INTERREG-BioGrenzKorr - part 2

Forest bats:

Cross-border diversity and habitat improvements
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1 Introduction

This report is an account of project activities on bats in the border region between southern Denmark and northern Schleswig-Holstein in Germany, as part of the INTERREG4A project BioGrenzKorr. As activities for bats are only part of the project content and not the major focus of the project, it is necessary to know the project context, in order to understand the choices made regarding activities on bats.

BioGrenzKorr is an abbreviation “Biodiversity in cross border corridors” and focus on dispersal corridors for small mammals specifically protected by the EU habitat directive and thus, the two countries national legislation. The species included in the project are the hazel dormouse, the birchmouse and the bat species in the region. The major focus of the project is on the special habitat requirements of the rare hazel dormouse (Muscardinus avellanarius) and connectivity between habitats. The project works with habitat improvements in inner forest corridors between habitats inside forests, forest edges and corridors in the open landscape for improved connectivity between forests. Special attention is on the very isolated and near extinct hazel dormouse population in the forests of Graasten on the Danish side of the border. The project works with a vision of a cross border corridor between the forest of Graasten on the Danish side and the forest of Handewitt on the German side of the border. For detailed accounts of project activities regarding hazel dormouse conservation see the project report: BioGrenzKorr: Part 1. Cross-border conservation of the Hazel Dormouse: Presence, genetics, management and perspectives.

1.1 Why bats in this project?

It may be surprising but hazel dormice and bats do have several features in common regarding habitats and their biology:

1. Both dormice and bats depend on trees with hollows and cavities for roosts or nests.
2. They both respond positively to artificial nest boxes.
3. Dormice prefer dense vegetation with a diversity of flowering bushes that produce many fruits, nuts and insects. Such habitats are often found in open forest patches or inner or outer forest edges that allow enough light and warmth to reach the understory. Thus, warm sunny spots with many flowering bushes produce many insects. Several bat species forage in the open space above such gaps, along forest edges or between large trees in open stands and some forest bat species has specialized in hunting within the foliage.
4. When developing inner forest corridors for dormice they may serve the same purpose for bats. Dormice move in the dense vegetation and some bat species commute or hunt along the corridor.
5. The same applies for corridors in the open land. Dormice depend on hedgerows or other dense vegetation between forests in order to spread in the landscape. Many bat species, especially the smaller species, prefer to follow linear landscape features when commuting between their day roost in a forest and hunting grounds e.g. at a lake. Thus, bats use hedgerows and forest edges when commuting and hunting in the landscape. Bats benefit from the leeward side of hedgerows as they save energy when flying, especially under more windy conditions. Furthermore, on the leeward side, more insects are found compared to the open land making it an attractive hunting ground. See eg. Verboom & Huitema (1997).
6. Both dormice and bats hibernate during winter, which has implications for many aspects of their biology and vulnerability e.g. to climatic changes.
7. The dormouse and all bat species in Denmark and Schleswig-Holstein are listed on the EU Habitats Directive Annex IV. In accordance with Articles 12 EU Member States must,
impose strict protection of all animal and plant species on the Habitat Directive Annex IV, whether they occur within one of the designated habitat areas, or outside. For species on Annex IV the following disturbances are not allowed: a) all forms of deliberate capture or killing of specimens of these species in the wild; b) deliberate disturbance of these species, particularly during the period of breeding, roosting, hibernation and migration; c) deterioration or destruction of breeding sites or roosting places.

Project objectives
The overall objective of the project was to develop methods for management of corridors in forests and the open land with a specific focus on Annex 4 species.

Some of the specific objectives relevant for bats include:
- To exchange knowledge between the partners on management of Annex 4 species.
- To improve habitat quality and habitat management methods in forest.
- To increase awareness and information on Annex 4 species by dissemination and involvement of volunteers.

Specific objectives regarding bats have been to monitor bat species in the project areas and test artificial roosts for bats. Exchange of knowledge between experts on both side of the border on application of different methods was core in order to achieve this objective. First, three different approaches to get an overview of bat habitats and species diversity were tried. Secondly, the first systematic attempt to test artificial roosts for bats in Denmark was made based on German experiences.

Activities
The activities in the project are divided into four main work packages (WP):
WP1: Management of corridors in the forest
WP2: Management of corridors in the open land linking fragmented habitats.
WP3: Networking and exchange of knowledge.
WP4: Public participation, dissemination and information.

This report focuses on forest bats and forest habitats in relation to WP1, WP3 and WP4. WP1 activities for bats are described in chapter 2 and 3. Chapter 2 describes bat species found in the project areas and their use of the forest, which species are found in which forest types. Chapter 3 describes habitat improvements and the use of artificial roosts.

Some habitat improvements are made in open land in order to connect habitats. Most of these are mainly for dormouse and are not included in this report. No attempt was made to investigate bats use of the open land (WP2), even though it is clear that landscape elements such as hedgerows and small habitats in the open land play a role for bats. An important part of WP2 is the challenge of linking fragmented habitats in the open land. This problem does not seem to be such a major issue for bats as they are much more mobile compared to other small mammals. Bats do cross open land, even though some species are more willing to do so than others (Baagøe & Degn, 2007). Due to their mobility, bats are likely to adapt faster to climate change compared to other small mammals.

In fact Denmark may see new bat species coming up from the south as a consequence of a warmer climate. Such a likely development underlines the need for cross border collaboration and coordination. WP3 is about cross border collaboration and networking. Networking regarding bat activities as well as public information and participation (WP4) are accounted for in chapter 4.

Figure 1: Nyctalus noctula is one of the largest bats in the region. Breeding colonies are found in hollow trees in the forest (© Photo: Dietmar Nil)
2 Habitats of bats

2.1 Introduction

To understand how bats use forest habitats three surveys were carried out during the BioGrenzKorr project:

1. Six forest sites in Germany and Denmark were studied in details during 2010-11.
2. In 2013 mapping was carried out in twenty-two forest areas in southernmost Jutland to get more detailed information on the local variation of bat diversity.
3. Telemetry was used in Germany to get detailed information on the behavior and preferences for a strict forest species – *Myotis bechsteinii*.

The three surveys represent different levels of bat diversity in forest. Survey 1 describes the differences in species diversity and composition at forest unit level, 175 to 700 hectare. Survey 2 describe similar patterns but on much more detailed level and Survey 3 address the details of habitat selection for one bat species only.

It is well known that different species of bats use different habitats for roosting, breeding and feeding. Some species are strictly dependent on forest for all phases of their life including roosting and foraging, whereas others only use forest habitats for roosting (Dietz et al. 2009).

2.2 Survey 1: Bat diversity in six forest in Denmark and Germany 2010-11

The purpose of the first bat survey was to describe the diversity within a forest unit. Six forests were selected in Northern Germany and in Southern Denmark. The forests were between 175 and 1040 hectares and represent typical forest units of the region. The results presented in this chapter is an extract of two more detailed technical reports and a paper presented in the Danish forest journal “Skoven”, all based on field work done in the project areas.

2.2.1 Methods

Bats have been mapped and species determined using an ultrasound detector that converts bat navigation signals and social calls into sounds that is heard by the human ear (Ahlen & Baagøe 1999). During monitoring the behavior and typical flight patterns are observed in order to support bat species identification.

Some of the most advanced bat detectors on the market (Pettersson D1000x and Echometer EM3) are used for the monitoring. Both make use of real-time ultrasound signals and are connected with GPS for exact positioning of the recordings. Bats sounds are recorded and stored as wav files containing information about the position of the observation with a precision of + / - 10m.

The exact location for the survey was selected based on forest maps and information on vegetation structures. The maps are supplemented by a review of aerial photographs to identify the primary hunting grounds, for example lakes, woods and wetlands where many insects are expected. Based on these information a transect walk was laid out. All sites were visited at least two times to ensure overage of the breeding season and either spring or late summer following the guidelines or standards set by (Møller et al. 2013).
2.2.2 Sites included in the bat survey 2011

**Kluesries** (175 ha) in the North of Schleswig-Holstein on the border to Denmark is a forest characterized by nutrient-rich soils and partly steep slopes from the highest elevation about 57m down to the seashore. Due to the landscape characteristics, dry sites on the top of the elevation are mixed with sites with moist condition. The forests are well-structured with a high amount of broadleaved trees, (25% ash (*Fraxinus excelsior*), maple (*Acer pseudoplatanus*) and other broadleaved species and about 55 ha or 31% of beech (*Fagus sylvatica*). Of special value for biodiversity is an oldest forest structures in the forest enclosure. Oak is present, mostly as a mix within the other species, but also as a dominant species.

Kluesries include only few coniferous trees (about 20 ha (11%)). The next forest generations will follow this scheme and the main part of the regeneration is planned to become broadleaved stands. About 9 ha of 100-year old beech mixed broadleaved stands are set aside for natural development. These “Naturwälder” develop without human intervention, felling nor any other management.

Kluesries has a high species diversity of bats with at least 7 bat species represented. However, none of the species are numerous and several of the species are only encountered one or very few times during the survey. *Pipistrellus pygmaeus*, *P. pipistrellus* and *Myotis daubentonii* are the most frequent species. The record of *Myotis brandti* is remarkable because the species is considered very rare in Denmark outside of Bornholm and has only been recorded very few times (detector recording of *M. brandti/mystacinus*) in southern Jutland (Møller et al. 2013).
Schäferhaus (approx. 300 ha) is located west of Flensburg and is divided into two completely separate parts. It is a former military airport. The area is owned by the Nature Conservation Foundation (Stiftung Naturschutz, Schleswig-Holstein (SN-SH)). Schäferhaus is a “semi-open pasture land” and are grazed throughout the year, extensively with cattle. The southern part of Schäferhaus is classified as a conservation area, while the northern is classified as a nature reserve.

The soils consist of sandy loams and sands of a pure sand west of Flensburg. There are several old gravel pits in the area. The forest in the project area Schäferhaus consist of plantations of conifers and oaks. Open areas of land are kept according to the concept of “half-open pasture land” by grazing, with grassland and heaths.

Schäferhaus house at least 6 species of bats. The area differs from the two other German sites by the dominance of Eptesicus serotinus and Pipistrellus pipistrellus. These two species are known primarily to roost in buildings and to benefit from human activity. Also the large open spaces in the areas attract a large number of Nyctalus noctula and a lake attracts Myotis daubentonii.

Handewitt (562 ha) is a forest situated south of Flensburg. The landscape is relatively flat with soils vary less than in Kluesries and suffer mainly from little water and little nutrient supply. Compared to Kluesries, some of the soils have a constant water supply. These parts are potential sites for the development or restoration of bogs, as the water level in Handewitt is strongly influenced by drainage. An elaboration with a height model visualizes the drainage system in detail and shows the interesting points to be closed to stop of slow down the dehydration. Here water management becomes an interesting point within the project measurements. Handewitt is dominated by larch (Larix kaempferi, 32%) and spruce (Picea abies and Picea sitchensis, 38%). Especially to be mentioned is the south-south-west edge of Handewitt with a 250 years old oak stand. These oaks are, beside some smaller compartments in the East, the only broadleaved parts in Handewitt (in total 15% of the forest enclosure).

Handewitt has a relatively high diversity of bat species with no species being dominating. Most frequent species are Pipistrellus pygmaeus, P. pipistrellus and P. nathusii and Nyctalus noctula.

Figure 3: Forest edge with old oaks (Abt. 4021) in Handewitt
**Frøslev Plantation** (1040 ha) is a great, rather monotonous conifer plantation, with older deciduous trees in the central parts. With the exception of a few observations of *Pipistrellus pipistrellus* and unidentified *Myotis* species bats were mainly observed in the edge of the forest where farms and older deciduous trees provide more roosting places and hunting grounds for bats. Around the Frøslev camp a slightly greater diversity of bats was found, including a large colony of *Eptesicus serotinus* in the old barracks and observations of both *Nyctalus noctula* and *Pipistrellus nathusii*, which is probably associated with a number of mature trees in the area.

**The forests of Graasten** (700 ha) The forests are situated two kilometers from the fjord of Flensburg in the south eastern corner of Southern Jutland. The forests of Graasten are situated in a hilly landscape east of the edge of the icecap that created the landscape Beech (*Fagus sylvatica*) is the main tree species covering 75% of the forest area. Oak (*Quercus robur*) and other deciduous species cover 15%. Open areas in the forest constitute of 11% of the total area with several forest meadows, lakes and grasslands. The forest of Graasten represents the best bat area in the project with at least eight species represented. All three species of *Pipistrellus*, *Nyctalus noctula* and *Myotis daubentonii* are observed in large numbers. *Myotis nattereri* and maybe also other species of *Myotis* are represented in the forest as well as *Plecotus auritus*.

**Svanninge Bakker and Sollerup forest on Fyn** (app. 500 ha) The area represents a varied open and semi-open landscape with relatively young forest and a mosaic of lakes, hedgerows and small forest patches.

This landscape includes habitats for several of the “generalists” among bats. Especially *Eptesicus serotinus* and *Pipistrellus pygmaeus* seem to prefer this mosaic of habitats. The specialized bat *Myotis daubentonii* appeared over several of the smaller lake in the area, while *Nyctalus noctula* was seen over-flying the area. However, it is uncertain whether the area has actual breeding populations of the two species.

### 2.2.3 Bat species

The six areas examined include many suitable habitats for bats. A total of 10-11 species were registered during the surveys of the six sites between 2010 and 2013.

The greatest diversity was found in Graasten, Handewitt and Kluesries where eight species occur. Frøslev Plantage and Schaferhaus represent relatively poor sites with only 6 species confirmed.
**Pipistrellus pygmaeus** is one of the smallest bats in Europe. The species is considered a species generally benefitting from the impact of human activity. The breeding and roosting sites are places in houses as well as trees and bat boxes. The species was recorded at all sites and is common in most of them. In Frøslev plantation and in the German sites the species occurs less frequently and almost exclusively in connection with settlements on the outskirts of the forests. *Pipistrellus pygmaeus* sometimes follows linear landscape elements in the open countryside typical hedgerows and woods very typical forest roads within the dense forest. In Graasten forests the species occurs almost everywhere and seems to be slightly more frequent than the close relative *Pipistrellus pipistrellus*.

At the two Jutland sites both *Pipistrellus pipistrellus* and *P. pygmaeus* appear with approximately the same frequency. However, it seems that *Pipistrellus pipistrellus* occurs deeper inside the conifer-dominated plantation of Frøslev Plantation compared with observed *Pipistrellus pygmaeus*. Thus, the latter is only found in the margin of the plantation and often in places with buildings and deciduous forest areas. Conversely *Pipistrellus pipistrellus* occurs slightly less frequently in Graasten forests. *Pipistrellus pipistrellus* also occurs frequently in less forested area in Schäfferhaus. Whether these two closely related species in general divide habitats between them is uncertain, but it might be the case.

**Pipistrellus nathusii** is widespread in most parts of the region, but generally a little less frequent than the previous. Along with the *Nyctalus noctula*, *Pipistrellus nathusii* is the most forest dependent species and its resting places and breeding sites are all linked to the presence of large old hardwoods. The *Pipistrellus nathusii* has a particular preference for breeding and roosting in disconti-
nued often broken trees. The species was observed at all six sites, but only abundant in Graasten Forest and in Handewitt. Suitable broken trees for roosting only occur commonly in Graasten Forest, and this is probably the primary explanation for the lower frequency at the other sites. In addition to the observations above, *Pipistrellus nathusii* were found roosting in a stack of fuel wood at Martin Reimers house in Graasten Forest (see photo figure 7).

*Eptesicus serotinus* is common in most of Denmark and in Northern Germany (Baagøe 2007, Borkenhagen 2011). The species is closely related to man-made structures and relatively open countryside. They rest and breed predominantly in houses.

The species was observed most frequently in Schäferhaus and Svanninge, where the semi-open landscape, mixed farms, houses and villages are a perfect area for the species. In the larger forested areas in Graasten forests, Frøslev Plantation and Handewitt the species is less frequent and mainly observed in outlying areas for example a large colony in the old barracks in Frøslevlejren.

*Vespertilio murinus* occurs with a very high population in Northern Zealand in Denmark and has

![Image of Pipistrellus nathusii bats](https://example.com/image)

Figure 6: *P. nathusii* bats found roosting in a stack of fuel wood at Felstedvej by Graasten Forest 2010. Photo: Martin Reimers.

### Table 1: Summary of species frequency in the six studied sites, 2010-2013

<table>
<thead>
<tr>
<th>Species</th>
<th>Svanninge</th>
<th>Graasten</th>
<th>Frøslev</th>
<th>Kluesries</th>
<th>Schäferhaus</th>
<th>Handewitt</th>
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<tbody>
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<td><em>Pipistrellus pygmaeus</em></td>
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<td>XX</td>
</tr>
<tr>
<td><em>Pipistrellus pipistrellus</em></td>
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<td>XX</td>
<td>XXX</td>
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<td></td>
</tr>
<tr>
<td><em>Pipistrellus nathusii</em></td>
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<td>XXX</td>
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</tr>
<tr>
<td><em>Myotis brandtii</em></td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><em>Myotis daubentonii</em></td>
<td>XX</td>
<td>XXX</td>
<td>-</td>
<td>XX</td>
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<td>X</td>
</tr>
<tr>
<td><em>Myotis nattereri</em></td>
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<td>X</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
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<td><em>Myotis sp.</em></td>
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<td>X</td>
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<td><em>Eptesicus serotinus</em></td>
<td>XX</td>
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<td>X</td>
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<tr>
<td><em>Vespertilio murinus</em></td>
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<tr>
<td><em>Nyctalus noctula</em></td>
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<tr>
<td><em>Plecotus auritus</em></td>
<td>X</td>
<td>X</td>
<td>-</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>7:8</td>
<td>6:7</td>
<td>8</td>
</tr>
</tbody>
</table>
been found with detectors here and there over most of the rest of Denmark (Baagøe 2007, Møller, et al. 2013). The species was not observed during our field work at the Danish sites. But in the same period, a few animals were observed at Sollerup northeast of Svanninge (Baagøe pers. comm.). The species may be observed during field work in Kluesries and Schäferhaus in 2011. The species has been observed very rarely in Schleswig-Holstein.

**Nyctalus noctula** is widespread over most of the eastern parts of Denmark and also common in Northern Germany (Baagøe 2007, Borkenhagen 2011). It is more or less restricted to areas with a high proportion of older deciduous forest. The roosts and breeding colonies are primarily in old trees where the typical breeding sites are old woodpecker nests or cavities in old trees. *Nyctalus noctula* was observed at all sites but most frequently in Svanninge Hills, Graasten forests and Schäferhaus. In Frøslev Plantation the species was only recorded around Frøslev camp. *Nyctalus noctula* is known to fly very far from their roost and it is likely that many of the individuals observed have their roosting and breeding sites outside the areas investigated.

**Plecotus auritus** is relatively widespread across both Germany and Denmark but has probably been partly overlooked because it is difficult to find with the use of an ultrasound detector (Baagøe 2007, Borkenhagen 2011). The species was only observed a few times during the surveys in areas in Kluesries, Handewitt and Svanninge and a freshly dead specimen was found in the Northern part of Graasten forests (see photo figure 7). Most likely *Plecotus auritus* also occurs in other sites.

**Myotis species**

Species of the genus *Myotis* are often very difficult to identify from their ultrasound only. A brief observation of an unidentified *Myotis* was recorded in Frøslev Plantage and Graasten.

**Myotis brandtii** was observed only in two German sites Kluesries and Handewitt. This species is connected to old forest and seem to prefer broadleaved stands. The species is rare in Denmark outside of Bornholm and there are only very few detector recordings (of *M. brandtii/mystacinus*) from southern Jutland (Baagøe 2007, and Møller et al. 2013).

**Myotis daubentoni** is most often observed hunting above rivers, lakes and other water bodies. It is widespread across both Germany and Denmark and relatively frequent. The species almost exclusively have day roosts and breeding colonies in trees, often at some distance from the water. *Myotis daubentoni* was observed at all sites except Frøslev Plantation. At the lakes by Graasten Castle and at the lake in Schäferhaus the species were observed in large number. In Svanninge Hills individuals were observed hunting above several of the smaller lakes. In Frøslev plantation species was not observed and the general lack of open water is probably the main reason.

**Myotis nattereri** is rare, but quite widely distributed in both Germany and Denmark (Baagøe 2007, Borkenhagen 2011). The species probably occurs over Denmark in small fragmented populations. In northern Germany the species is apparently more common than in most of Denmark (Borkenhagen 2011). It is more common on the Island of Bornholm (Baagøe 2007, Baagøe 2011). *Myotis nattereri* was observed only in Graasten forest and seem connected to old broadleaved forest.

### 2.2.4 Conclusion

The six sites included in the bat survey are rather different in species composition and the frequency of each species. Richest sites include Graasten, Handewitt and Kluesries, whereas Frøslev plantation is comparable poor in terms of both species number and frequency. Highest diversity is found in areas with high habitat diversity including forest with old trees and easy access to wetlands and lakes.

Figure 7: *Plecotus auritus* found dead in the forests of Graasten at Felstedvej 2010. Photo: Martin Reimers.
2.3 Survey 2: Habitat preferences for bats - Importance of forest types

To compare local species composition directly to forest types a number of stationary bat detectors were placed in 22 forests in a gradient from poor sandy soil and coniferous plantation in western part of the border region to old broadleaved forest in eastern part of the area.

The area represents a corridor between the forest south of Flensburg such as Handewitt and the forest of Graasten. Many of the forests in this area may be important stepping stones for the bat species strictly connected to forest.

2.3.1 Methods
The bat detectors were placed in trees near open structures such as forest roads or meadows. The detectors were programmed to record all bat passes during a full night. Each bat pass was recorded and the species identified by analysis of the bat calls using Batsound software. Typical sites produced between 50 and 200 such recordings. However, in coniferous plantations only very few bats were recorded, whereas some sites in rich broadleaved forest created up to 1500 recording in a single night.

Auto boxes used for the survey were Songmeter SM2Bat (Wildlife Acoustic). They were placed approximately 4 meters above ground attached to a tree in relatively open condition. The box was set up to trigger only when bats were around the box. The trigger starts three seconds of recording followed by a short break of 7 second. The number of recordings is used as a relative measure for bat activities, but cannot directly be compared to other measures and results from surveys using other types of equipment and methods.

2.3.2 Study area
22 forest localities in the south eastern most parts of Denmark were included. The localities include a range from sandy soil with pure conifer plantation in west to rich broadleaved forest in south and east (see figure 8). The localities are separated according to habitat characteristics, two localities are pure conifer plantation, four localities represent mixed forest of both coniferous and broadleaved trees, six localities are pure broadleaved forest in closed managed stands, four localities are situated in the margin of four grazed meadow surrounded by forest and six localities are characterized with old growth forest near forest edges, lakes or other wetlands.
2.3.3 Results

Pure conifer plantation

Pure monoculture of coniferous species like pine (Pinus sp.) and spruce (Picea sp.) are very poor as habitats for bat. Only very few recording of Pipistrellus pipistrellus and occasional recordings of an unidentified Myotis species are the result of two auto boxes places in this habitat. Similar impression was the result of a manual listening during two nights in the breeding season. Mixed coniferous and broadleaved plantation in plantation forest with a mix of coniferous and broadleaved trees the diversity of bat rises slightly and between 2 and 4 species occurs in the recording per night. The general activity of bats is still rather low and it is likely that this mixed plantation only hold rather small population of each species. Most frequent species are Pipistrellus pygmaeus and Pipistrellus pipistrellus. Pipistrellus nathusii and Myotis daubentonii occur less frequently. Nyctalus noctula and Eptesicus serotinus are recorded flying above some of the localities.
Figure 10: Pure conifer plantation at Frøslev plantation.

Figure 11: Mixed deciduous of beech (Fagus sylvatica) and ash (Fraxinus excelsior) forest in Roden Skov.
<table>
<thead>
<tr>
<th>Habitat &amp; sites</th>
<th>Nnoc</th>
<th>Eser</th>
<th>Ppyg</th>
<th>Ppip</th>
<th>Pnat</th>
<th>Mdau</th>
<th>Myotis sp</th>
<th>Paur</th>
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Table 2: Bat species and habitats and sites: XXXX: over 200 records per night; XXX: 51-200 record per night; XX: 6-50 records per night; X: 1-5 records per night.
Pure and closed broadleaved forest
Broadleaved forest is an important habitat for most bat species. Older trees serve as roosting and breeding places and insects in the canopy are an important food resource for the bats. At dusk and dawn areas with closed forest are important hunting areas for the bats because of the dark condition compared with open areas. *Pipistrellus pipistrellus* and *Pipistrellus pygmaeus* are commonly present and *Nyctalus noctula* and *Eptesicus serotinus* are often recorded hunting above the canopy during night. *Pipistrellus nathusii* and *Myotis sp.* are recorded from closed forest, but seem to prefer older forest.

Old forest, forest edge and wetlands
Old forest is the most important habitat for many bat species. Only *Eptesicus serotinus* seems less frequent in this habitat. Most species are frequently recorded and especially the presents of *Myotis sp.* indicate possible presents of rare species such as *Myotis nattereri* and *M. brandti*.

Forest meadows
Forest meadows are generally considered good habitats for bats. However all of the studied meadows show surprisingly low diversity of bats. Weather conditions on the night of recording may explain part of this result. Other more general condition such as air moistures and temperature may influence the patterns as well, because bats often avoid moist and cold places during hunting.

2.3.4 Conclusion
The diversity of bats in a forest strictly depends on the forest structure and the forest tree composition. At least in a Danish context, coniferous forest appears to be less important for most bat species. Presence of wetlands and high quality forest edges with a number of flowering shrubs are very important to attract a high number of bats. The density as well as the diversity appears to follow the age of the oldest forest trees and presence of trees older than 200 years often indicate a high value for bats. Open meadow without presence of wet areas and lakes and surrounded by younger trees are less important than expected.
2.4 Survey 3: Myotis bechsteinii habitat use survey using telemetry

2.4.1 Introduction:
This survey was relatively late added to the project. Bat boxes were installed in a forest corridor partly as a field exercise as part of a cross border workshop on bat boxes. See more elsewhere in this report. The structure and habitat quality seemed interesting for bats and artificial roosts were installed in 2011. It was a surprise to find the very rare *Myotis bechsteinii* in the bat boxes and we decided to apply for a more thorough survey as part of the BioGrenzKorr project. *M. bechsteinii* is very rare in both countries and most parts of Europe and is listed on the European Red List and the EU Habitat directive annex II and IV. In Denmark it is only found on the island of Bornholm (Baagøe 2011). The species is strictly bound to forest and are rarely seen in open areas (Dietz et al., 2009).

The fauna passage in Kiebitzhom is part of a habitat network across the motor highway A 21 approximately 130 km south of the border. West of the fauna passage a corridor has been created in the forest for habitat connectivity in order to create a natural forest development within a (mainly) coniferous forest stand. This was done as part of a local project.

A first control of the bat boxes was conducted in August 2012 with surprisingly high amounts of *Myotis bechsteinii*. *Myotis nattereri*, *M. daubentonii* and *Pipistrellus nathusii* were also found in the boxes.

Bat population development and habitat improvement is part of the INTERREG project BioGrenzKorr and one of the objectives is to learn more about the distribution and behaviour of bats along such a changed habitat structure (corridor). The combina-
tion of a newly created forest corridor, application of bat boxes and the presence of this rare bat was a unique opportunity to investigate how a bat species behave in a forest corridor including its use of bat boxes. The research focused on habitat usage and evidence of *M. bechsteinii* just within the recently changed forest structure and was conducted in May 2013. The surrounding forests have not been included in the research. This chapter is a short summary of the field work done by the German bat specialist Matthias Göttsche. For the full account of the survey including more details on methods applied see the full report.


### 2.4.2 Methods - Research design

The aim was to find maximum five *M. bechsteinii* bats for radio telemetry. The control of the artificial roosts and net catches gave an overview on the bat species richness within the corridor.

The research was conducted in May, which was characterized by extremely cold and rainy days in comparison to the years before. Especially if not reproducing (yet) bats, may reduce their activities dramatically within rainy and cold periods, as the chances for hunting are lower.

Two *M. bechsteinii* bats (Alf and Bernie) were caught and surveyed up to 9 nights.

### 2.4.3 Results

Ten different bat species have been found within the corridor, which is a high number for the time of year and just 4 nights with net catches. 31 adult female *Myotis nattereri* are evidence for a reproducing population in the area. Observations indicate that *Plecotus auritus* do not seem to have a reproducing population within the research area. For the other species no evidence of reproduction in the corridor was found.

*M. bechsteinii* were using artificial and natural roosts during the research period. Together with earlier results (2012) it is concluded, that *M. bechsteinii* use the corridor in their whole activity period from April to September. Alf and Bernie were using a home range of <500m, and which was mainly within the corridor. As mentioned above, areas beside the corridors were not checked during the research for bat activity. Anyhow it can be stated that the corridor is providing suitable structures for the bats.

The three main bat species; *M. bechsteinii, M. nattereri* and *P. auritus* belong to the bat species, which collect their food from dense forest and are thus closely related to this habitat type. Other species found, such as *Myotis daubentonii* and *Nyctalus noctula* do usually roost in the forests but hunt in open spaces far from the home roosts. *Pipistrellus, P. pygmaeus, P. nathusii* and *Myotis brandtii* are typical for intermediate structures along paths, forest edges or hedgerows. *Nyctalus leisleri* is the last species found.

![M. bechsteinii “Alf” and “Bernie”](https://example.com/figure15.jpg) Notice the small radio transmitter on “Bernie” to the right (Photos M. Göttsche)
2.4.4 Further research is needed for the following topics:

- How many *M. bechsteinii* bats are in the whole forested area; have they settled permanently?
- At which time of the year the bats may be found in the area?
- Is the area attractive for reproducing females?
- Is there an exchange within the male bats and to which amount?

The habitat connectivity in the area needs more detailed research especially on the role of the corridor in comparison to the surrounding forests. Another research subject is the habitat destruction and its permanent influence on the behaviour of the bats, e.g. the amount of exchanges between the two sides of the motor highway.
2.5 Perspective

The three surveys of bat diversity in a forest habitat represent three different methods. Survey 1 uses the traditional site species richness methods used for mapping of bats in Denmark, see Battersby (2010) p.21-25. Survey 2 uses passive detector monitoring. Survey 3 uses telemetry. The time effort used for each of the survey methods are very different, with survey 2 as the least time consuming methods and survey three as the highest consumption of time. The result also differs considerably and each method has advantages and disadvantages.

The site species richness method is already in use for the Danish NOVANA monitoring program and used for other purposes as well. Passive monitoring with auto boxes only, is until now mainly used for monitoring around wind turbines and along roads. However, this method has potential also for screening of bat diversity in large forests and for identification of high value areas for bats in such areas. It is important for the application of the method that sites are selected according to preferred bat habitats when placing auto boxes. See also Stahlschmidt and Bruhl (2012) for a discussion on the advantages and disadvantages of the transect walk (site species richness), the method used in survey 1 and stationary monitoring (passive monitoring) as used in survey 2. Telemetry is a strictly scientific method for research purposes and is applied for a single species.

<table>
<thead>
<tr>
<th>Survey 1: Site species richness</th>
<th>Survey 2: Passive monitoring</th>
<th>Survey 3: Telemetry</th>
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<tbody>
<tr>
<td><strong>Advantages:</strong></td>
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<tr>
<td>Best for description of diversity</td>
<td>Standardized setup</td>
<td>Important information on individual bat behaviour</td>
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<tr>
<td>Easy identification of most species</td>
<td>Least time consuming</td>
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<tr>
<td>Important information on behaviour</td>
<td>Good for screening for rare species</td>
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<tr>
<td><strong>Disadvantages:</strong></td>
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<tr>
<td>Time consuming. An expert needs to go through each transect.</td>
<td>Difficulties in identification of Myotis spp.</td>
<td>Require highly specialised experts</td>
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<td></td>
<td>Less information on behaviour.</td>
<td>Time consuming</td>
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<td>High cost</td>
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<td>Physical contact with animals</td>
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Table 3: Comparison of bat survey methods
3. Habitat improvements and artificial roosting

The forest structure in many forests in Northern Germany and Denmark are poor in old trees and trees with holes and crevices. This is partly due to forest history with few forests that are older than 200 years and the introduction of a very efficient coniferous plantation forestry. Plantation forestry introduced drainage and grazing animals were kept out of the forest. This reduced the number of forest meadows and bogs with open water and thus fewer edge zones for herbs and shrubs, thus less variation in habitats and fewer niches, as well as insect diversity. There is a need for improvement to support biodiversity.

Forest structures and lack of old trees cannot be changed within a few years, however habitat improvements are possible and artificial roosting may compensate for the lack of old trees.

3.1 Habitat improvement through forest management

3.1.1 Kluesries and Handewitt

The measurements in Handewitt and Kluesries focus on habitat improvement for dormouse and bats within the two forests. The second focus is on habitat connectivity, especially with the neighbouring project site Schäferhaus, which is owned by the project partner Stiftung Naturschutz. Schäferhaus is situated in between Handewitt and Kluesries. The habitat improvements done, is based on advice by Heiko Grell reported in more detail in:


Small open areas are found spread in forests. These islands of light, warmth and sun serve many species well. Besides being attractive for insects and reptiles these areas are frequently used by deer for feeding. The management of these sites differs; some are kept open to ensure the above mentioned functions; others are places for natural succession. The management of open forest structures is important within the project as it serves the dormouse and favors insect life, which is hunting ground for the local bat populations.

Coppice in oak

A 40-years old oak stand in Handewitt was coppiced. The future management follows the old forest management of rotational forestry in little parts of the site. This kind of “Niederwaldwirtschaft” was a common method to produce firewood in former times. It favors light and warmth in the forest as the different development stages of a forest stand are always present at the site, but spatially separated. The oak-site is neighboring a natural clearing. This has been improved with a landscape modulation. A pond with a south-exposed structure of roots and stone piles supports amphibians and reptiles. The area is kept open from forest succession. Neighbouring willows in older ponds will be removed over time. It is important to preserve the species richness, as many different willows are present, while opening up the old ponds for new life. The whole complex is surrounded by a younger oak stand (30 years old). It was opened up during the project lifetime and the management criteria were vice versa the conventional forestry managements: trees with rather bad qualities in terms of further use were left over as future “Habitatbäume”. Better qualities were removed. The whole site is close to a 111-year old beech stand with several habitat structures.

Conservation of old oaks, corridor management and forest edges

Especially in Handewitt older oak stands are endangered by upcoming natural regeneration especially by Picea sitchensis, which originates from the surrounding stands. Picea sitchensis is a very fast and successful species on any conditions, with a high potential for natural regeneration. However, it does not suit to the envisaged forest profile neither in Handewitt nor in Kluesries. Older broadleaved stands are relics and of high nature
conservation value. The upcoming natural rege-
neration of spruce was partly removed in order
to safeguard the older oak stands. The removal
improved ground conditions in terms of light and
(warmer) temperatures. Such conditions are good
foraging areas for bats as it holds many insects, as
more insects are to be expected around the war-
er stems. Some of the places were replanted with
shrubs and suitable bushes to create attractive ha-
bitats for dormice. Flowering bushes also provide
habitats for insects, thus good habitats for bats. Of
special value in Handewitt are ancient oak stands
exposed to the south. See also picture figure 3.

It was decided that a relatively simple measure
to improve habitats for bats was to improve the
leading structures along the inner forest edges in
Handewitt. The same was done in Kluesries, where
the removal of spruce connected parts of the
“Naturwald” with an old oak-beech mixed stand.
This measurement brought more light to a species-
rich part in the forest, where several shrubs are
found. As a major measurement in Kluesries, an
old recreation place in one of the oldest oak and
beech forest stands was deconstructed and will
be replaced on another site within the forest. The
released site is used for the installation of 9 bat
boxes. Another group of bat boxes in Kluesries is
situated nearby the mentioned site. 6 bat boxes
have been placed here.

Open water in the forest
As a result of the consultation with Heiko Grell, the
SHLF decided to bring back natural water flow to
a small bog in Handewitt forest. The main stand of
larch was harvested in 2012, yet some birch and
older pine remained. Remaining ditches were filled
up with local material in spring 2013 to retain water
at the site. The objective for the site was to attract
more insects for the benefit of the existing bat po-
pulations. 5 bat boxes were hung up in April 2013
at the site to offer the missing structures. Removal
of Picea sitchensis towards the bat box site opened
up the forest and may serve as leading structure
for bats into the forest.

Further habitat improvements are planned to be
continued after the end of the project. There are
several old, nowadays unused fish ponds in
Kluesries, which will be restored by the owner, the

Figure 16: Handewitt forest:
Red circle: coppice of oak.
Violet circle: 250 years old
oaks at southern edge and
corridor via partly removed
spruce connecting linking to
a bog restoration area.
local nature conservation association. Water Violet (Hottonia palustris) is abundant in these ponds, but it is just fairly interesting for insects and amphibian species. Dragonflies and tree frog (Hyla arborea) occur there, but the ponds have a great potential for more biodiversity. Here as well as on other sites the restoration of the natural water flow, which means in most cases closing down the ditches, is a main subject in Kluesries.

Management of single trees along roads and paths
Saving old trees with special structures as many years as possible has been discussed in the project. The responsibility for the safety of visitors in the forest is always raised and is the responsibility of the forest owner. Along official hiking routes and public streets the owner of the forest has to check the health status of the trees along paths and roads. This visible check mainly serves to prevent later juristic discussion in case of harm to people. The forest owner has a strong position in the potential conflict, if he shows his efforts to keep these roads save. Unfortunately most of the interesting trees seen from a nature conservation point of view, e.g. old broad-leaved trees with holes or fungus, are situated along these forest roads and paths. In case of a danger to the public these trees are normally felled as this is the most cost effective (and long-lasting) solution. Along the entrance to the enclosure Kluesnes 20 old beech trees could be saved, as dangerous branches was removed, instead of cutting down the whole tree. The method was suitable for this situation, as the trees are situated along a forest road, which is easy to access for lift. It saved the important structures of older beech stands.

3.1.2 The forests of Graasten
The forests of Graasten (700 ha) are situated 2 km north of the fjord of Flensburg. The forest is dominated by beech (Fagus sylvatica) and other deciduous tree species. Open areas in the forest constitute 11% of the total area with several forest meadows, lakes and grasslands, thus including a variety of bat habitats. The objective of the habitat improvements have mainly focused on creating core habitats and corridors between these for dormouse in the forest. However, these core habitats and corridors are also very good bat habitats. 13 core habitats of 1500 m² each were created by clearing of spruce followed by planting of a number of different lowering bush species such as Corylus avellana, Crataegus monogyna and Viburnum opulus. As these habitats only include bushes, to be managed by coppice, the areas will remain open gaps in the forest. These gabs give shelter from the wind and create warm sunny spots in the forest. Here bushes will flower and create good habitats for a large number of insects and thus for bats. In order to link these core habitats a total of 17 corridors, app. 12 m wide, with a total length of 8 km were laid out in the forest. These are also planted with bushes and work as corridors for bats in the forest. The corridors are also linked to existing old oak stands. For more details on these habitat improvements see the project report: BioGrenzKorr: Part 1: Cross-border conservation of the Hazel Dormouse: Presence, genetics, management and perspectives.
3.2 Artificial bat roosts in trees (Graasten, Denmark)

As a consequence of the problem described above on dangerous trees along roads and cutting of dangerous branches, an experiment was made to create artificial fractures in such old trees for bat roosts. The idea is when the chainsaw operator works on cutting branches in order to make the tree safe, the marginal cost of adding artificial cavities to the tree for the benefit of bats is limited. In the winter of 2012/2013, four trees in Roden Forest at Graasten were provided with chainsaw cavities in half to seven meters above ground. The slots are generally 15 cm long, 2 cm wide and 20-30 cm deep. The trees were also pollarded in approx. seven meters above ground and all major branches were cut off. Most of the horizontal cavities inclined slightly upwards into the trunk.

The intention is to investigate whether bats in the short and long term will use the cracks and monitor how cracks develop over the years. The trees are marked with numbers at the bottom of the trunk towards the nearest road.

Figure 18: Map of trees with artificial bat cavities

![Map of trees with artificial bat cavities](image-url)
Figure 19: Tree no. 1, Dep. 3045b near Felstedvej. 4 horizontal artificial cavities created.

Figure 20: Tree no. 2, near no. 1. Dead beech with 1 horizontal crack and 1 vertical crack created.
Figure 21: Tree no. 3 close to tree 1 and 2. Living oak with 8 horizontal and 8 vertical cracks and 1 oblique crack.

Figure 22: Tree no. 4, near Gl. Aabenraavej, dep. 3037a. Living oak with 7 horizontal and 3 vertical cracks.
3.3 Bat boxes

3.3.1 Introduction

Bat boxes can be used where the quality of natural habitat is low or may become limiting for the presence of bats. Examples include new and young forest or where habitat is removed for example in connection with the construction of roads or railways. In addition, boxes on site with many species of bats can be an interesting tool for a better understanding and mapping of specific species.

Bat boxes should not replace a long-term nature-friendly operation where bat suitable trees are preserved. Several studies suggest bat boxes installed at sites with abundant natural roost and nesting sites, will not be used by the bats. This supports the theory that the natural habitat is preferred by bats and emphasizes that the boxes must only be seen as temporary solutions. The types of bat boxes selected for this project were targeted to species that have their primary roosting and nesting sites in hollow trees, woodpecker nests and behind loose bark on older trees primarily found in the forest.

After a coordination meeting in Germany December 2011 following strategy were agreed

- The boxes must be placed in groups of 3-6 boxes preferably in combination with one or two bird boxes. The latter ensure that bird, such as tits not move into bat boxes.
- It can be advantageous to set up several types of boxes in the same group.
- To ensure the best opportunities for a statistical analysis it is proposed to use the same composition of all groups. In the longer term, it will of course make sense to adjust the composition of the boxes to the local species composition.
- The distance between the individual groups of boxes should be about 100 meters.
- It should be avoided to set up bat boxes in particularly cold conditions, for example at lake shores, or landscape depressions in the woods.
- For large species of bats, it is essential to ensure free access to the boxes, for example near a road or open space in the forest. This is less important for small species.
- Since there is no significant effect of placement height of the boxes, it is proposed to use a standard height of approx. 4 meters.

3.3.2 Bats boxes, installation and sites

A total of 225 bat boxes were setup in 5 different forests. The first boxes were installed in December 2011 at Kiebitzholm; here 6 box types were used in 8 groups. In Handewitt and Kluesris 4 types were used in 8 and 4 groups respectively and were installed in April 2013.

At both Danish sites the same five box types were used in each group. In April 2012 boxes were installed at Sollerup in 9 groups and 10 groups were installed at Graasten in May 2013. Figure 22 gives an overview of box types, table 3 an overview of the distribution and number of box types installed at each site and the exact location of each group of boxes in the forests are seen on five maps in appendix 2.

An ideal bat box site consists of several types of bat boxes to fulfil the needs of the different bat species. Furthermore, it consists of a smaller box attractive for tits, as they are otherwise likely to inhabit bat boxes and leave no place for the bats. A tit box is always placed near by the other bat boxes. Due to the territorial behaviour of tits it is ensured that the neighbouring bat box will not be inhabited by another pair of tits. German experiences indicate that the tree species where the boxes are placed is less important. More important is the exposition, as bats like the warmth southsoutheast or south-west expositions. The boxes should be placed rather uphill in a hilly environment. This avoids that fog cools down the boxes especially in summer mornings close to smaller water ditches.

When handeling the boxes it is important not only to consider bats. Wasps and birds prefer certain box types. If wasps and birds build nests in the boxes it require cleaning of the box every year. Box types with entrance from below (Hasselfeldt FGRH/FGHD, Hasselfeldt FSPK and Greentools Small) are less prone for wasps and birds and they are generally self cleaning. Also, this type of boxes can be monitored form the ground with a flashlight without handling the box.
Figure 23: Types of bat boxes used in the project
3.3.4 Preliminary results

Most of the boxes were installed late in the project and these boxes were only inspected once or twice. In Sollerup and Kiebitzholm boxes were installed in 2012 and 2011 respectively, and the results of the first inspection show some bat activities in the boxes.

In Sollerup 21 out of 40 boxes were used by bats during the first 18 months. Only *Pipistrellus pygmaeus* was found in all box types and the bats were most numerous in the autumn. In most cases only one individual was found in the boxes. See photo figure 25. In autumn 2012 up to nine individuals were found in a 2FN bat box – When more indivi-

<table>
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<th></th>
<th>Schwegler 2F/2FN</th>
<th>Schwegler 1b</th>
<th>Hasselfeldt FGRH/FGHD</th>
<th>Hasselfeldt FLH dv</th>
<th>Hasselfeldt FSPK</th>
<th>Hasselfeldt U-oval</th>
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</table>
duals in the same box only one male was present. This indicates that the males *Pipistrellus pygmaeus* use the box for mating as the males sit and attract females using a certain call, at this time of year.

In Kiebitzholm four species were observed in the boxes *Myotis bechsteinii*, *M. daubentonii*, *M. nattereri* and *Pipistrellus pygmaeus*. *M. nattereri* and *M. bechsteinii* were exclusively found in the Hasselfeldt FLH-DV box type and *M. daubetonii* was only seen in Schwegler 2 F. Previous experiences from Germany show that the first bat appearance in a box normally takes place after approximately 18 months.

### 3.3.5 Conclusion

It is too early to draw clear conclusions as the number of observations is too few. However, the preliminary results indicate that the use of bat boxes can be a useful tool to quickly improve a habitat for bats. The bat boxes installed by the BioGrenzKorr project will be monitored in the coming years and hopefully the information will contribute to more exact guideline for when, where and why bat boxes should be used.

![Figure 25](image-url) *Pipistrellus pygmaeus* found in a Hasselfeldt FSPK bat box in group 1 in Sollerup on Fyn, autumn 2012.

![Figure 26](image-url) Group of 22 *Myotis nattereri* in a FLH bat box in group 2 in Kiebitzholm (Photo M. Göttsche)
Figure 27: Group of 21 Myotis daubentonii in a 2F bat box in group 3 in Kiebitzholm (Photo M. Göttsche)
4. Networking, public information and dissemination

4.1 Networking:

Why network – experience between Germany and Denmark

Two types of networking have taken place: First, network meetings among bat experts with the aim of sharing experiences and knowledge and create an informal platform for further contact, specific collaborations and coordination. Second, networks between BioGrenzKorr and other projects. Collaboration or partnership between projects brings more value to the projects. However, flexibility is required as different projects may have slightly different objectives. Networking activities are part of the project working package 3.

4.1.1 Network meetings

Danish-German bat network meeting 03.02.2011

Danish and German leading bat experts met in Bad Segeberg in Schleswig-Holstein in order to exchange experiences on bat management and monitoring. The bat museum Noctalis hosted the morning program, which included presentations on distribution of species, monitoring and methods. Subsidies and protection measures for bats in forests were discussed. Finally participants exchanged experiences on public participation and involvement of NGOs. Topics included involving volunteers in monitoring and methods of raising public awareness on bats and their biology.

In the afternoon a network meeting was held in the local council hall. The meeting was opened by Dieter Schönfeld, mayor of Bad Segeberg. Focus for the discussions were on future cross-border collaboration on bat management.

Figure 28: Participants at the Danish-German bat network meeting 03.02.2011 in Bad Segeberg
The following topics where discussed:
- Collaboration on a species level (Myotis bechsteinii, Myotis dasycneme, Myotis myotis).
- Bat monitoring.
- Bats and forestry.
- Bats and public participation including collaboration between Danish and German NGOs.
- Collaboration between the limestone mines in Jutland and Bad Segeberg.
- Bats and compensating actions in infrastructure projects including windmill projects.

As a result of the discussions collaboration was initiated on the use of bat boxes. See activities on bat boxes below. Also collaboration between the limestone mines and Myotis dasycneme was initiated. See more on the pond bat project below.

In April 2011 the German-Danish project management team went on a study visit to England. Part of this visit went to the Bat Conservation Trust in London. The focus of the visit was on legal issues concerning their interpretation of the EU Habitat directive e.g. management of forests and not disturbing bats. Another issue of interest was British experiences with public participation. In England they have good experiences with engagement of volunteers in local bat groups for monitoring. A total of more than 5000 people are involved on a voluntary basis.

Bat box expert meeting 12.12.2011
Danish bat experts went to Bad Segeberg in Schleswig-Holstein in order to learn about the use of bat boxes for monitoring and as artificial roosting sites for bats. German experts have many years of experience with the use of bat boxes for monitoring and conservation, as oppose to Danish experts. The objective of the meeting was for the Danish experts to study the opportunities and limitations of the use of bat boxes in bat monitoring and conservation. The day included presentations on German experiences, visits to field sites with bat boxes installed and finally practical exercises in putting up bat boxes. These exercises gave room for more detailed discussions on practical matters. The bat boxes were put up in a forest corridor near the Kiebitzhom fauna bridge. See more about these bat boxes in the paragraph on Bechstein bats in Kiebitzhom in paragraph 4. After the meeting the Danish experts decided to design a testing program for bat boxes in Denmark based on German experiences. The BioGrenzKorr project sites are included as testing sites. See next paragraph.

4.1.2 BioGrenzKorr and other bat projects
Danish bat box testing project
The engineering company Grontmij A/S has initiated at project in order to systematically test bat boxes. The objective is to test bat boxes in relation to new infrastructure projects, in order to investigate if boxes may replace (compensate for) the loss of bat habitats. At least 6 sites along new highway and railway project sites are involved. As a reference the BioGrenzKorr project areas in Sollerup, Southern Fyn and the forests of Graasten are included in the project. At these sites a baseline survey had already been done on bat species. At each site 50 boxes are installed in 10 groups of 5, using 5 different box types. In total almost 400 boxes are included in the survey. The bat boxes will be monitored for three years two times each year.

Project partners are the Danish national road authorities (Vejdirektoratet), railway authorities (BaneDanmark) and the Danish Nature agency. BioGrenzKorr contribute with bat boxes in BioGrenzKorr project sites as well as the first monitoring of the boxes on these sites. For information on the specific results see more in paragraph 3.
Pond Bat (Myotis dasycneme): Genetic differences between pond bat populations from northern Germany and Denmark.

The pond bat (Myotis dasycneme) is listed on the Danish red list as vulnerable (VU) (Baagøe 2010) and on IUCN’s red list 2008 as “Near threatened”. The species is on annex II and IV of the Habitat directive.

The Pond bat has a fragmented distribution in northern Europe. Traditionally three apparently stable populations have been considered: 1) one in the Netherlands-North Western Germany, 2) one in Middle and Northern Jutland, Denmark, and 3) one in the Baltic States and westernmost Russia. There are scattered records and small stable occurrences from elsewhere in northern Europe such as a small population around Guldborgsund in Eastern Denmark.

Information gathered during the latest decades suggests that the populations of pond bats in Jutland, Denmark, and in Eastern Schleswig-Holstein are less isolated from each other than earlier believed (Ahlén et al. 2007, 2009, Baagøe 2007, Borkenhagen 2011, Møller et al. 2013). To optimize cross-border conservation and management activities for the pond bat it is essential to know the extent of connection between the two populations.

The aim of the present cross-border pilot project was to analyse the genetic relationship and migration directions of pond bats between the two areas based on DNA-samples from the hibernation sites in Mønsted/Daugbjerg and samples representing 3 summer colonies in Schleswig-Holstein using microsatellites and mtDNA.

The project is a cross-border project conducted in collaboration with Ronja Dirksen (German biology student), Professor G. Hartl, University of Kiel, Germany, Florian Gloza-Rausch, Institute of Virology, University of Bonn Medical Centre, Scientific Director Noctalis - World of Bats: Bad Segeberg, Germany, Dr. Frauke Krueger, University of Kiel, Germany, Dr. Hans J. Baagøe, Curator of Mammals, Natural History Museum of Denmark, Copenhagen, Denmark and Dr. Morten Elmeros and Dr. Liselotte W. Andersen, Aarhus University, Denmark.

Results show a clear connection, and thus gene flow, between populations in Denmark and Schleswig-Holstein, indicating a need for cross-border management and coordination.

Results are part of the doctor diploma thesis of the German student, Ronja Dirksen. BioGrenzKorr partners have supported the cross-border project with a grand of 25,000 DKR, in order to finalise the analysis of DNA samples.

Collaboration with Eurobats

Under the UN Environmental Programme (UNEP) The Agreement on the Conservation of Populations of European Bats came into force in 1994 and was set up under the Convention on the Conservation of Migratory Species of Wild Animals, which recognises that endangered migratory species can be properly protected only if activities are carried out over the entire migratory range of the species. The Bat Agreement aims to protect all 52 European bat species through legislation, education, conservation measures and international co-operation. (www.eurobats.org)

BioGrenzKorr has worked with Eurobats regarding information on bats and forestry and regarding public events.

Bats and Forestry

Eurobats have had focus on bats and forestry and has produced a flyer: Bats and forestry. They offer the opportunity to translate the flyer to local language. BioGrenzKorr made a campaign on bats and forestry. See more below. As part of this campaign it was obvious to translate and use the flyer Eurobats provided for free the masterfile including photos etc for the flyer. Based on this, BioGrenzKorr has translated the texts and made a Danish version which is available on www.eurobats.org

European bat night

Each year in August Eurobats organise a European Bat Night, where bat events all over Europe takes place. For this purpose they provide posters and a website where all events are posted and small reports from each country are available. In 2010 BioGrenzKorr arranged three European Bat Night events. See more below.
4.2 Public information and dissemination

Public information has been provided at three levels. Professional publication for foresters and nature guides in journals and as a flyer, particularly on bats and forestry. Articles have been written in national and regional newspapers as well as in national radio. Finally public events have been arranged inviting people on bat safaris, both for ordinary people and for professionals. Public information and dissemination is part of working package 4 of the project.

Campaign on Bats and Forestry

The EU Habitat directives regarding annex IX species was implemented in Danish legislation in 2009/10. The law protects the habitats of all bat species. Many species depend on trees for roosting. This created uncertainty in the forest sector. How are these regulations going to affect the management of forests? In order to meet the gap for more knowledge on bats and their use of trees as habitats, BioGrenzKorr initiated a campaign targeted at forest managers.

Campaign on Bats and Forestry for the press:
- Flyer published at the Nature Agency’s website
- Distribution of flyers to 3800 foresters via the Danish monthly forest magazine Skovener
- Articles in 3 national newspapers
- Articles in 7 regional newspapers.
- Interview in direct national radio

Publications:

Public events

August 2010: Three European bat night events.

The first Danish European Bat Night events ever took place on Fyn on the 12th and 13th of August 2010. Both events took place in and near Søl-

lerup Forest in a mosaic landscape with forest, hedgerows, open grasslands, meadows and near the largest lake on Funen. A third event took place on the 11th September 2010 in Graasten forest, a deciduous forest in Southern Jutland near the German border. All three events were hosted by The Danish Forest and Nature Agency under the Danish Ministry of the Environment.

The events were targeted at two different groups. The first event was targeted at nature guides and the two others were publicly announced events. On the 12th of August, the objective of the event was to provide nature guides with hard facts on bat ecology. Hans Baagøe, a Danish expert and leading researcher on bats from the University of Copenhagen, gave an intensive presentation of bat ecology, including echolocation technique and different bat species niches in their use of the
landscape for hunting grounds and roosting places. After the presentation and discussion, the group of approximately 25 persons went into the forest to observe and listen to bats with echolocation equipment.

The sun went down at 8.30 pm. It was cloudy with a high humidity due to heavy rains earlier that day. Seeing that these were not the most favorable weather conditions for this type of events, we were not too optimistic about the outcome. However, not long after sundown the first *Nyctalus noctula* appeared from the forest into the open grassland hunting along the forest edge. Soon they were followed by *Eptesicus serotinus* and *Pipistrellus pygmaeus*. All three species are common in Denmark. Near Arreskov Lake *Pipistrellus nathusii* and *Myotis daubentonii* were hunting. The latter was hunting in its very characteristic way just above the surface of the lake - a fascinating sight seen with a strong flashlight. A total of 6 different species were observed during that night. One of them: the *Vespertilio murinus* has not previously been seen in this area which adds a 10x10 km square for this species to The Atlas of Danish Mammals.

The public event concept European Bat Nights was handed over to the group of nature guides as an inspiration and hopefully more Danish European Bat Night events will take place the coming years.

A public event took place the following evening in the same area. Our nature guide used knowledge and ideas gained from the experience of the previous evening. Echolocation equipment with loudspeakers was used for all to be able to hear the sounds of bats. The event was spiced up with tales from Danish folklore on bats. In total 70 peoples participated.

A third event took place on the 11th September in Graasten forest, an old deciduous forest in Southern Jutland. Here the local nature guide together with the bat expert Morten Christensen hosted the event. For practical reasons the number of participants were restricted to 30 people and booking was required. In fact, at least twice as many wanted to join the event. Morten Christensen was interviewed by the regional radio station. Again, echolocation equipment with loudspeakers was used for all to be able to hear the sounds of bats. The main attraction was observation of Daubenton bats hunting on the Graasten Lake with the Royal Graasten Castle in the background.

10.05.2013: Installation of bat boxes in the forest of Graasten.

The local group of The Danish Society of Nature Conservation in Sønderborg (DN-Sønderborg) has established a local bat group. The group began operating in 2011 and they showed interest in collaboration with BioGrenzKorr and NST-Sønderjylland. On the 10th May 2013 40 bat boxes were installed in the forest of Graasten. Seven volunteers from the local group of the Danish Society of Nature Conservation participated. They assisted in the practical work of putting up the boxes and were informed about the use of bat boxes. After these activities the volunteers have assisted in observing the bats appearance in the boxes. This activity is expected to continue also after the finalizing of the BioGrenzKorr project. The group will also monitor the artificial cavities made in trees as described in chapter 3.2. In addition NST-Sønderjylland cooperate with the group when planning forest operations, as they screen forest stands before the harvest season and identify trees valuable for bats and other biodiversity, in order to retain the trees as habitat trees. The volunteers photograph the trees and the final selection is done together with the local forester. The selected trees are marked. NST has a policy to retain 3-5 trees pr ha. The trees are to stay until they die and the dead wood left is an important habitat for insects and fungus.
5. References


Skov- og Naturstyrelsen 2010: God praksis for skovarealer med flagermus. Miljøministeriet


Appendices
### Appendix 1: Names and conservation status of bat species in the region

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<td>Pipistrellus pygmaeus</td>
<td>Dværgflagermus</td>
<td>Mückenfledermaus</td>
<td>Soprano pipistrelle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paur</td>
<td>Plecotus auritus</td>
<td>Langøret flagermus</td>
<td>Braunes Langohr</td>
<td>Common long-eared bat</td>
<td>VU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vmur</td>
<td>Vespertilio murinus</td>
<td>Skimmelflagermus</td>
<td>Zweifarbfledermaus</td>
<td>Parti-coloured bat</td>
<td></td>
<td></td>
<td>EN</td>
</tr>
</tbody>
</table>
Appendix 2: Maps of boxes

Bat boxes in Handewitt
Bat boxes in Kluesries
Bat boxes in Roden Skov near Graasten
INTERREG-BioGrenKorr - part 2

Forest bats:
Cross-border diversity and habitat improvements