



Bat 1: Estimate of bat populations at the southern North Sea

Supporting note to ZDV report no. 2016.031

Migration bats at the southern North Sea

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1 Supporting note

1.1 Introduction

In recent years, exploratory research into the occurrence of bats at the Dutch North Sea has shown that there is regular seasonal migration over sea of at least Nathusius' Pipistrelle *Pipistrellus nathusii* but perhaps also of Parti-coloured Bat *Vespertilio murinus* and Common Noctule *Nyctalus noctula* (Boshamer & Bekker 2008; Jonge Poerink et al. 2013; Lagerveld et al. 2014a, 2014b, 2015; Leopold et al. 2014).

Given the planned large-scale development of wind farms in the Dutch part of the southern North Sea in the coming years (SER Agreement 2013), the growing evidence that bats are vulnerable to collisions with wind turbine rotor blades and barotrauma caused by the fluctuating air pressure near the blades (e.g. Baerwald et al. 2008, Brinkmann et al. 2011, Bach et al. 2014, Cryan et al. 2014), the Ministry of Economic Affairs commissioned to Rijkswaterstaat (RWS) a two-year monitoring programme in 2015 to determine the occurrence and abundance of bats at the North Sea. This study is currently being conducted in a monitoring project titled 'Research on distribution and behaviour of bats in the southern North Sea' (RWS case number 31103115). It aims at providing insight into bat movements over sea.

However, in order to be able to make better estimates of the actual numbers of bats at sea and thus to get a clearer picture of the potential impact of offshore wind energy development on population level, more research is needed into the population ecology of bats in Europe and beyond. It is currently unclear what is the population size of the relevant species, which proportion migrates over sea and which proportion travels over land.

1.2 Assignment

To close the knowledge gap described above, or better said in order to make a start to overcome this crucial lack of insight into (sub)population sizes, RWS commissioned the Bats_1 study as part of the *Wind op Zee Ecological Programme* (Wozep; in English: Wind at Sea Ecological Programme), a multi-annual research programme initiated in view of the realisation of new offshore wind farms under the SER agreement (2013).

Aim of the Bat_1 desk study is to estimate the extent to which (sub)populations of Nathusius' Pipistrelle and possibly other relevant bat species, expressed in terms of numbers of individuals, use migration routes across the southern North Sea (SNS)¹. This information is of great importance to be able to make better estimates of what the Potential Biological Removal (PBR) values are of Nathusius' Pipistrelle and possibly other bat species, knowing that these values depend on the size of the (sub)populations to be considered.

1.3 The project team

The project was carried out by the Dutch Mammal Society (DMS; in Dutch: *Bureau van de Zoogdierverseniging* (ZDV); Herman Limpens, Marcel Schillemans and Eric Jansen), Wageningen Marine

¹ the area between 51°N and 56°N (see map in Leopold et al. 2014).

Research (WMR, formerly: IMARES; Sander Lagerveld) and many European bat workers and researchers².

1.4 Project results

The agreed project results comprise a technical report (Migrating bats at the southern North Sea, ZDV report no. 2016.031) and this supporting note. Taking into account the objectives of the Wozep programme the latter provides a summary of the technical report and a brief discussion of the aspects that play a particular role in relation to the continuation of the bat research in the context of Wozep.

1.5 Summary of ZDV report

The ZDV report (Limpens et al. 2017) provides a framework by which both the size of seasonal bat populations per country or region across their distribution range and the migratory movements between particular countries or regions can be assessed. Based on this framework a flow model has been designed to estimate the migratory population of Nathusius' Pipistrelle over the southern North Sea and the size of its source population.

The model design is straight-forward:

$$\text{Summer population } i + \sum \text{Immigration } ij - \sum \text{Emigration } kii = \text{Winter population } i$$

In words: the summer population in country/region i plus the autumn migration into country/region i from country/region $1..j$ in autumn minus the autumn migration from country/region i to country/region $1..k$ equals the winter population. Each population (migratory, summer- or winter-) consists of adult females, adult males and juveniles. Of each number in the model the most likely value is estimated as well as the (likely) upper and lower limit of that particular value.

An extensive expert panel consisting of bat workers and researchers across the continent was consulted in order to obtain actual field data on population sizes (summer population and winter population³), seasonal movements (number of individuals and migration directions) and two ecological parameters (number of juveniles per female and number of satellite males per territorial male). However, the data received appeared to be highly fragmented and incomplete, involving high uncertainty levels. As a consequence, it was inevitable to base virtually all data and parameters in the model on expert judgement of the ZDV authors, rather than that of the consulted experts. Currently no published data per country or region are available. Therefore, based on the available knowledge of the annual reproductive cycle of Nathusius' Pipistrelle, the associated migratory movements and a rudimentary set of field data, numerous assumptions had to be made in order to estimate the bandwidth of the number of bats likely crossing the southern North Sea in autumn.

Subsequently, the preliminary results of the model were shared with the expert panel, and after several iterations some adjustments were made, eventually leading the expert panel to consider the model outcomes not unreasonable. Despite the obvious uncertainties, the result actually is a first step towards an estimate of the number of individuals migrating over the southern North Sea. It was estimated that the relevant summer population of Nathusius' Pipistrelle consists of approximately 275,000 individuals (bandwidth 25,000 – 2,000,000) of which approximately 40,000 individuals (bandwidth 100 – 1,000,000) may migrate over the southern North Sea. Most migrants travelling over the southern North Sea are expected to depart from the Dutch and Belgian coast (approximately 18,000 and 14,000 individuals, respectively). Migration from Germany and Denmark towards the UK

² See Limpens et al. (2017)

³ For a limited number of regions (Netherlands, UK, and Ireland) the estimates were based on actual field data (maternity colonies, mating roosts, and/or hibernacula), for the other regions these estimates were based on expert judgement.

and crossing the current study area, is considered less extensive (approximately 6,000 and 2,000 individuals, respectively).

The outcomes of the model show significant uncertainty intervals, but this is inevitable given the uncertainties in the underlying estimates of the regional population sizes, seasonal movements and parameter values. One parameter in particular needs further clarification. The model outcomes indicate that the sex ratio of the summer population in the area concerned is biased (at least two times more males than females). This outcome is mainly caused by the model parameter *ratio territorial and satellite males*. Generally bat species give birth with a sex ratio of 1 (Dietz et al. 2007).

For the basic estimates on population size, relatively elaborate data and estimates were available for 6 out of 16 units (here the UK is divided in the four countries). One third of the information used is derived from technical reports, reviewed papers and expert judgement. Limited data and data for smaller regions/sites were available for 7 out of 16 units, and no data for 3 out of 16. For the regions with limited data, expert judgement was used and discussed with the contributors. Expressed as percentages, usable information is about 15% from technical reports, 15% peer reviewed and 70% expert judgement. For the units with no data 100% expert judgement was used. Regarding the flow model more quantitative input was available for 8 out of 16 units, where quantitative data on population estimates were 15% from technical reports, 15% peer reviewed and 70% expert judgement. Data on fluxes were 100% expert judgement. For population dynamical parameters 50% was from technical reports and peer reviewed sources and 50% expert judgement.

Although the study focuses on the autumn migration of Nathusius' Pipistrelle, the model approach can also be applied to other migratory bat species.

1.6 Significance of the study for Wozep

The study estimates that roughly between 100 – 1,000,000 (with an intermediate of 40,000) individuals of the Nathusius' Pipistrelle migrate over the southern North Sea. It cannot be stressed enough that this preliminary result is indicative only, since it is to a great extent based on expert judgement. However, it does show that a significant proportion of the source population may be at risk due to the development of offshore wind farms at the southern North Sea.

Priority topics for further research, in order to improve the estimate and reduce the uncertainty in the results of the flow model, are:

1. Inventories across the entire European continent to assess (at least) the summer population and territorial male roosts per country/region; if possible, intensive survey of a sample of sites can be used to model larger geographical areas.
2. The migratory flux through particular areas;
3. The ratio of territorial to satellite males;
4. The percentage males, females and juveniles participating in migratory movements;
5. Migration directions and, in particular, the role of guiding landscape features near the coast.

Since the objective of Wozep concerns the ecological effects of offshore wind farm development in the southern North Sea, it seems logical to focus on this geographical area. The need for topic 1, however, is obvious. On the other hand, carrying out inventories across the entire European continent requires an enormous effort, which in our view should be committed by several countries/parties together under the auspices of the UNEP/EUROBATS secretariat.

It seems feasible to incorporate topic number 2 to 5 into the Wozep programme. In fact, multiple research questions have already been addressed in projects being part of this programme. Their results can feed into other research projects, e.g. those that build on the approach presented in the ZDV report (Limpens et al. 2017). If supplemented by quantitative information of other European countries, this provides the opportunity of establishing ground truth (part of topic 1).

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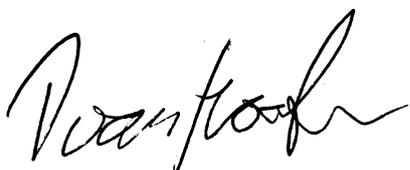
Justification

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The scientific quality of this report has been peer reviewed by a colleague scientist and a member of the Management Team of Wageningen Marine Research

Approved: Dr. Tobias van Kooten
Senior researcher

Signature:



Date: 10 March 2017

Approved: Drs. J.A. Asjes
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Date: 10 March 2017

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