees and trees with holes in all forestry operations (around 7-10 roosting trees per ha is recommended (63)). Clusters of old trees are particularly valuable. In Germany, the conservation programs from Berlin, Hesse and Rhenanie-Wetsphalie include good practices regarding the conservation of 5 to 10 old trees per ha and their marking (64).

The importance of tree-dwelling bats in the rural countryside (isolated trees, hedges...) is not well known because tree-dwelling are very difficult to find and studies are scarce. However, bat will benefit from the next CAP reform as some areas of ecological interest will have to be conserved within the farmers' estate.

Logging in areas with high potential for roosting bats should be carried out outside the breeding season (mid-may to the end of July, or August in northern countries) but also outside the hibernating season (December to March included).

The conservation value of bat boxes (for certain forest species) is limited to areas without old trees, where natural bat roosts are missing. In such areas bat boxes can be helpful for bats to survive until such time when trees become old enough to have holes and crevices. However, bat boxes should only be used if it is ensured that somebody cares for them for many years. Bat boxes should not be used in old-growth forests and core areas of nature reserves or national parks (62).

4.2 - Commuting and foraging in fragmented landscapes

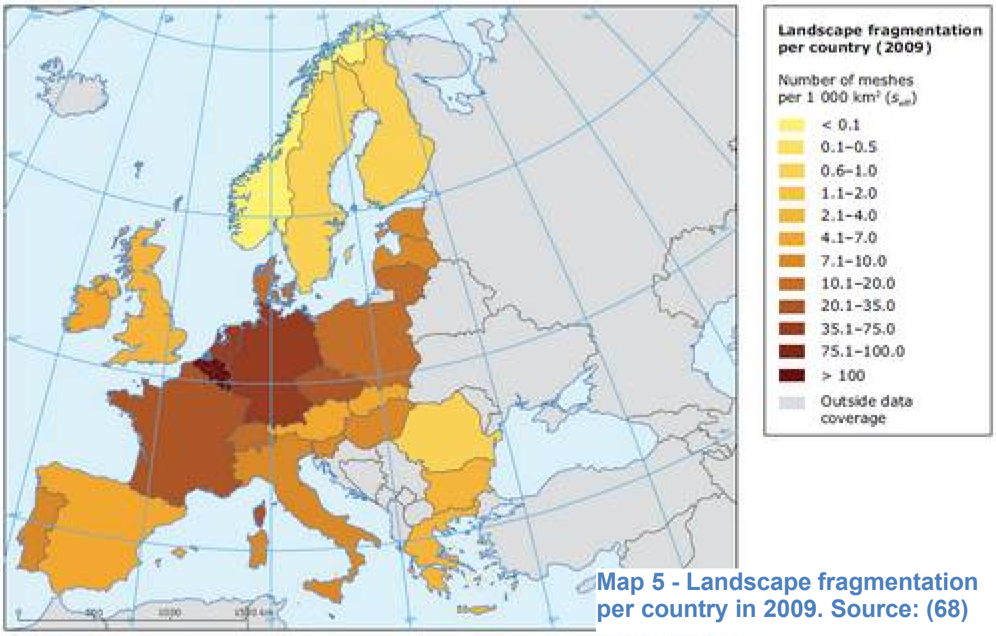
To reach their foraging sites or sheltered places, most species are following commuting routes using various features either natural (rivers) or man-made (hedges, walls, bridges). Certain species tend to forage not too far from their roosts like *Rhinolophus spp*. while others do not hesitate to travel 40 km and even more away from it for a rich meal like *Miniopterus schreibersii* and *Myotis capaccinii*. All the species are covering long distances every night and a single bat may forage up to 20 different areas in a night to maximise its yield. This means that both foraging areas and commuting routes are key features for the conservation of bats and the scale to be used is the landscape one.

A EUROBATS IWG is currently working on guidelines concerning conservation and management of critical feeding areas and commuting routes. Apart from species accounts, it includes a chapter on landscape structure and changes in it and a more detailed chapter dealing with e.g. different habitat types. Concerning examples of successful habitat management cases, however it was noted during the work that there are not that many cases where habitats had been managed and the outcomes monitored and reported. Rather, many cases include suggested or implemented management measures but no monitoring on the effects of these actions.

4.2.1 - Land planning and fragmentation

Commuting routes play a key role in conservation of bat populations as foraging areas are sometimes far away from roosting sites. Bats are thus very sensitive to landscape fragmentation by both infrastructures and disappearance of habitat diversity. Furthermore, landscape fragmentation increases the risk of populations of becoming locally extinct as isolated populations are more vulnerable to natural stress factors such as natural disturbances (e.g. weather conditions, fires, diseases (68)).

In 2011, the European Environment Agency has published a report in association with the Swiss Federal Office for the Environment (FOEN) specifically addressing the issue of landscape fragmentation in Europe (68). A European map of fragmentation has been produced and many highly fragmented regions are located in Belgium, the Netherlands, Denmark, Germany, France, Poland and the Czech Republic.



Map 5 - Landscape fragmentation per country in 2009. Source: (68)

Note: Landscape fragmentation was calculated using fragmentation geometry FG-B2.

High fragmentation mostly occurs in the vicinity of large urban areas and along major transportation corridors. Many more new transportation infrastructure projects were planned after 2009, in particular in Eastern Europe. As a consequence, fragmentation of landscapes is still rising.

However, the fast pace of road development by far exceeds our increase in understanding the effects on the environment and biodiversity, which makes appropriate adaptive management impossible. This results in a lack of accountability for the majority of uncertain effects and effects that become manifest years after the construction of new transportation infrastructure due to the long response times of wildlife populations (68).

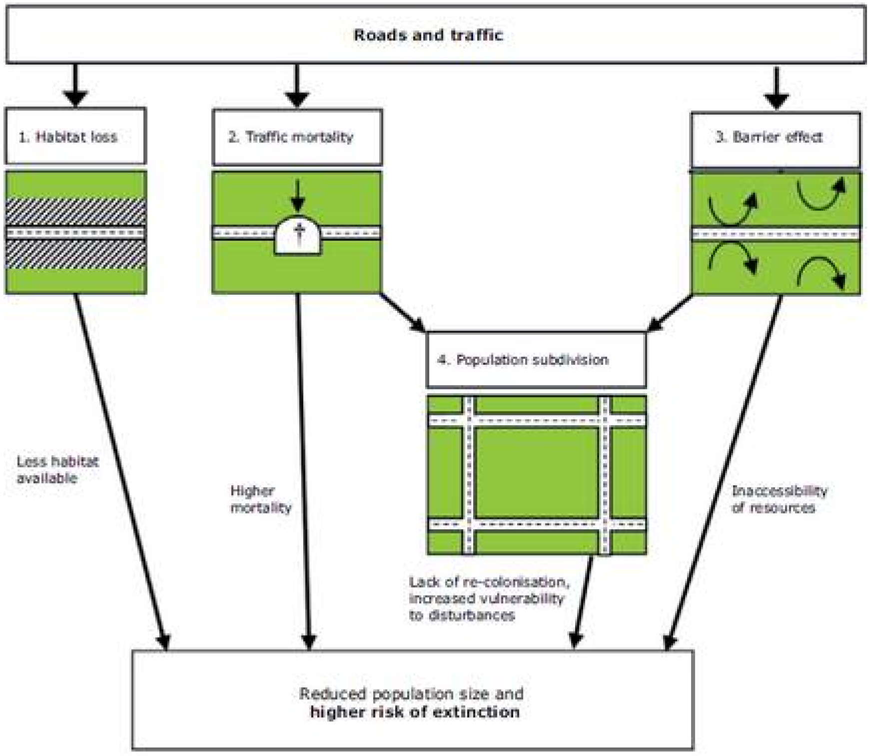


Figure 4 - The four main effects of transportation infrastructure on wildlife populations. ***Source: from Jaeger et al., 2005b in* (68).**

While single alterations are easily visible and assessed as 'not significant', their cumulative effects over longer periods of time are much more difficult to observe. Thus, single landscape alterations are easily marginalised and their cumulative impacts are underestimated. This has been called the 'pitfall of marginalisation'. Only after several decades can the full extent of the alterations and the resulting degradation of the landscape be properly evaluated (68)).

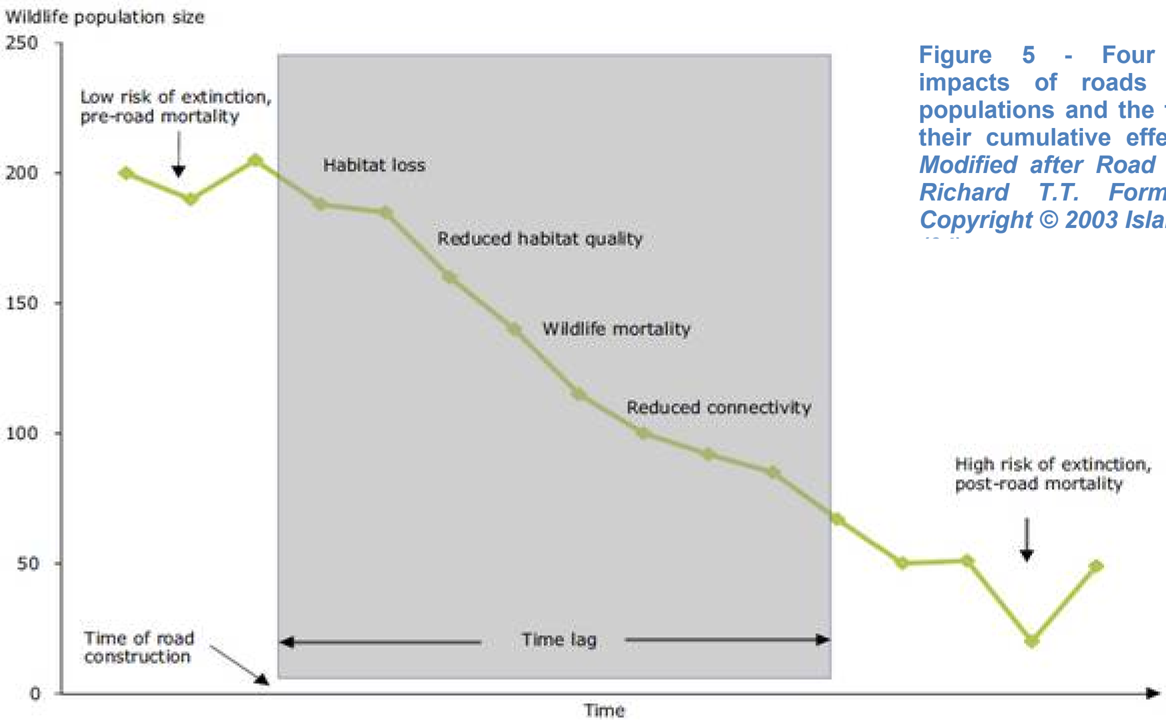


Figure 5 - Four ecological impacts of roads on animal populations and the time lag for their cumulative effect. *Source: Modified after Road Ecology by Richard T.T. Forman et al. Copyright © 2003 Island Press. In*

The 2011 report of the EEA on landscape fragmentation in Europe made the following recommendations with regard to biodiversity that are worthwhile for bats:

- "[...] We recommend drawing up guiding concepts for the landscapes in Europe (together with the MS) that include the identification of regionally and nationally important unfragmented areas and priority areas for defragmentation. To make these guiding concepts more tangible, it is desirable to adopt appropriate benchmarks or targets for the degree of landscape fragmentation. For example, the German government and the German Conference of Environmental Ministers claimed as an important goal a 'trend reversal in landscape fragmentation and urban sprawl' in Germany (Bundesminister des Innern, 1985; LANA, 1995). To achieve this goal, the German Advisory Council on the Environment (SRU) (1994: 128; 253) recommended the development and implementation of limits and orientation values for changes in landscape structure over time. Waterstraat et al. (1996) recommended the protection of large unfragmented low-traffic areas in Germany. More recently, the German Federal Environment Agency suggested that region-specific limits to control landscape fragmentation should be introduced (Penn-Bressel, 2005) [...]".
- "[...] Appropriate objectives and measures should be elaborated that are made binding for European and national offices and should state what measures should be taken and where and how they should be implemented, in connection with ongoing EU initiatives for a green infrastructure48. A process of Europe-wide documentation and coordination is recommended to produce an overview of measures at the European level and to enable regional strengths and shortcomings to be recognised more easily. This work could build on the achievements of the previous EU COST 341 Action (Luell et al., 2003) and the Infra Eco Network Europe (IENE) (http://www.iene.info) [...]".
- "[...] Further research should also address the question of how current transportation systems can be improved to keep landscapes unfragmented. The identification of thresholds of landscape fragmentation is a particularly important task [...].

4.2.2 - Agricultural practices

Apart from using hedgerows as commuting routes, bats regularly forage in crop fields and meadows. This is especially the case on edges between meadows or crop fields and wooded structures or water courses. Pasture may play a key role as a foraging habitat for some species (*Eptesicus serotinus*, *Rhinolophus ferrumequinum, Rhinolophus hipposideros, Myotis myotis, Myotis blythii oxygnathus, Myotis nattereri, Plecotus austriacus*).

Removal of hedgerows, loss of foraging areas (meadows, ponds), and reduction in insect prey with the increased use of pesticides will impact bat populations. Agricultural intensification is suspected to be a major cause of the decline in many European bat populations (13). It has partly driven bat populations of central Europe near to the extinction, and Mediterranean populations have strongly declined in intensively farmed areas (10).

4.2.2.1 - Changes in farming practices

While farmland covers 45% (180 million hectares) of the EU-25 (69), intensively managed agricultural landscapes have become increasingly monotonous in some areas. After World War II, increased size of fields, mechanisation, loss of traditional rotations management and the subsidised intensification of agriculture led to the loss of semi-natural habitats. However, patches and networks of natural elements are essential for increasing connectivity within the landscape (70; 71). Intensification leads to the degradation of hedgerows, conversion of crops to large monoculture fields, draining of pastures, ponds and other wetland, loss of crop rotation, conversion of pastures to arable land and conversion of woodland to farmland. (69).

These changes lead to a decrease in non-crop habitats such as hedgerows, groves, field margins, unmown grass strips, ponds and orchards (72), which are essential habitats for bats (flight paths,

[48] http://ec.europa.eu/environment/nature/ecosystems/

foraging sites, insect source) (13). Moreover, a number of bats are likely to have suffered from destruction of roost sites in groves and hedgerows.

Even though bats do not feed during the day, the European Grassland Butterfly Indicator 1990-2011 (73) efficiently demonstrates the influence of these changes on potential prey. 17 butterfly species are assessed including 7 widespread and 10 specialist species. Out of the 17 species, 8 have declined in Europe, 23 have remained stable, 1 has increased and for 6 species the situation is uncertain. No doubt that the situation is more or less the same for bat preys such as moths. The reasons involve intensification leading to uniform grasslands which are almost sterile for biodiversity, and abandoned land as unmanaged meadows are naturally replaced by scrub and woodland.

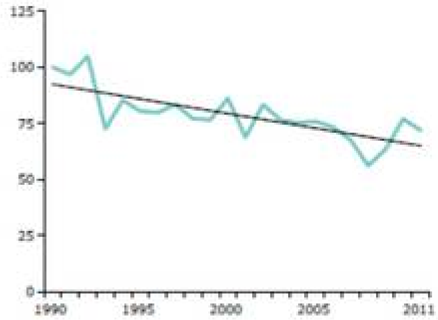


Figure 6 - European Grassland Butterfly Indicator 1990-2011(from (73))

Linear landscape elements may be of prime importance for bats and provide them with more protection against wind, but also foraging habitat with higher prey densities than in open areas. Isolated trees, tree lines or hedgerows are landscape elements for both commuting (certain bat species are reluctant to fly in open habitats) and foraging.

In a recent Swiss study (71), bat activity was 1.4–2.8 times higher around landscape elements compared to open and unstructured control areas. This indicates that bats significantly prefer landscape elements over open habitat. This study corroborates previous findings that open habitats seem to be less attractive to bats for foraging, apart for cattle grazed pastures according to another British study (74). The shape of landscape elements (linear vs. patchy) is much less crucial for bats than the area covered by vegetation structure. Higher bat activity around structural elements suggests that the presence of a single isolated tree to a highly connected hedgerow or forest may benefit bats. Authors highlight the importance of connectivity for bat communities in farmland-dominated landscapes and claim that fragmentation is a major threat to bat populations.

Another UK recent study (75) has demonstrated that the effect of boundary loss on most bats was very strong in both crops and grasslands, but the larger species of bat (*Nyctalus*/*Eptesicus* spp., mostly identified as *Nyctalus noctula*) showed no sensitivity to boundary loss.

From 2000 to 2006, 22 % of semi-natural habitats loss was due to the conversion from natural land to farmland (76). The common agriculture policy (CAP) instruments have been created in order to slow down that trend. It includes the concept of eco-conditionality, which sets up a number of conditions under which farmers can get direct payments from CAP's first pillar (77). In order to get those, farmers must fulfil good agricultural and environmental conditions (GAEC), which include the implementation of field margins, the maintenance of set-aside and/or cultivated land, the grassland management and the upkeep of landscape features (hedges, ditches, woodland edges, etc.) (78). Reintroduction of structural elements should also be planned in the framework of agri-environment schemes which compensate farmers for loss of income or extra work due to measures they take to improve biodiversity.

4.2.2.2 - Pesticides and chemicals

The use of pesticides and chemicals is also an important threat to bats. It reduces food supply by eliminating insects and can poison birds and mammals that feed on them (69). However, a study in UK (75) has demonstrated that bats were relatively insensitive to increased agrochemical inputs and the switch from hay to silage, but more strongly sensitive to boundary loss (hedgerows, tree lines...). Authors nonetheless stipulate that they cannot comment on possible toxicological effects.

Pesticides can also accumulate in insects and then concentrate to lethal levels in bats. Such pesticides used for agriculture and forestry are known to kill (79). Furthermore, the impact on prey populations may be high as it was demonstrated for endectocides.

Endectocides (avermectins and milbemycins) are drugs used on livestock to control parasites (80). Ivermectin is an antihelminthic from the avermectin family, which is massively used (it was the most sold veterinary drug in 1996) (81). Many coprophagous invertebrates are negatively affected by avermectins or other antihelminthics coming from livestock dung (Beynon, 2012; Vickery et al, 2001 in (82)). These drugs can kill adult insects or larvae, impair reproduction of these insects, delay their development or cause malformations. In Europe, such antiparasitic drugs are used for livestock in at least 16 range states. The bat species most likely to be affected by this lack of food are *Rhinolophus* spp., *Eptesicus serotinus*, *Nyctalus* spp., *Myotis myotis, Myotis blythii*, *Myotis punicus* and some *Pipistrellus* spp.

A recent German study (83) showed that by following the toxicity-exposure ratio approaches of the current pesticide risk assessment, no acute dietary risk was found for all recorded bat species. However, a potential reproductive risk for bat species that include foliage-dwelling arthropods in their diet was indicated. The results emphasize the importance of adequately evaluating the risks of pesticides to bats, which, compared to other mammals, are potentially more sensitive due to their ecological traits.

There is an example from Rajec in central Slovakia on death of an attic colony of Myotis myotis caused most probably by using of chemicals in agriculture (possibly neonikotinoids) because females did not return back from the foraging site to the roost to their young ones[49].

Contrary to agriculture intensification, organic farming excludes the use of chemicals (synthetic fertilizers, pesticides, growth regulators and livestock feed additives). Organic farmland habitats have a higher quality and higher overall insect abundance, and key insect families important to bats are more common on organic farms than on conventional farms. As a consequence, bats seem to prefer organic farms over conventional farms for both foraging and general movements (13).

4.2.3 - Forestry practices

4.2.3.1 - Forests - Key habitats

As highlighted by the EUROBATS leaflet, forests of all types ranging from the dry Mediterranean forests to the boreal conifer forests are used by bats because they will seek out particular features, such as ponds or streams, clearings or forest edges, where insects tend to be most abundant.

The species for which forest habitats is vital, for both roosting opportunities and foraging areas, include two annex II species (*Myotis bechsteinii* & *Barbastella barbastellus*), and several annex IV species (*Pipistrellus nathusii, Myotis nattereri, Myotis brandtii*…). However, forests are also key habitats for *Nyctalus* spp., *Plecotus auritus* and *Myotis daubentonii*, and provide the favoured foraging areas for e.g. *Myotis myotis, Myotis emarginatus*, *Eptesicus nilssonii*, *Vespertilio murinus* and the *Rhinolophus* spp.

Specialised books on the ecology and conservation of bats in forested areas (64; 63) highlight the need of more research for these species in order to better understand their ecological requirements in view of a more sensitive management. There are links between management options and the related use of forest by bats such as partial thinning of the canopy which increases the light intensity and thus promote undergrowth which in turn is good for gleaning species like *Myotis bechsteinii and Plecotus auritus*. On the contrary, the development of dense canopy which eventually increases space between trees is the preferred foraging area of *Myotis myotis*.

4.2.3.2 - Forestry issues

Overall in Europe, most of the forested areas are managed for commercial purposes with limited consideration for the protection of bats. The main issues are the following (64; 63):

- Cutting trees during the hibernating season (winter), and thinning in summer (breeding season);
- The age of the trees are limited to its optimum in terms of quality of wood (80 years for the spruce and 120 years for the beech), hence there is usually a low number of trees with bat roosting opportunities (cavities, cracks, holes…);

[49] www.netopiere.sk/aktuality/2013/08/19/Rozsiahly_uhyn_v_kolonii_netopiera_obycajneho_v_Rajci

- An increase in coniferous plantations and other exotic species (e.g. the Douglas pine tree and the Japanese larch tree), which are unfavourable to most of bats;
- The impoverishment in insect diversity due to a limited number of tree species present in forest (monoculture) causes decreases in prey availability for bats;
- The sudden loss of foraging areas used for years when clear-cut harvesting on large areas;
- The use of pesticides which also reduces prey availability and possibly affect the bats themselves;
- The fragmentation of large forested split into smaller plots bordered with tracks and roads, and disturbance and mortality caused by the vehicle traffic at night;
- Classic harvesting techniques can be harmful to surrounding trees, while modern techniques using cranes allow to avoid damaging valuable trees for roosting bats;
- Structural and functional relationships between unmanaged and managed forests (they may act as sources and sinks respectively (84).

4.2.3.3 - Reducing the impacts of forestry practices

A EUROBATS Working Group was launched in 2004 and a leaflet on good practice guidance for bat-friendly forestry in Europe, “Bats and Forestry”, was published in 2004[50]. Apart from landscape planning advices related to fragmentation and corridors, 11 good practices for forestry operations where proposed as follow:

- Preserve and increase roosting sites by conserving standing dead trees, old and big trees and trees with holes in all forestry operations (logging, thinning and cleaning). Groups of old trees are particularly valuable;
- Wherever possible try to increase variation in tree species and forest structure. Use native species wherever possible;
- Conserve deciduous trees in coniferous forests. Deciduous trees produce food and roosting sites;
- Increase food production for bats by conserving important habitats: wet forests, riparian habitats, gaps and forest edge zones;
- Limit the use of pesticides in forests;
- Avoid drainage of forest land. Creating new small wetlands and ponds within the forest benefits the bats. Flooding and storms can create dead trees and a variable forest structure;
- Semi-open pastures are sometimes important habitats. Nowadays grazing is often abandoned and these areas are allowed to re-grow or are planted with trees. It is important to conserve some areas with semi-open structure and high abundance of flowering plants. Do not cover the whole landscape with monoculture plantations;
- Grazing and browsing by cattle or other large herbivores creates a variable semi-open forest which is a good foraging habitat for bats. However, too much grazing can remove the whole under storey;
- Avoid creating large clear-cuts;
- Identify the next generation of trees for bats and leave these during harvesting;
- Avoid cutting through any trees close to holes; there may be bats roosting inside.

The public body in charge of nature conservation in England (previously English Nature, now Natural England) has published several guidance documents on the good practice management of woodlands for bats (62), including one specifically targeted on Bechstein’s bat and the Barbastelle bat (85).

Another technical guide on this topic was also published by the Conservatoire des Espaces Naturels Rhône-Alpes[51] from France (86).

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[50] www.eurobats.org/publications/eurobats_leaflets

[51] www.cen-rhonealpes.fr/index.php/editiontech

Excerpt of a booklet on "*Woodland management advice for Bechstein's bat and barbastelle bat*" (85).

"[…] In dedicated plantation woodlands, Bechstein's bat colonies may exist for periods but they are neither stable nor sustainable in the longer term with current commercial woodland practice. Colonies rely heavily on semi-mature or mature canopy to forage in and a continuous supply of suitable roost trees into the distant future. This requires linked canopy cover with under storey over an area of about 50 hectares with further areas going into canopy decline and others not yet in canopy closure or in sapling stage. The current trend in forestry practice towards a wider remit of wildlife and recreation as well as timber production gives some scope for management practice to improve matters. A forestry timber extraction policy that follows the slow removal of prime individual trees on a continuous basis, rather than clear fell, will avoid sudden crashes in colony population sizes by maintaining adequate canopy cover for foraging.

Improvements in plantation management should include:
1. Creating non-intervention strips along all watercourses within the woodlands. This should include all the small floodplains and steep banks along the woodland streams.
2. Harvesting hardwood trees in plantations only when unavoidable and then by selected felling only, done on a slow continuing basis cutting only the best sound mature timber at appropriate times of the year.
3. Monitoring stands of trees used as nest sites by woodpeckers and leaving these stands as non-intervention until their natural decay.
4. Creating a series of suitable areas within which Green Woodpeckers can forage for ants. These areas should be over and above the woodland area required by the bats to forage in.
5. Ensuring, by new planting if necessary, that all hardwood blocks in nursery colony areas have deciduous woodland connections.
6. Leaving not only hollow trees but the immediate stand of trees around them together with the under storey during any felling operations

4.2.4 - Light pollution

Following the results of a EUROBATS IWG in 2008[52], light pollution might influence species through habitat disturbance, changing of behaviour, and in some cases on survival if intervening with crucial steps in the life cycles of species. In particular for bats, at least three main areas can be identified having a possible influence on populations:

- (In)direct effects on maternity colonies, hibernation sites and roosts;
- Effects on commuting e.g. barrier function of lit roads and fragmentation of the night landscape;
- Interaction with feeding activity, including prey distribution and intra-bat species competition;
- Higher risk to become a prey to the predator by illuminated roost sites.

Only few species (*Pipistrellus pipistrellus, P. Pygmaeus, P. kuhlii, Hypsugo savii, Eptesicus spp., Plecotus spp.* and *Nyctalus spp.*) seem to take advantage of the aggregation of insects to the UV-component of light sources for foraging (although may be adversely affected by illumination of roost entrances).

Observations of repeated predation of bats by diurnal raptors in urban areas (roosts present in blocks of flats) were made in Slovakia (Kladecik J., pers. comm.). The street lights allow to the Common Kestrel to adapt its foraging ability on bats during the evening.

52 www.eurobats.org/sites/default/files/documents/pdf/Advisory_Committee/AC13_Doc_13_IWGLightPollutionReport.pdf

Longer term effects were also shown by an Italian study (87): street light boosting in Italy may have acted as an evolutionary pressure on cranial size of *P kuhlii*, which has increased since 1940's-1950s possibly to catch larger prey concentrated near street lamps.

The Bat Conservation Trust, in partnership with Arup, will soon host a symposium on the topic of Artificial Light and Wildlife (to be held in London on the 20-21 March 2014). The symposium will bring together the lighting industry (manufacturers, installers, designers, and planners), local authorities, ecological consultants and academics, to discuss the current state of scientific knowledge of the ecological impacts of lighting and the needs of practitioners. Although talks will be on a range of wildlife the emphasis will be on bats and associated invertebrates.

4.3 - Infrastructures and mortality

4.3.1 - Traffic infrastructures

Linear infrastructures (particularly roads, motorways, railways...) have different impacts on bat populations, both during their construction and their use. They are generally negative ones; however some infrastructure may have a role for commuting routes (canals, bridges…).

4.3.1.1 - Issues

A HABITAT DESTRUCTION BY TRAFFIC INFRASTRUCTURES

The construction phase may lead to the destruction of roosts (buildings, caves or tree-dwelling). In this case, there is a strong adverse impact if these roosts are maternity or hibernation roosts (e.g. *Nyctalus noctula*). The impact is less adverse for transitional roosts if precautions are taken to avoid mortality of individuals. Roosts destruction can also occur when a bridge have to be reshaped, widened or maintained (reinforcement, joints), and roosting animals can be trapped (88).

Construction phase will also induce destruction of habitats which can be used by bats for foraging. In addition to the land take for the infrastructure itself, works require additional areas for compound sites and temporary storage areas, building engines circulation ways. It may represent a large area which becomes unfavourable for bats (88). To give an idea, a motorway may block around 3 ha per kilometre. The pollution of wet zones via the run off waters loaded in hydrocarbons, heavy metals... can also induce a decrease of insects productions and hence a loss of interest for foraging (88).

B HABITAT FRAGMENTATION BY TRAFFIC INFRASTRUCTURES

New linear infrastructures will intercept many flyways and make them unusable by bats. Older infrastructures have the same effect but bats may have found new strategies for using local territories. Every type of flyways can be concerned: hedgerows, forests edges, rivers, forests canopy or alley, tree alignments... Zurcher *et al*. (89) explained that 60 % of bats crossing road turn back when a vehicle arrives. The different habitats used within a year by bats (breeding roosts, mating sites, hibernacula, foraging sites ...) will be affected because of a lack of accessibility.

However some species can cross roads more easily than other, depending on their ecology: *Nyctalus* species generally fly high and are less dependent from landscape features. This is not the case for other species as *Rhinolophus* or *Plecotus spp.* (90; 91; 92).

A study by Kerth *et al* (91) demonstrated that motorways can restrict habitat accessibility for bats but the effect seems to depend on the species' foraging ecology and wing morphology. Motorways seem to have stronger barrier effects on bats that forage close to surfaces than on bats that forage in open space. Using radio-telemetry, mist netting, and mark-recapture data the authors investigated the effects of a motorway with heavy traffic on the habitat use of two threatened forest-living bats. They have compared *Barbastella barbastellus*, which forage in open space, to *Myotis bechsteinii*, which glean prey from the vegetation. Five of six radio-tracked barbastelle bats crossed the motorway during foraging and roost switching, flying through underpasses and directly over the motorway. In contrast, only three of 34 radio-tracked Bechstein's bats crossed the motorway during foraging, all three using an underpass. Bechstein's bats, unlike barbastelle bats, never crossed the motorway during roost switching.

C BAT MORTALITY

Direct destruction can occur by casualties with traffic (93; 94; 95). Some studies show that all kind of species are concerned (95; 96; 90; 93; 94; 97) although not to the same extent. The following table illustrate this issue with some results gathered during monitoring surveys carried out along roads.

Table 8 - Case studies of bat mortality due to traffic

References	Country	Context	Mortality
Bickmore 2003 (98)	Wales	A477 and A487 in 2001 and 2002	16 carcasses (10 in 2001 and 6 in 2002 on the A487 - nothing on the A477).
Choquène, 2006 (93)	France	7 Km of a 2 x 2 lanes in 1997	30 carcasses - 3 species.
		27 Km of the RN27 (2 x 2 lanes)	87 carcasses in 3 years (31 in 1997; 42 in 1998 and 14 in 1999) - 9 species.
		Few Km of a 2 x 2 lanes	12 carcasses in 4 consecutive days in August.
Capo *et al.*, 2006 (94)	France	On a 2 x 2 lanes near a hibernacula	104 carcasses (17 in 1998; 41 in 1999; 23 in 2001 and 23 in 2002). Mortality pick in May and August-September.
Graisler *et al.* 2009 (95)	Czech Republic	Two roads R5204 (3.5 Km) and R5205 (4.5 Km)	119 carcasses in 2007 - 11-12 species. Mortality pick in July-August and September-October.
Lesinski, 2008 (96)	Poland	1 km of highway (2 x 2 lanes)	52 carcasses in 2.5 years (2 in 2004; 28 in 2005 and 19 in 2006).
Lesinski, 2007 (90)	Poland	8 km of a 2 x 2 lanes - 1994-2000	112 carcasses - 11 species. Death pick in August-September. Different mortality pick according to the species.
Lesinski *et al.*, 2011 (97)	Poland	16.6 km of a 2 x 1 lanes in the National Park Kampinos in 2008 and 2009	61 carcasses - 7 species. 2 mortality picks: July-August and October.

Lesinski (90) specified that young-of-the-year seems more sensitive to accidental killing than adults. Some differences appear also depending on the surrounding landscape (96; 97; 95) which can lead bats on road. He noticed that there are more carcasses at a junction between road and forest edges or with trees alley (90; 96). He also showed that casualties depend on the landscape surrounding with a higher rate of mortality in building areas and in forests (97).

Different studies report three mortality peaks during the year:

- At the end of hibernation (98), when adults need to intensively forage in order to build up energy supplies;
- At the end of summer, when young-of-the-year begin to fly and are in dispersal phase (97; 90),
- September to October, when bat populations are at their peak numbers, seeking to mate and to build up fat reserves for hibernation (97).

Poisoning by pollution via the run-off waters from roads loaded with hydrocarbons, heavy metals... may have an impact on bats through food chains (88). However, this requires more research studies as it may only concern a few individuals.

D DISTURBANCE

Noises, vibrations and light due to the construction phase of the infrastructure can induce disturbance of bat populations. Bat roosts can be located near a building site (old trees, bridge, buildings...). These disturbances can trigger the desertion of these roosts (98). Disturbance can also occur on flyways: bats tend to avoid built areas, especially because of work lights (99), and can make unapproachable different habitats. It had been shown that bats, even species able to hunt around street lights, avoid lights when commuting along flyways.

Berthinussen & Altringham (100) have shown a clear avoidance of major roads by bats: the bats activity and the number of species are three times more important at 1,600 m far from the road than at its direct edges. Schaub *et al.* (101) wanted to test the reaction of gleaning bats when they have to forage in noisy areas. These species can use the sound emitted by their prey in order to catch them

(102). They observed foraging behaviour of *Myotis myotis* in different compartments: three noisy ambiances and a silent one. It appeared that there was a clear noise effect through the time spent in each compartment. Noise affects the hunting success of bats and so they tend to avoid noisy compartment. This experience shows that bats tend to desert foraging areas close to important source of noises, like major roads.

4.3.1.2 - Mitigation measures for traffic infrastructures

A CURRENT KNOWLEDGE

Different studies show that bats can cross a road or a railway using sheltered passages. The use of tunnels as flyways, when they are not too far from the original flyways, has already been demonstrated (103).

Better ways to mitigate fragmentation by different sheltered passages have been compiled recently (92). Results showed that bats use more frequently underpasses and river bridges than overpasses (regularly proposed for bigger mammals like deer). In this study, 93.6 % of bats were crossing via underpasses and 98 % via river bridges whilst only 50 % were using overpasses. They have also noticed that underpasses and river bridges are not so efficient if bats can stay in higher canopy as the height of the road verge tends to induce bat to increase the height of their flight.

In another study (104), it was demonstrated that if an underpass allows bats to cross without changing their direction or their flight height, they are the ones preferably used (96 % of crossings); remaining cases concerned direct crossing over the road. They have also seen that gantries seem to be ineffective.

The height of underpasses is a key feature for bat crossing whilst the length seems to be a non significant element (105).

Several reviews and reports have been drafted, in which solutions and good practices have been compiled and summarized (98; 99; 88).

B GOOD PRACTICES AND EXPERIMENTAL PROJECTS

- In **Ireland**, the National Roads Authority (NRA) has established guidelines and procedures that focus on the impacts on bats during the construction of new national road schemes[53]. These can also be adopted for road realignment and bridge maintenance programmes.

[53] www.nra.ie/environment

Innovative palliative measures for the A7 motorway (Spain)

The motorway A7 in Alcoi (Spain) was recently constructed next to an important bat shelter. Different mitigation strategies were assayed there. A sector of the motorway was entirely covered with a net of 20 cm of aperture size to avoid bat collisions. The preliminary results showed that the net can effectively block the access to the road to bats. The net is combined with overpasses and underpasses. The preliminary results showed that underpasses are preferred to overpasses by commuting bats.

Photo 1 - Detail of the net that covers the A7 in the vicinity of the bat shelter (© J. Juste)

Photo 2 - Overpass details (© J. Juste)

Innovative bat bridge for the A89 motorway (France)

In southern France, an innovative approach is currently being tested on a new motorway. However, data are still missing in order to assess the effective use of these group-specific overpasses by bats. On the A89, the specific overpass is only a part of a comprehensive project including the erection of artificial galleries, the monitoring of tree roosting, the development of specific bat roosts in the structures… The overpass itself was an experimental project with a specific structure being also safe in terms of security, easy to manage, and attractive for both bats and the human eye!

Photo 3 – Bat bridge of the A89 in France (© ASF)

A EUROBATS Working Group was launched a few years ago to look into methods to minimise the impact of roads and other infrastructures. Its objectives include:

- the collection and review of the different studies, scientific literature and impact assessment reports available on bat mortality, habitat fragmentation relating to roads, railways, etc;
- the collection and review of technical documents on the approach to road building and landscape management which seek to minimise impacts when constructing new infrastructures; and

- the production of general guidelines to raise awareness on the impact of traffic infrastructures on bats and provide some advice for assessing mortality, fragmentation of habitats and others impacts on bats.

4.3.2 - Wind energy development

The Eurobats published in 2008 the "*Guidelines for consideration of bats in wind farm projects*" Guidelines for assessing potential impacts of wind farms on bats was worked out by the IWG of Eurobats and adopted by Meeting of Parties in 2006. Then, the guidelines were updated with new data from recent literature and published (106). However, knowledge is rapidly increasing on this issue and new measures to reduce the impacts are proposed.

As part of the implementation of the Kyoto Protocol, the interest of renewable energy sources has resulted in the European Union promoting wind energy through the energy-climate package and this is now is one of the three main regions of wind installations in the world.

4.3.2.1 - Issues

Although development of renewable energy sources is generally considered environmentally friendly, wind power development has been associated with the deaths of bats. While many studies have long since shown the impact of wind turbines on birds, mortalities of bats are really documented since 1996. It was in 1999 that the American and European studies begin to mention potentials impacts on bats corroborated by corpses discovered under and near wind turbines. Two causes of bat deaths have been documented: collision with blades and barotraumas that involves tissue damage to air-containing structures caused by rapid air pressure reduction near moving turbine blades (107; 108; 109).

Today monitoring studies of bats mortality are required at wind energy facilities. Several monitoring methods continue to be developed in Europe and mortality rates can be corrected thanks to tests determining the search efficiency, the predation rate and the surface correction. Data processing can cause statistical difficulties because mortality rates are expressed with or without the use of bias correction. Moreover, results are very variable depending on the calculation methods used to remove bias (sometimes differences of several tens). Also bat mortality is very different depending on the site related to the habitat type. All of this generates very different results. The following table summarizes some number of bats fatalities identified for various European studies.

Table 9 – Number of bats fatalities identified for various European studies

References	Country	Context	Mortality results	Bats killed/ turbine/year	
				Unadjusted numbers	***Corrected numbers***
ABIES, 2009 (110)	France	28 turbines - 4,5 months	30 fatalities	-	1,07
AVES Environnement, 2009 (111)	France	9 turbines -1 year	103 fatalities	11,44	79,3
Behr O. & Helversen O., 2005 (112)	Germany	4 turbines - 1 year	31 fatalities	7,75	31,5
Brinkmann R., 2004 (113)	Germany	16 turbines - 1 year	40 fatalities	2,5	20,9
		8 turbines -1 year	10 fatalities	1,25	11,8
Georgiakakis P. et al., 2012 (114)	Greece	88 turbines -1 year	181 fatalities	2,08	-
Leuzinger et al.,2008 (115)	Switzerland	5 turbines - 4,5 months	2 fatalities	-	8,2

Bat fatalities at wind turbines in Europe have been compiled since 2002 by Tobias Dürr from the Ornithological Station of the State Office for Environment, Health and Consumer Protection of the Land Brandenburg, Germany[54]. Most of the data come from Germany, Spain, France and Portugal. The figures are dependent of the data providers and do not stem from standardized studies, but there are only ones available to date. The most impacted species are *Pipistrellus* spp., *Nyctalus* spp. and *Eptesicus* spp. All the available data is in the Appendices section.

Recently, indirect monitoring techniques were developed, such as methods for estimating mortality calculated with the acoustic activity and statistical models. Many questions remain unanswered about if collisions occur fortuitously or if bats are attracted to wind turbines. Yet several characteristics of the wind turbine could influence the mortality of bats like the diameter of the rotor, the size tower, the ground clearance and the blade tip speed which can exceed 300 km/h. Other parameters increasing bat mortality like meteorological and time factors have been demonstrated (116).

4.3.2.1 - Mitigation measures

Minimizing these fatalities is critically important to both bat conservation and public acceptance of wind-energy development. Currently, only curtailment, the act cutting-out the generator from the grid when bat activity is high, has demonstrated effective reductions of bat fatalities (117; 118). Techniques using automated systems based on models incorporating variables in addition to wind speed (time of night, bat activity…) and meteorological data have been developed (119). When risky periods for bats (high bat activity) are detected, turbines are stopped automatically.

Although these measures showed a significant reduction of the mortality, this technique requires a lot of time for data collection and the many consecutive starts and stops can cause an abnormally wear of the wind turbine.

Easier methods like the increasing cut-in speed and feathering blades by slowing rotor speed up to the turbine manufacturer's cut-in speed yields substantial reductions in fatality of bats. The cut-in speed is the wind speed at which the generator is connected to the grid and producing electricity. The manufacturer's set cut-in speed for most contemporary turbines is between 3.0 and 4.0 m/s. The principle of this measure to reduce the risk of bat mortality is increasing the cut-in speed. The turbine's computer system (referred to as the Supervisory Control and Data Acquisitions or SCADA system) is programmed to a cut-in speed higher than the manufacturer's set speed. The turbines are set to remain almost completely stopped until the increased cut-in speed is reached over some average number of minutes (usually 5-10 min). Several studies have shown that raising turbine cut-in speeds from the manufactured speed by 1.5-3.0 m/s results in significant reductions in bat fatalities compared to normally operating turbines. Most of them have shown a 50 % reduction in mortality of bats when the cut-in speed was delayed by 1.5 m/s. The lost power for this operational mitigation is generally lower than 1 % of total annual power output. However, altering turbine operations, even on a limited basis, potentially poses operational and financial difficulties for some project operators. At wind speeds below operational cut-in speeds, turbines are generally "freewheeling". Even though turbines are not producing any electricity while freewheeling, they still may rotate at high speeds that are lethal to bats. Thus, altering turbine operations to eliminate blade movement at or below normal cut-in speed also may reduce bat fatalities without raising cut-in speeds. Normally operating turbine blades are angled perpendicular to the wind at all times. The feathering is adjusting the angle of the rotor blade parallel to the wind, or turning the whole unit out of the wind, to slow or stop blade rotation. The advantage of the feathering turbine blades is that it could be implemented at many facilities with those turbine models that have SCADA systems capable of relatively easy programming.

At last, studies have tested the effectiveness of ultrasonic acoustic deterrent for reducing bat fatalities at wind energy facilities (120). They proved that the emission of ultrasonic broadband can affect the behaviour of bats directly by discouraging to approach the sound source, or indirectly by reducing the hunting time spent near the turbine because insects are repulsed by ultrasounds.

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[54] Die Staatliche Vogelschutzwarte des Landesamtes für Umwelt, Gesundheit und Verbraucherschutz Brandenburg (www.lugv.brandenburg.de/cms/detail.php/bb1.c.312579.de)

However, this mitigation measure has some limitations. Deterrence by ultrasound is limited by distance (efficiency up to 15 meters) and weather conditions like humidity. Further effectiveness is different between bat species. Future studies must also evaluate cost-effectiveness of deterrents in relation to curtailment strategies to allow a cost-benefit analysis and mitigating bat fatalities.

Regarding the micro-wind turbines for local energy production, they may also potentially have significant impacts on bats if they are erected in close proximity to a roost or commuting route of these animals. A British study[55] carried out in 2010 on 20 different sites located in Scotland and England showed that bat activity (dominated by *Pipistrellus pipistrellus*) was 50 % lower near the micro-win turbine (1-5 m) compare to bat activity recorded at a further distance (20-25 m). Besides, a guidance document[56] has been published in May 2010 by the Malta Environment and Planning Authority. This document includes considerations of related impacts to bats and their minimisation.

Case study: Estimating bat (and bird) mortality occurring at wind energy turbines from covariates and carcass searches using mixture models (121)

Two approaches have been employed to assess collision rates: carcass searches and surveys of animals prone to collisions with wind turbines. The authors combined carcass search data with animal density indices in a mixture model to investigate collision rates. In a simulation study, they showed that the collision rates estimated by their model were at least as precise as conventional estimates based solely on carcass search data. Furthermore, if certain conditions are met, the model can be used to predict the collision rate from density indices alone, without data from carcass searches. This can reduce the time and effort required to estimate collision rates. They applied the model to bat carcass search data obtained at 30 wind turbines in 15 wind facilities in Germany. They used acoustic bat activity and wind speed as predictors for the collision rate. The model estimates correlated well with conventional estimators. Their model can thus be used to predict the average collision rate. It enables an analysis of the effect of parameters such as rotor diameter or turbine type on the collision rate. The model can also be used in turbine-specific curtailment algorithms that predict the collision rate and reduce this rate with a minimal loss of energy production.

year	number of turbines (I)	number of nights	number of recordings	number of carcasses found	average carcass detection probability	Average wind speed in m/s (SD)
2007	12	473	2187	22	0.58	5.2 (1.9)
2008	18	1225	16263	35	0.61	5.5 (1.8)

doi:10.1371/journal.pone.0067997.t001

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[55] Park K., University of Stirling. "*Integrating applied ecology & planning policy: the case of micro-turbines & wildlife conservation*" (Presentation at a conference on Renewable Energy and Biodiversity Impacts, 7-8 November 2012, Cardiff).

[56] "*Planning Guidance for Micro-Wind Turbines*" (www.mepa.org.mt/file.aspx?f=4983)

4.4 - Infectious diseases

4.4.1 - Infections affecting bats

Many different infectious agents have been found in bats (reviewed in (122)). However only very few of them has been shown to affect bat health or to be effectively transmitted to humans from bats.

4.4.1.1 - White-nose syndrome

White-nose syndrome (WNS) is a disease affecting hibernating bats. A newly cold adapted soil fungus, *Pseudogymnoascus destructans* (*Pd*) previously known as *Geomyces destructans* (123), has been demonstrated to cause this disease which was first documented in New York in the winter of 2006-2007.

Named for the white fungus that appears on the muzzle and other body parts of hibernating bats, WNS is associated with extensive mortality of bats in eastern North America: in some hibernacula, 90 to 100 % of bats have died. Bats with WNS exhibit uncharacteristic behaviour during cold winter months, including flying outside in the day and clustering near the entrances of hibernacula57.

In response to WNS in North America, researchers in Europe initiated a surveillance effort during the winter of 2008–09 for WNS-like fungal infections among hibernating populations of bats. *Pd* in Europe was previously reported in a single hibernating bat which was sampled in Périgueux (France) during March 2009 (124). Despite laboratory confirmation that bats obtained in Germany, Switzerland, Austria and Hungary were colonised by *Pd,* deaths were not observed at collection sites. Although the mechanism(s) by which hibernating bats died because of infection with *Pd* in North America is not yet fully understood. Bat species in Europe may exhibit greater resistance or respond differently to infection by this fungus than their counterparts in North America.

A more recent study seems to demonstrate that altered torpor-arousal cycles underlie mortality from WNS and provide direct evidence that *Pd* is a novel pathogen to North America from Europe (i.e. accidental introduction by tourists visiting caves). (125).

A resolution "*Guidelines for the Prevention, Detection and Control of lethal fungal Infections in Bats*" was adopted by the Parties of EUROBATS[58] to encourage monitoring of this issue and to raise awareness on this subject (NGOs, operators of tourist caves in Europe, laboratories …).

4.4.1.2 - Mass mortality on *Miniopterus schreibersii* - Lloviu virus as putative cause

In 2002, mass mortality on several populations of *M. schreibersii* was observed. It started in May in France and moving south to end on southern Iberian Peninsula in July. France, Spain and Portugal were affected by the event (126). Other bat species sharing roosts with *M. schreibersii* were not affected. Subsequent investigation revealed interstitial pneumonia as the cause of the death.

High loads of a new filovirus related to Ebola and Marburg viruses called the Lloviu virus was found in several organs of the affected bats including lungs. The Lloviu virus has been proposed as a new genus (Cuevavirus) within the family Filoviridae. Intensive search of the virus in affected populations of *M. schreibersii*, as well as in many other bat species from Spain has not succeeded on detecting the virus again. Consequently, the origin of the virus remains unknown. According to the extreme pathogenicity observed and to the absence of the virus in other populations of *M. schreibersii* than the affected ones by this particular mass-mortality event, punctual cross species from an unknown source resulting in a self-limited outbreak without further adaptation to the new host remains as the most likely hypothesis.

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[57] http://whitenosesyndrome.org/about-white-nose-syndrome

[58] www.eurobats.org/sites/default/files/documents/pdf/Meeting_of_Parties/MoP6_Record_Annex9_Res_6_6_GuidelinesFungalInfections.pdf

4.4.1.3 - Other infectious agents

In Europe, research is predominantly focused on European virus, but first indications of bat-pathogenic bacteria isolated from deceased bats in Germany and Great Britain has been found (127; 128; 129; 130).

Bats attacked by cats are likely to succumb to bacterial infection even if non-fatal injuries were present since various bacteria can be transmitted via bites. This relation has been proven for *Pasteurella multocida* infections in European bat species (128; 127; 131). On the other hand, bats already debilitated by disease are more vulnerable. Consequently, bats may also act as vectors for zoonotic pathogens, as domestic cats could pass these infectious agents on to humans. Such cross-species transmission events from bats to domestic animals are well documented (132; 133).

Ectoparasites (mites, fleas, and ticks) and endoparasits (helminth parasites and different protozoan) can also affect bats.

Impact of diseases and infectious agents on bats in Germany (134)**.**

Alongside to trauma-associated mortality and undefined mortality cases, disease aspects represented one third of mortality causes in 486 investigated bats of 19 European Vespertilionidae species. By comparing pathology and bacteriology results, the authors were able to detect 22 different bacterial species (families *Pasteurellaceae*, *Enterobacteriaceae*, *Steptococcaceae*) that were clearly associated with disease in bats. There was a strong association between cat predation and bacterial infections in bats as almost one half of bats (44 %) caught by cats were affected by bacterial disease.

Ectoparasites were noted in 14 % of bats. Microscopic examination of organ tissues revealed endoparasitic infection in 29 % of investigated bats, involving different protozoan (families *Eimeriidae* and *Sarcocystidae*) and helminth parasites (trematodes, cestodes, and nematodes). Helminthes were predominantly found in the gastro-intestinal tract of the bats, while in some animals, granulomatous organ lesions were associated with larval migration of nematode species. Large bats like *N. noctula*, *E. serotinus* and *V. murinus* revealed higher endoparasite prevalence compared to individuals of medium-sized or small Vespertilionidae species. At least 12 % of all bats had died due to bacterial, viral and parasitic infections. They also found clear seasonal and individual variations in disease prevalence and infection rates, indicating an increased susceptibility to infectious agents in female bats and juveniles during the maternity season.

4.4.2 - Negative public opinion of bats as carriers of viruses

The occurrence of viruses in certain European bat species has been confirmed in several MS. The negative public opinions on potential health risks may influence bat conservation with actions reducing their conservation status (individual killing, roosts destruction...). The media and the general public is a key concern for this issue.

4.4.2.1 - Rabies

The occurrence of Lyssaviruses (European Bat Lyssaviruses or EBLVs) in certain European bat species has been confirmed in several MS. These viruses have an extremely rare incidence in humans or other non-bat wild and domestic mammals; and none of these viruses seems to be a threat to bat populations.

EBLVs might be under-reported as prevalence is routinely reported only in countries that have a regular surveillance programme. Bat rabies reporting is historically based on passive surveillance made on bats in circumstances like dead, injury or diseases.

These circumstances facilitate contact with humans. Consequently, anthropic species and their associated viruses are overrepresented while bat species restricted to the wilderness are underrepresented and their associated viruses are rarely detected or even remain unknown.

The following current situation, known from passive surveillance only, is detailed in the Annexe 4.

A resolution was adopted by EUROBATS in 2006[59] including recommendations such as:

- Establishment of national bat rabies surveillance network in close collaboration with bat specialists,
- Supporting education efforts that reflect the best scientific advice available regarding the human health risks associated with bat rabies,
- Supporting efforts to avoid overreaction to incidental bat bite exposures and to develop policies for determining the fate of bats involved in contact incidents with humans (and domestic animals such as cats);
- Ensuring that reasonable advice on precautions to avoid infection is available and implemented, including for the maintenance of colonies in buildings where rabies-positive bats have been recorded.

Protocols based on recommendations of the EU Med-Vet-Net working group (*Rabies Bulletin Europe*, 2005(4): 3.1) were proposed.

4.4.2.2 - Other viruses

Viruses from most families relevant for human health have been found in bats. However, only some of them have been proved to have a relevant role in public health. Several seminal studies have recently implicated bats as sources of important RNA viruses of humans and livestock (122; 135; 136), including:

- coronaviruses (CoVs, human pneumonia, severe acute respiratory syndrome as SARS virus and the recently described MERS virus (137));
- filoviruses (viral hemoragic fever as Ebola and Marburg viruses (138));
- henipaviruses causing severe respiratory disease as hendra virus or severe encephalitis as Nipah virus, which are naturally harboured by Pteropid fruit bats in Asia and perhaps Africa (no current occurrence in the EU); and
- orthoreoviruses (diarrhea) (139; 140; 141)

It has been shown that bats harbour a great diversity of viruses of families such as Rhabdoviridae, Coronaviridae, Paramyxoviridae or Astroviridae that are considered as putative ancestors of members of these families infecting other mammals, including humans. However, a recent study found that bat hepadanvisuses may have been ancestral sources of primate hepadnaviruses including the Hepatitis B virus (142).

DNA viruses, including herpesviruses and adenoviruses (AdVs), have also been detected in bats, although with less clear implications regarding the role of bats as sources of infection for other mammals (143; 144; 136).

Most bat viruses transmitted to humans are carried by tropical fruit bats (filoviruses, henipaviruses) with no current emergence in the EU. But the predominant hosts of mammalian CoVs, including those related to the agent of Severe Acute Respiratory Syndrome (SARS), are insectivorous bats that are not restricted to tropical climates (145). The presence of SARS-related CoV in Europe has recently been demonstrated (136). Coronaviruses related with the Middle East Respiratory Syndrome (MERS) has been also found in Europe recently (146)

Knowledge is currently lacking on the ecology of bat-borne viruses in bat reservoirs (136). However, the Food and Agriculture Organisation of the United Nations has published in 2011 a document investigating the role of bats in emerging zoonoses worldwide (147). It shows that the advance of molecular tools and increased scientific activities in this field will uncover many more new bat viruses in the near future. Bat populations are more and more under stress, foraging and behavioural patterns are altered, niches expand, and livestock and humans come into closer contact than ever. The involvement of veterinarians and other wildlife specialists has highlighted the role that they can play in the surveillance, control and prevention of emerging zoonoses.

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59 www.eurobats.org/sites/default/files/documents/pdf/Meeting_of_Parties/MoP5_Record_Annex5_Res5_2_bat_rabies.pdf

4.5 - Misunderstandings and myths

4.5.1 - Ignorance

Simply because they are active only at night and difficult to observe and understand, bats rank among our planet's most misunderstood and intensely persecuted mammals.

A good description of ignorance on bats in accordance to time line was made by Arthur & Lemaire in 2009 (148) and is briefly summarised below. The first descriptions of bats were made according to the knowledge and superstitions of the moment. It was firstly described as a viviparous bird, according to Pliny the Elder (23-79) and then as a flying mouse by Albertus Magnus (1200-1280). Although bats aroused curiosity among their first observers, they have been suffering from man's misunderstandings. Back in time, several myths on bats led people to fear them and to try to eradicate them. They were considered as vampires sucking blood from sleeping animals. They were suspected to transmit scabies and to tangle into hair. Individuals were captured and nailed to doors or dived in molten lead (148).

From the 19th century to nowadays, this perception has now changed gradually thanks to naturalist observations and the wish to take out any negative popular belief on bats. Bats were considered as mammals for the first time in the second half of the 19th century (11). At the beginning of the 20th century, they were finally described as auxiliaries to agriculture by feeding on pest insects and started to be protected. However, since pesticides are used to control pest insects, bats' part in crop protection has been minimised (148). Nowadays, some prejudices against bats remain today. Bats are still believed by some to be dirty rodents and full of germs, or even ugly "little monsters". They would be feeding on human blood (while only 1 out of 1,200 bat species known worldwide feed on cattle blood and 2 others on bird blood). Intentional damages or destructions still occur as bats are sometimes unwanted in buildings because of the noise they make and their bad smell. Thus, colonies can be sprayed with chemicals, smoked out with suffer, shot, etc (148).

4.5.2 - Educational programs

Stakeholders, local authorities, land owners, buildings owners, farmers, foresters and other land users are key players in the conservation of bats. They need to be provided with all relevant information concerning the species ecology and the required management of their habitat. It is also very important to provide information to general public and to improve the public relation with bats. The following initiatives play an essential role in targeting this issue.

- Local bat groups

Many local bat groups in all European countries run events at night or during the day to raise public awareness on the issues that bats face nowadays. Nationwide NGOs assist them through the provision of communication materials.

- European/International bat night

The Bat Night, which is organised by EUROBATS, takes place every year since 1997 in more than 30 countries on the last weekend of August[60]. Nature conservation agencies and NGOs from across Europe pass on information to the public about the way bats live and their needs with presentations, exhibitions and bat walks, often offering the opportunity to listen to bat sounds with the support of ultrasound technology. From 2012, it was renamed the "International Bat Night" in order to be in phase with similar events taking place in other continents.

- Year of the bats in 2011-12

In 2011-12, The Convention on Migratory Species (CMS) and The Agreement on the Conservation of Populations of European Bats (EUROBATS) have joined together to celebrate the Year of the Bat. It enabled to attract the attention of the media and thus numerous members of the general public were invited to join in at a local event near where they live. It also helped in increasing data gathered by amateur naturalists with the aim of publishing regional distribution maps.

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[60] www.eurobats.org/international_bat_night

5 - FRAMEWORK FOR FUTURE ACTIONS

5.1 - Vision and overall goal

In the 2011 EC Communication "Our life insurance, our natural capital: an EU biodiversity strategy to 2020" (COM 244 final), the target 1 specifies:

"To halt the deterioration in the status of all species and habitats covered by EU nature legislation and achieve a significant and measurable improvement in their status so that, by 2020, compared to current assessments: (i) 100% more habitat assessments and 50% more species assessments under the Habitats Directive show an improved conservation status".

In reference to this policy the vision of this EU bat species Action Plan is:

To halt the deterioration of the status of all EU bat species

The overall goal of this action plan is:

To achieve a significant and measurable improvement in bat conservation status, so that 50% more species assessments under the HD show an improved conservation status by 2020 compared to current "inadequate" or "bad" assessments.

Waiting for the results of the current assessment of 2013 bat conservation status (analysis of article 17 reports) it is impossible to size this overall goal at this stage. However on a set of 606 assessed "trinomials"[61], there are 413 ones with an "inadequate" or "bad" assessment. To fulfil this overall goal, this means an improvement for more than 200 "trinomials"!

5.2 - Goal targets

The goal targets were defined on the basis of the issues identified in the first part of this report.

n°	Issues	Goal targets
1	Old or local or single species action plans in 16 MS and lack of action plans in 12 other MS (see 2.4) does not offer the right framework for bat conservation.	Multi/single bat species action plans published in all the EU Member States
2	Gaps in biological knowledge were identified (see 3.2)	Knowledge improved for the identified gaps
3	Lack of capacity or common understanding or common tools to get an EU overview on bat conservation status	Capacity building sufficiently developed with common approaches to assess population trends and bat conservation statutes
4	Lack of knowledge and involvement of local authorities and private landowners to correctly protect underground roosts	Decline of bat underground roosts stopped within Natura 2000 sites and the Eurobats Important Underground Sites.

[61] Trinomial = one species in one biogeographic area from one Member State (combinations - BA/MS/sp)

5	Lack of knowledge and involvement of local authorities and private landowners to correctly protect overground roosts	A European campaign launched on a shared approach between European building insulation schemes and European bat conservation policies
6		Technical solutions for bat conservation implemented in all key overground roosts especially within Natura 2000 sites
7	Lack of EIA/AA, or poor quality concerning bats, for building renovation, roads, or railways wind farms projects	Quality of bat studies in the framework of AAs and EIAs improved
8	Large mortality in quite all wind farms due to the lack of mitigation measures to reduce risks	Mitigation measures applied in all new wind farm projects and old wind farms revised within Natura 2000 sites
9	Large mortality along roads not designed in relation with local bat issues	A brochure on mitigation measures for road projects is published and a system to monitor road killing is developed in at least 14 MS
10	Fragmentation through transportation infrastructures, disappearance of hedgerows or habitat degradation is affecting commuting roads and bat key habitats	Any initiative to reduce fragmentation of EU landscape is supported and a bat indicator is developed to measure fragmentation
11	Forest are key habitats for bats but forest management does not take enough into consideration bat needs	A common scheme/strategy is developed between Eurobats, Forest Europe and EC to better integrate bat conservation within forest management policies/practices
12	Bad use of endectocides (antihelminthics) lead to insects mortality and reduce preys of some bat species	Define the best protocol possible concerning the use of antihelminthics
13	Conservation objectives hindered by a negative opinion against bats related to the risk of transmission of rabies and viruses to human and domestic animals	Public health, environmental authorities and conservation NGOs correctly informed on risks associated with viruses carried by bats
14	Fears due to misunderstandings and lack of knowledge on the life of bats	Key stakeholders correctly informed on bat requirements and action possibilities to conserve them

5.4 - Actions

Legends for the time scale in the tables below:

- ***Ongoing***: *currently being implemented and should continue,*
- ***Immediate***: *action should be completed in 1 year;*
- ***Short:*** *action completed in 3 years (2014 – 2017);*
- ***Medium***: *completed in 6 years (2014-2020);*
- ***Long***: *completed in more than 6 years;*

Legend for priorities in tables below:

- ***Priorities***: *high, moderate, low*

Goal target 1: Multi/single bat species action plans published in all the EU Member States						
No.	**Action**	**MS**	**Priority**	**Time scale**	**Responsible organizations**	**Indicator**
1.1	Distribute this EU Action Plan and promote its implementation among all EU MS.	EU level	high	immediate	European Commission, (Eurobats, Batlife Europe)	Done before 2015
1.2	Prepare and implement National (Regional) multi-bats action plan	All MS	high	medium	National authorities, Conservation agencies, NGOs	Number of MS where such action plans have been adopted
1.3	Identify all appropriate EU funding resources for the activities outlined in the Action Plan, ensuring that all relevant organizations, institutions and individuals are aware of such opportunities	All MS	moderate	short	European Commission, National authorities	Already done for Natura 2000 Done before 2017 for Annex IV species
1.4	Assess the current EU multi-bats action plan in 6 years	EU level	high	long	European Commission (Eurobats)	Done before June 2021

Goal target 2: Knowledge improved for the identified gaps (see also other targets)						
No.	**Action**	**MS**	**Priority**	**Time scale**	**Responsible organizations**	**Indicator**
2.1	Launch conservation programmes on the Endangered species that are not in a favourable status in the EC (biology, habitat requirements, range): *Nyctalus azoreum, Pipistrellus maderensis, Roussettus aegyptiacus...*	CY, PT	high	medium	National authorities, Eurobats, Conservation agencies, Research institutions, NGOs	Number of species with actions undertaken
2.2	Promote research on the following issues: - Knowledge on regional meta-population - Migration mechanisms and precise assessment of migration routes, including possible movements between Africa and Europe - Knowledge on cryptic species (*Pipistrellus, Myotis*...) - Effects of pesticides/biocides on bat survival / fitness - Role of compensation schemes and artificial roosts in population dynamics;	All MS	moderate	medium	National authorities, Conservation agencies, Research institutions, Eurobats	Number of publications/reports concerning these issues

Goal target 3: Capacity building sufficiently developed with common approaches to assess population trends and bat conservation statutes						
No.	**Action**	**MS**	**Priority**	**Time scale**	**Responsible organizations**	**Indicator**
3.1	In the framework of article 17 reports, define a common understanding for reference value concerning bats and appreciation of pressure from human activities	all MS	high	medium	European Commission, EEA, national authorities, Conservation agencies	A report published
3.2	Development of the prototype pan European bat population indicator based on existing data (hibernacula counts, statistical package TRIM used for national trends, combination by a central statistical team to create pan European trends).	More than 15 MS	high	short	EEA, Eurobats, Batlife Europe, Conservation agencies, NGO's	A new report published by EEA before 2017
3.3	Development of the same kind of pan European population indicator based on maternity roosts.	At least 5 MS	moderate	medium	EEA, Eurobats, Batlife Europe, Conservation agencies, NGO's	A report published before 2020
3.4	Develop capacity building for monitoring in countries which do not currently have national monitoring schemes.	To be determined	high	medium	National authorities, Batlife Europe, NGOs	Number of new countries participating in European bat population indicators

Goal target 4: Decline of bat underground roosts stopped within Natura 2000 sites and the Eurobats Important Underground Sites						
No.	**Action**	**MS**	**Priority**	**Time scale**	**Responsible organizations**	**Indicator**
4.1	Review and update the list of Eurobats important underground sites for bats and the criteria for assessing them.	all MS	high	medium	Eurobats, national authorities, Conservation agencies, NGOs	A list published before 2020
4.2	Ensure that all the underground sites of international importance are within the Natura 2000 network. This could be mandatory when it concerns the Annex II species.	EU level	high	immediate	European Commission, Eurobats, national authorities	An assessment carried out before end of 2015
4.3	Ensure that all the underground sites within the Natura 2000 network have adapted closure systems and are safe from excessive disturbance	all MS	high	medium	European Commission, national authorities, Conservation agencies, NGOs	Assessment done within the next article 17 reports (2020)
4.4	Define a strategy to conserve underground sites at the national level in relation with the needs of species to be in a favourable conservation status.	all MS	high	medium	National authorities, Conservation agencies, NGOs	Chapter included within the National/Regional action plans
4.5	Ensure implementation of compensation measures in case of destruction of roosting sites in order to maintain the species conservation status.	all MS	moderate	medium	European Commission, Eurobats, national authorities, Conservation agencies, research institutions, NGOs	Assessment based on national derogation reports and/or article 6.4 schemes

Goal target 5 : A European campaign launched on a shared approach between European building insulation schemes and European bat conservation policies						
No.	**Action**	**MS**	**Priority**	**Time scale**	**Responsible organizations**	**Indicator**
5.1	DG Environment to liaise with other EU departments encouraging insulation, to make sure the needs of protected species are taken into account (e.g. programme Jessica)	EU level	high	short	European Commission	Key contacts identified and a meeting organised
5.2	Ensure EU and national policies promoting building insulation (in new and existing buildings) include the need to survey for the presence of bats and take account of their needs by including space for bat roosts	All MS	high	medium	Conservation agencies, NGOs, site managers, land owners and users	An assessment conducted for 2020
5.3	Launch an EU campaign on bat conservation within building insulation programmes	EU level	high	short	European Commission, Eurobats, Batlife Europe	A brochure published before 2017

Goal target 6: Technical solutions for bat conservation implemented in all key overground roosts especially within Natura 2000 sites						
No.	**Action**	**MS**	**Priority**	**Time scale**	**Responsible organizations**	**Indicator**
6.1	Ensure appropriate management on all Natura 2000 overground roosting sites with regular bat occurrence	all MS	high	medium	National authorities, Conservation agencies, NGOs, owners	Assessment done within the next article 17 reports (2020)
6.2	Ensure appropriate management on all other overground roosting sites with regular bat occurrence for priority species (to be determined nationally)	all MS	moderate	medium	National authorities, Conservation agencies, NGOs, owners	An assessment conducted for 2020
6.3	Define the best protocol possible concerning timber treatment during renovation of buildings, compile guidance documents already produced in a single web page with a summary on good practices	EU level	moderate	short	European Commission, Eurobats, Batlife Europe	A web page produced at the end of 2017
6.4	Management of problems caused by bats in cultural heritage roosting sites: compile guidance documents already produced in single web page with a summary on good practices.	EU level	moderate	short	European Commission, Eurobats, Batlife Europe	A web page produced at the end of 2017
6.5	Bridge restoration: compile guidance documents already produced in a single web page with a summary on good practices.	EU level	moderate	short	European Commission, Eurobats, Batlife Europe	A web page produced at the end of 2017
6.6	Biodiversity offset by building bat houses: compile and assess "experimental" designs in view of producing guidelines.	All MS	moderate	short	Eurobats, Batlife Europe, conservation agencies, NGOs	Guidelines published at the end of 2017
6.7	Define the best protocol possible concerning precaution in tree cutting in rural and urban areas, compile guidance documents already produced in a single web page with a summary on good practices.	All MS	moderate	short	Conservation agencies, NGOs	A web page produced at the end of 2017

Goal target 7 : Quality of bat studies in the framework of AAs, or EIAs or derogation procedures (art.12) improved						
No.	**Action**	**MS**	**Priority**	**Time scale**	**Responsible organizations**	**Indicator**
	Update the EC guidance document on Natura 2000 and wind farms to include bats conservation issues (especially mitigation measures).	EU level	high	short	European Commission	New EC guidance published before 2017
	Develop guidelines for assessing impacts of wind turbines on bat population	All MS	high	medium	Eurobats, National authorities, Conservation agencies, NGOs	A report published for 2020
	Develop guidelines for assessing impacts of roads on bat population	All MS	high	medium	Eurobats, National authorities, Conservation agencies, NGOs	A report published for 2020
	Develop guidelines for AAs (HD Art.6.3) for projects such as sky beamers or installation of any kind of large spotlights	All MS	moderate	medium	National authorities, Conservation agencies	A brochure or a web page published for 2020

Goal target 8 : Mitigation measures applied in all new wind farm projects and old wind farms revised within Natura 2000 sites						
No.	**Action**	**MS**	**Priority**	**Time scale**	**Responsible organizations**	**Indicator**
8.1	Organise a technical seminar on the impacts of wind farms on bats and develop guidelines for assessing impacts of wind turbines on bat populations	All MS	high	short	Batlife europe, National authorities, Conservation agencies, NGOs	A seminar organised before 2016 and a report published for 2017
8.2	Develop guidelines for the design of new wind turbines taking into consideration the ecological requirements of bat populations (mitigation measures)	EU level	high	medium	European commission, Eurobats, batlife Europe	Guidelines published or a web page produced at the end of 2020
8.3	Promote research supported by EU or national authorities on the impact of mortality due to wind farms on local bat meta-populations or European cross-border populations	All MS	moderate	long	EEA, Batlife Europe, Conservation agencies, Research institutions	Number of publications/reports concerning this issue
8.4	Produce a pilot register/data base to collect mortality cases (HD, art 12d)	EU level	high	medium	EEA, National authorities, Conservation agencies, NGOs	A report published by EEA before 2020

Goal target 9 : a brochure on mitigation measures for road projects is published and a system to monitor road killing is developed in at least 14 MS						
No.	**Action**	**MS**	**Priority**	**Time scale**	**Responsible organizations**	**Indicator**
9.1	Organise a technical seminar on the impacts of roads on bats and develop guidelines for assessing impacts of roads on bat populations	All MS	high	short	Batlife europe, National authorities, Conservation agencies, NGOs	A seminar organised before 2016 and a report published for 2017
9.2	Produce European technical guidance to help local authorities and stakeholders to minimise negative impacts during the planning and construction phases of new transportation infrastructures.	EU level	high	medium	European Commission, Eurobats, Batlife europe	Guidelines published or a web page produced at the end of 2020
9.3	Address the question of how current transportation systems can be improved to enhance the ecological coherence of the Natura 2000 network in relation with HD art.10. This includes works on the infrastructure transparency for bats (underpass and overpass, mitigation to reduce mortality) and actions to restore connectivity across existing infrastructures systems (by building tunnels and wildlife bridges) on the basis of national priorities.	All MS	moderate	medium	National authorities, Conservation agencies, NGOs	Assessment done within the next article 17 reports (2020)
9.4	Produce a pilot register/data base to collect mortality cases (HD, art 12d)	EU level	high	medium	European Commission, EEA, Topic centre	A report published by EEA before 2020
9.5	Promote research supported by EU or national support on the impact of mortality due to roads on local bat meta-populations or European cross-border populations	All MS	moderate	long	EEA, Batlife Europe, Conservation agencies, Research institutions	Number of publications/reports concerning this issue

Goal target 10: Any initiative to reduce fragmentation of EU landscape is supported and a bat indicator is developed to measure fragmentation						
No.	**Action**	**MS**	**Priority**	**Time scale**	**Responsible organizations**	**Indicator**
10.1	Support the recommendation made by EEA on landscape fragmentation in Europe: *"[...] We recommend drawing up guiding concepts for the landscapes in Europe (together with the MS) that include the identification of regionally and nationally important unfragmented areas and priority areas for defragmentation. To make these guiding concepts more tangible, it is desirable to adopt appropriate benchmarks or targets for the degree of landscape fragmentation. [...]".* *"[...] Appropriate objectives and measures should be elaborated that are made binding for European and national offices and should state what measures should be taken and where and how they should be implemented, in connection with ongoing EU initiatives for a green infrastructure. A process of Europe-wide documentation and coordination is recommended to produce an overview of measures at the European level and to enable regional strengths and shortcomings to be recognised more easily. [...]".*	EU level	high	immediate	European commission	A support given by Habitats Committee before end of 2015
10.2	Develop a prototype indicator on bats and fragmentation	EU level	moderate	medium	European Commission, Eurobats, EEA, Batlife Europe	A report published by EEA before 2020
10.3	To enhance the ecological coherence of the Natura 2000 network in relation with HD art.10, improve connectivity between bat populations by creating line corridors and stepping stones with appropriate habitat and its management, especially in areas with fragmented populations (e.g. connection of forest fragments with hedgerows and tree lines)	all MS	high	medium-long	National authorities, Conservation agencies, NGOs	Assessment done within the next article 17 reports (2020)

Goal target 11 : a common scheme/strategy is developed between Eurobats, Forest Europe and EC to better integrate bat conservation within forest management policies/practices						
No.	**Action**	**MS**	**Priority**	**Time scale**	**Responsible organizations**	**Indicator**
11.1	Integrate bat conservation issue in the guidance document on forest and Natura 2000 (under preparation)	EU level	high	short	European Commission and Habitat committee	Forest guidance document published with bat issues
11.2	Promote research work on the relationship between bat communities and forest types in the next research and innovation programmes supported by the EU: Assessment of direct mortality in bats due to forestry operations, evaluation on the density of "suitable" trees (e.g. dead trees) to be left in order to sustain populations of forest species, effects of forest fragmentation on dispersal / gene flow of forest bat species.	All MS	moderate	long	European Commission, EEA, Batlife Europe, Conservation agencies, Research institutions	Number of publications/reports concerning this issue
11.3	In relation with the new EARDF or LIFE funding possibilities, implementing agreements regarding forest management with forest owners in important key Natura 2000 sites for vulnerable tree-roosting bats.	All MS	moderate	medium	National and regional authorities, NGOs	Number of projects co-financed
11.4	Encourage MS to promote training and awareness for forest managers and forest workers in order to improve bat conservation with the help of their own national guidance relevant to their bat communities, forest ecosystems and forest management practices.	All MS	moderate	medium	National/regional conservation and forest authorities, conservation agencies, NGOs	An assessment conducted for 2020
11.5	Produce European technical guidance to help local forests authorities and stakeholders to combine forestry with bat conservation in intensively managed forests or in key bat forest habitats	EU level	high	medium	European Commission, Eurobats, Batlife europe	Guidelines published or a web page produced at the end of 2020

Goal target 12: Define the best protocol possible concerning the use of antihelminthics						
No.	**Action**	**MS**	**Priority**	**Time scale**	**Responsible organizations**	**Indicator**
12.1	Define the best protocol possible concerning the use of antihelminthics, compile guidance documents already produced in a single web page with a summary on good practices	EU level	moderate	short	European Commission, Eurobats, Batlife Europe	A web page produced at the end of 2017

Goal target 13: Public health, environmental authorities and conservation NGOs correctly informed on risks associated with viruses carried by bats						
No.	**Action**	**MS**	**Priority**	**Time scale**	**Responsible organizations**	**Indicator**
13.1	Support education efforts that reflect the best scientific advice available regarding the human health risks associated with bat rabies and support efforts to avoid overreaction to incidental bat bite exposures and to develop policies for determining the fate of bats involved in contact incidents with humans (and domestic animals such as cats).	All MS	moderate	medium	Eurobats, National authorities, Conservation agencies, NGOs	An assessment conducted for 2020
13.2	Ensure that the bat conservation and speleogy societies are aware of the threat associated with the fungal infection known as White Nose Syndrome in North America and encourage liaison between them. Encourage surveillance for the presence of fungal infections in bats. Identify laboratories with facilities to identify skin fungi and refer any such fungi found on bats for identification.	All MS	moderate	medium	National authorities, Conservation agencies, Research institutions, NGOs	An assessment conducted for 2020
13.3	Ensure that reasonable advice on precautions to avoid infection is available and implemented (e.g., rabies compulsory vaccination for people regularly handling bats) including for the maintenance of colonies in buildings where rabies-positive bats have been recorded.	All MS	moderate	medium	National authorities, Conservation agencies, Research institutions, NGOs	An assessment conducted for 2020

Goal target 14: Key stakeholders correctly informed on bat requirements and action possibilities to conserve them						
No.	**Action**	**MS**	**Priority**	**Time scale**	**Responsible organizations**	**Indicator**
14.1	Continue the event “International Bat Night” on an annual basis	All MS	high	Ongoing	Eurobats, NGOs	See Eurobats
14.2	Draft and publish on the web a list of FAQ concerning solutions to problems arising from the discovery of colonies in private properties (public: owners)	All MS	high	Medium	Conservation agencies, NGOs	An assessment conducted for 2020
14.3	Training workshops, informative seminars, factsheets, etc., to involve volunteers into conservation work (e.g. monitoring of colonies, acoustic monitoring…).	All MS	moderate	long	Batlife Europe, NGOs	An assessment conducted for 2020
14.4	Compilation of a list of scientific publications on the effectiveness and value of rehabilitation for bats and a list of handbooks and papers on bat rehabilitation and care in captivity; development of guidelines for protocols for accepting animals into captivity.	All MS	moderate	medium	Eurobats, Batlife Europe, Conservation agencies, NGOs	Guidelines published by Batlife Europe for 2020

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