Rijkswaterstaat
Ministry of Infrastructure and Water Management

RWS INFORMATION

New approach to quantitatively estimate bat casualties at offshore wind farms

KEC 5.0

Datum	17 March 2025
Versie	1
Status	

Colofon

Uitgegeven door	RWS
Auteur	Bob Jonge Poerink (Ecosensys), Robin Brabant (KBIN)
Informatie	
Telefoon	
Mobiel	
E-mail	
Datum	17 March 2025
Versie	1
Status	Final

Contents

1 Introduction

Since the discovery that Nathusius' pipistrelle regularly crosses the North Sea in significant numbers during seasonal migrations, researchers have sought to account for potential fatalities caused by offshore wind farms (OWFs) in ecological impact assessments (EIAs).

Research has shown that bats are more common at sea than previously assumed. For several years, it has been known that among others Nathusius' pipistrelles (*Pipistrellus nathusii*) cross the North Sea from the European mainland to the United Kingdom and vice versa. During these migrations across the North Sea, the bats pass through OWFs and are at risk of collision.

There are still many knowledge gaps concerning bats. For example, there is limited understanding of population size and behaviour in relation to operational wind farms. Furthermore, there is no reliable model for estimating the number of collision victims at sea for bat species, and estimating the impact at the population level is not yet possible due the lack of accurate population estimates. In conclusion, insufficient knowledge is currently available to estimate the number of bat victims that can be used in an EIA or CEA other than through expert judgement.

Because of the lack of quantitative data on fluxes and flight behavior, it is not possible to use a collision model such as the Band model, compared to the methodology of predicting birds casualties.In order to make a quantitative estimation, Leopold et al. (KEC 1.0, 2014) provided a rough indication of the possible collision victims: 0-1 casualty per turbine per year. This assumption is based on available data from collision victims found at onshore wind turbines. However, the conditions on land differ greatly from those at sea.

During an expert session (RHDHV, 2024) https://www.noordzeeloket.nl/publish/pages/232837/results-of-the-workshop-on-predicting-bat-fatalities-and-offshore-wind.pdf, the experts indicated that bats may forage around turbines and that this behavior, along with their echolocation calls, can attract other bats. It is therefore likely that there will be no direct linear relationship between the number of bats, the number of turbines and the number of collision victims. If the population is already declining, this attracting effect will cause the population to decline even faster than estimated.

This issue, in combination with expanding offshore wind energy ambitions in the North Sea, highlights the importance of gaining more insights in the effects of wind farms on the Nathusius's pipistrelle population.
Despite intensive research in recent years, the knowledge gaps regarding population size, behavior in wind farms and collision risks at sea have not yet been resolved. Some knowledge gaps, such as collision risks at sea, are also virtually impossible to solve with offshore research.

Therefore, a new methodology was requested to make a more quantitative assessment, in such a way that the impact of these knowledge gaps are minimized. This KEC 5.0 update provides only a potential methodology designed to improve these assessments. The framework presents a preliminary model that will be further developed within Wozep, allowing for quantitative (offshore) data to be incorporated in future versions. This progression will support better evaluation and comparison of

wind energy scenarios. The design for this methodology is further elaborated on the next pages.

At this moment, the methodology is further developed in the Wozepprogramme. Additional research is conducted to fill in the missing parameters for the offshore application of this methodology. It should be noted that additional acoustic data will have to be collected first, before the spatial analysis for the Dutch part of the North Sea can be completed reliably.

2 Outline methods to estimate the number of bat casualties at offshore wind farms.

Authors: Bob Jonge Poerink (Ecosensys) & Robin Brabant (KBIN)

2.1. General introduction

Wind farms in Europe have been found to have a detrimental impact on bat populations, primarily due to bat collisions with turbine blades, resulting in increased mortality rates (Voigt *et al*., 2012). Research on bats in onshore wind farms indicates that bats are attracted to wind turbines due to the presence of insects, potential roosting sites or lighting, thereby heightening the risk of collisions (Cryan *et al*., 2014; Guest *et al*., 2022; Voigt *et al*., 2018). The most vulnerable species are often migratory bats, which travel long distances and may encounter wind farms along their migration routes (Lehnert et al., 2014).

Bats undertaking seasonal migration between summer roosts and wintering areas can cross large areas of open sea (Ahlén *et al*., 2009). This is also the case in the southern North Sea, where several bat species have been recorded. Nathusius' pipistrelles (*Pipistrellus nathusii*), common noctules (*Nyctalus noctula*), parti-colored bats (*Vespertilio murinus*), Leisler's bats (*Nyctalus leisleri*) and Northern bats (*Eptesicus nilssonii*) have been observed at offshore oil rigs and platforms (Boshamer en Bekker, 2008). Surveys with acoustic bat recorders also confirmed the presence of bats in offshore wind farms (OWFs) even at large distances from the coast (Jonge Poerink et al., 2013, Lagerveld et al., 2017 & 2022). Given the offshore presence of bats and the known impact of onshore wind farms on bats OWFs also pose risks to bats. The migrating bat species Nathusius' pipistrelle is more often detected over the North Sea compared to other bat species. In the period 2015 – 2020 more than 85% of all bats recorded over the North Sea with ultrasonic passive recorders were Nathusius' pipistrelles (Lagerveld et al., 2017 & 2022). Other bat species recorded over the North Sea are found offshore only incidentally or as a vagrant species.

The Dutch Offshore Wind Ecological Programme (WOZEP) and the Framework for Assessing Ecological and Cumulative Effects (KEC) guide the research and assessment of the impacts on (marine) ecosystems from offshore wind energy developments in the Netherlands, including the impact on bats. WOZEP and KEC provide input for environmental assessments and decision-making for OWFs in Dutch marine territories. The WOZEP and KEC programs signaled the need to further qualify and quantify the impact of bat collisions of offshore wind farms on populations, with a focus on Nathusius' pipistrelles. This information is necessary to be able to reduce current worst-case assumptions, and as a guidance for KEC, Environmental Impact Assessments (EIAs) and future research as well as for the management of current and future wind farms at sea.

Legal conservation status

The European Habitats Directive (HD) is protecting all European bat species. The overall objective of the HD is to maintain and restore natural habitats and species of wild fauna and flora of Community interest to a 'favourable conservation status'. A 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. Nathusius' pipistrelle is one of the bat species listed in Annex IV of the HD (i.e. 'animal and plant species of community interest in need of strict protection'). Consequently, the collision risk and the impact of the OWFs on the conservation status of this species should be determined for the Dutch EEZ. Currently (2024) the conservation status of Nathusius' pipistrelle in the Netherlands is 'moderately unfavourable'.

To support EIAs, the current mortality rate of bats in OWFs in the Dutch EEZ is estimated at 0-1 bats per turbine per year (Leopold *et al*., 2014) and included in KEC1.0 (Ministerie van Economische Zaken & Ministerie van Infrastructuur en Milieu, 2016). This quantification is based on the limited data that were available in 2014 and was mainly based on expert judgement. Therefore it should be regarded as a rough estimate . In the application of the range of 0-1 bats per turbine per year within EIA's the worst-case number of 1 bat per turbine is always emphasized, which might lead to an overestimation of the number of collisions.. Nathusius' pipistrelles are found offshore during the migration periods of this species in spring (April – June) and autumn (August – October) (Jonge Poerink & Dekker, 2018; Lagerveld et al., 2017 & 2022). To prevent casualties of Nathusius' pipistrelles at OWFs, curtailment measures (Arnett *et al*., 2013; Adams *et al*., 2021) are only useful in the migration periods. Since the expert judgement of 0-1 bats per turbine per year was made, important additional data were gathered on the offshore occurrence of Nathusius' pipistrelle. The available dataset could aid defining a more accurate and evidence based estimate of the average number of bat casualties at offshore wind turbines. This document presents an overview of the available data and results and also provides an outline of the methods that can be used to create a new estimate.

2.2. Available datasets and results Dutch EEZ

Offshore research on bat collisions is difficult to conduct. In the current situation, mainly acoustic research (capturing the sounds of bats) and research with tagged individuals was conducted. Maybe in the future other techniques will be available to conduct offshore research on bats.

2.2.1. Acoustic data

2.2.1.1. Dataset

Acoustic data of bats over the North Sea were first collected in 2012 at two offshore wind farms in the Dutch EEZ (Jonge Poerink *et al.,* 2013). Until 2020 data were collected at 18 offshore locations as part of the WOZEP monitoring program (Lagerveld *et al*., 2017 and 2022). In 2015 and 2016 bats were also monitored with passive recorders at 5 onshore locations (ID's 5, 6, 8, 11 and 14 in Figure 1) situated at the coast of the Netherlands and Belgium. An overview of offshore and onshore ultrasonic recorder locations in the period 2012 – 2020 are shown in Figure 1. All recorders were positioned at a height of 15 – 35 m above mean sea level.

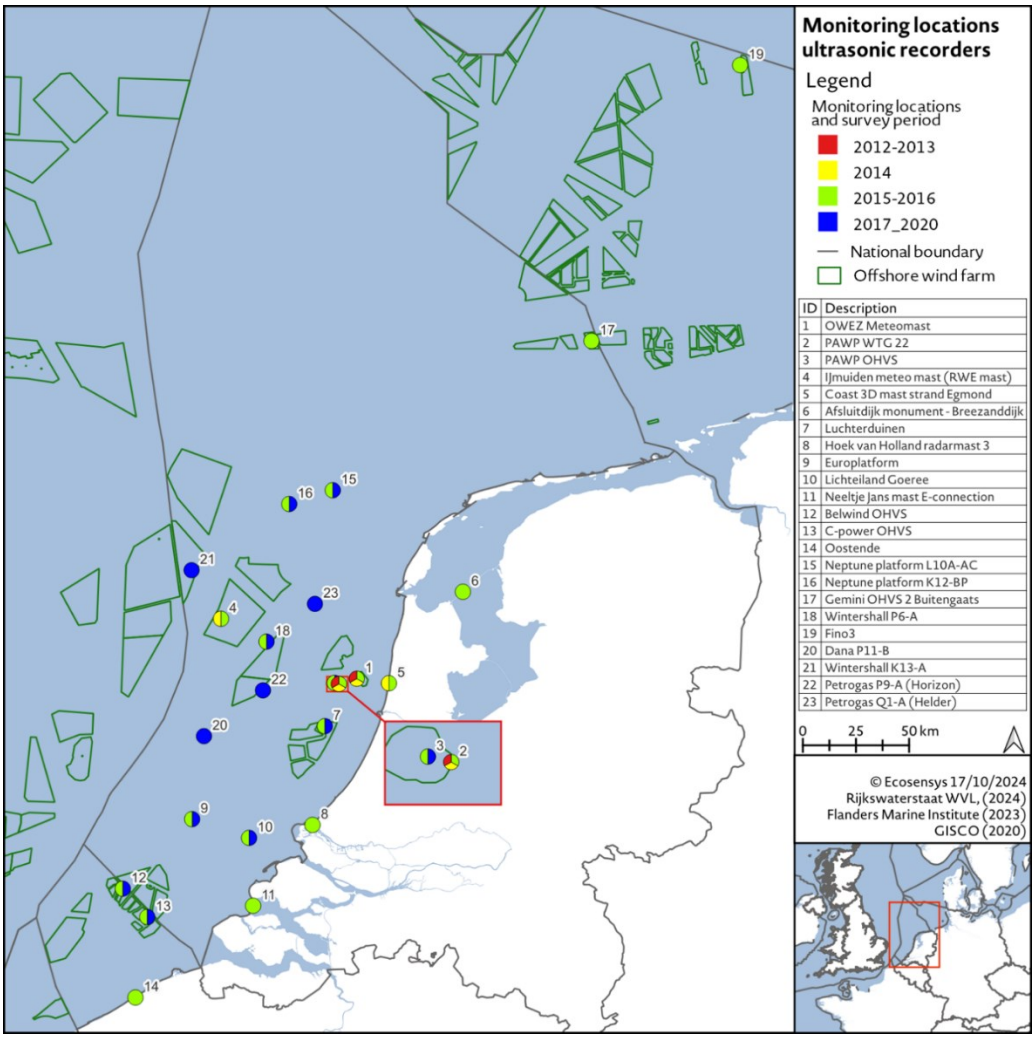

Figure 1. Acoustic monitoring locations and survey periods 2012 -2020 (data sources: Jonge Poerink et al., 2013, Lagerveld et al., 2014b, 2017 & 2022 and RWS-WVL)

In addition, acoustic data were collected at the North Sea near the Dutch EEZ in Belgium (Brabant *et al*., 2019) and Germany (Seebens-Hoyer *et al*., 2020). The Belgian survey was carried out within a OWF and included acoustic data collection 16 m above mean sea level and from nacelle height (93 m).
After 2020 the acoustic monitoring of bats within the WOZEP research program has not been continued. Adjacent to the Dutch EEZ KBIN-MARECO is collecting data at three locations within the Belgian EEZ since 2020. Starting in 2025, the WOZEP research program will begin collecting data at the offshore wind farms located in the northern part of the Dutch EEZ, north of the Wadden Islands.

2.2.1.2. Results

At offshore acoustic monitoring locations the number of detections is relatively low compared to onshore locations. At offshore locations the average percentage of nights with detections of Nathusius' pipistrelle was 11%. At onshore locations this percentage was 66% (Lagerveld *et al.*, 2017). Lagerveld *et al*. do not report the exact numbers of detections per night. However, it can be concluded from the presented graphs that during these nights, the number of offshore detections was significantly lower compared to onshore locations (Lagerveld et al., 2017). The acoustic data collected in a Belgian wind farm at 16 meter above mean sea level (MSL) and at nacelle height (93 m MSL) show a significant decrease of bat activity at nacelle height (Brabant *et al.,* 2019). The average number of recordings at 93 m

(MSL) were around 10% of the number of recordings made at 16 m (MSL). Compared to the average number of recordings at nacelle height of onshore wind turbines in coastal areas (Bach *et al*., 2020a), the number of recordings at nacelle height collected during the Belgian offshore survey is significantly lower. It should be noted however that the survey comprised only a limited number of sampling points during a single autumn migration period in 2017.

2.2.2. Telemetry data

2.2.2.1. Dataset

Aside from acoustic data, Lagerveld *et al*. (2017 and 2022) also collected telemetry data of tagged noctules and Nathusius' pipistrelles (Lagerveld *et al*., 2021 and 2024). A total of 409 Nathusius' pipistrelles were tagged and followed with Motus automated telemetry receivers in the period 2018 – 2020 (Lagerveld *et al.,* 2024).

2.2.2.2. Results

The telemetry research confirmed that most of the Nathusius' pipistrelles are migrating along the Dutch coast (Lagerveld *et al*., 2024). Approximately 69% of the tagged bats showing directional movement were migrating south along the coast. A relatively small percentage (6 - 10%) of the tagged bats departed over sea directly from the study area. Eight Nathusius' pipistrelles departed over sea. Only one individual certainly crossed the North Sea and was detected in the UK (Lagerveld *et al.*, 2024). According to Lagerveld *et al.* (2024) some of the tagged bats that initially followed the coast may have migrated over sea further south along the coast. Therefore Lagerveld *et al*. (2024) regard the overall percentage of 6-10% of bats departing over sea as a conservative estimate. Although many bats were tagged the actual number of evidence based North Sea crossings is, at this point, too limited to be used to estimate the number of bat casualties at OWF's.

2.3. Bat Population Conservation Status Impact Assessment

According to the European Habitats Directive the population of Nathusius' pipistrelle should be maintained or restored to a 'favourable conservation status'. To assess the impact of OWFs on the conservation status of populations of bat species found within the Dutch Exclusive Economic Zone (EEZ), the following principal steps have to be taken:

1. Collision risk assessment: Estimate the average number of bat casualties / offshore Windturbine.
2. Cumulative risk assessment: Estimate the total number of bat casualties to be expected each year at OWFs within the Dutch EEZ.
3. Estimate the size of the population of Nathusius' pipistrelle in the Netherlands.
4. Assess the impact of the yearly cumulative number of bat casualties caused by OWFs within the EEZ on the conservation status of the population of Nathusius' pipistrelle in the Netherlands.

Ad 1 Collision risk assessment strategy

For onshore WFs, the number of casualties can be determined effectively by carcass searches.

Under offshore circumstances, carcass searches are impossible. Collided bats will drop to the seawater surface and be washed away or removed by seabirds and other marine organisms quickly. Alternative techniques like thermal imaging and

radar technology could detect colliding bats. Apart from the technical challenges of using these technologies under offshore circumstances, the low number of bats passing OWFs will lead to a low chance of detecting a collision. Before these techniques will shed light on the collision risk of bats in OWFs, many years of research at different turbines will be needed.
Several models, like Probat and Chirotech, are available to predict the number of bat casualties at wind farms and to calculate bat-friendly cut-in wind speeds (wind turbine start-up wind speeds) for onshore wind farms.Most of these models are based on carcass searches combined with acoustic measurements.

ProBat was developed on the basis of results of the extensive German federal research programs RENEBAT I-III (Behr *et al*., 2015 & 2019). The number of bat casualties to be expected per wind turbine can even be calculated with only acoustic data gathered at nacelle height, and combines three components:

1. acoustic monitoring of bat activity at wind farms (nacelle monitoring).
2. a substantial multi-year database from the RENEBAT projects.
3. a scientific, mathematical-statistical method to determine the site-specific collision risk for bats.

The algorithms are based on data gathered all over Germany. Consequently, the algorithms are based on a variety of landscapes and bat habitats, including mountains and forested areas. Data from coastal wind farms were underrepresented in the dataset on which previous versions of Probat were based, but was improved in the latest version (2019) by adding more data gathered in wind farms in coastal areas.

The following remarks should be made regarding the use of the algorithms to estimate the number of bat casualties at OWFs:

- The data used to validate are primarily based on onshore acoustic data.
- The algorithms of are based on data collected at wind turbines with a maximum height of < 150m.
- The correlation between acoustic activity and bat casualties found at onshore wind turbines (Behr *et al*., 2023; Runkel, 2020) cannot be validated by carcass searches at sea. However, it is likely that the measured acoustic bat activity at sea and the collision risk at offshore wind farms show a comparable correlation to onshore wind turbines.
- The data collected at sea at nacelle height show far lower bat activity compared to the average bat activity recorded at onshore wind turbine in coastal areas. The bat activity at offshore wind farms might be so limited compared to the average bat activity at onshore wind farms that it is not sure whether the model can estimate the number of bat casualties per windturbine. In that case the number of bat casualties per offshore windturbine is probably also significantly lower compared to the average onshore windturbine. More research into the practical restrictions of the available models is needed.

Although models based on carcass searches cannot be validated for OWFs it could be useful tools to estimate the number of bat casualties at offshore wind farms. It is likely that the measured acoustic bat activity at sea and the collision risk at offshore wind farms show a comparable correlation as onshore wind turbines situated close to the coast.

Ad 2. Cumulative risk assessment:
To estimate the expected yearly cumulative number of bat casualties at OWFs within the Dutch North Sea the following steps should be taken:

1. based on the measured bat activity at the OWFs and the spatial migration ecology of bats a spatial analysis can be executed to establish areas of high and low bat activity. For the German part of the North Sea a similar spatial analysis based on acoustic data was already completed (Seebens-Hoyer *et al*., 2020). It should be noted that additional acoustic data will have to be collected first, before the spatial analysis for the Dutch part of the North Sea can be completed reliably.
2. For wind farms present and/or planned within those parts of the Dutch North Sea where a relevant bat activity can be expected the numbers and types of wind turbines should be clarified.
3. For each type of wind turbine an estimate of the number of bat casualties must be made using the algorithms.
4. By combining the estimated number of casualties for each type of windturbine with the total numbers of each type of wind turbine the cumulative estimated number of bat casualties must be calculated.

Ad.3 Estimate the size of the population of Nathusius' pipistrelle in the Netherlands
The size of the population of Nathusius' pipistrelle in the Netherlands is estimated at 50.000 – 400.000 individuals during autumn migration (BIJ12, 2024). This estimate is based on an expert judgement. An accurate census was not carried out for the Nathusius' pipistrelle population in the Netherlands. The range of the current population estimate is very broad and can be improved by a systematic census of Nathusius' pipstrelles in the Netherlands.

Ad 4. Assess the impact of the yearly cumulative number of bat casualties at OWFs
As the estimate of 50.000 – 400.000 is a very broad range, it is not possible to accurately analyze the impact of the estimated number of bat casualties on the population of Nathusius' pipistrelle. An alternative approach would be to compare the offshore and onshore acoustic activity of Nathusius' pipistrelles in detail. By comparing the relative acoustic activity of Nathusius' pipistrelle over the North Sea with the activity onshore an assessment could be made what fraction of the population is flying offshore and could be exposed to offshore windframs. In this way, it can be assessed what fraction of the population is at risk within the OWFs and the relative impact of the additional mortality in OWFs on the total population of Nathusius' pipistrelle could be estimated. The available telemetry data can be used as an additional data source for this assessment.

3 References

Adams, E.M., Gulka, J. & Williams, K.A. (2021). A review of the effectiveness of operational curtailment for reducing bat fatalities at terrestrial wind farms in North America. PLoS ONE,
16, e0256382.

Ahlén, I.; Baagøe, H.J.; Bach, L. (2009).Behavior of Scandinavian Bats during Migration and Foraging at Sea. J. Mammal. 2009, 90, 1318–1323.

Arnett E.B., G.D. Johnson, W.P. Erickson & C.D. Hein (2013). A synthesis of operational mitigation studies to reduce bat fatalities at wind energy facilities in North America. A report submitted to the National Renewable Energy Laboratory. Bat Conservation International. Austin, Texas, USA.

Bach, P., Voigt, C. C., Göttsche, M., Bach, L., Brust, V., Hill, R., Hüppop, O., Lagerveld, S.,
Schmaljohann, H., & Seebens- Hoyer, A. (2022). Offshore and coastline migration of radiotagged Nathusius' pipistrelles. Conservation Science and Practice, e12783. https://
doi.org/10.1111/csp2.12783.

Bach, P., Bach, L. & R. Kesel (2020a). Akustische Aktivität und Schlagopfer der Rauhautfledermaus (*Pipistrellus nathusii*) an Windenergieanlagen im nordwestdeutschen Küstenraum. In: VOIGT, C.C. (Hrsg.): Evidenzbasierter Fledermausschutz in Windkraftvorhaben. Springer Spektrum, Berlin: 77-100

Bach, P., Bach, L. & R. Kesel (2020b). Akustisches Monitoring von Rauhautfledermaus an Windenergieanlagen: Ist ein zweites Ultraschallmikrofon am Turm notwendig? In: VOIGT, C.C. (Hrsg.): Evidenzbasierter Fledermausschutz in Windkraftvorhaben. Springer Spektrum, Berlin: 101-119.

Behr, O, Brinkmann, R., Hochradel, K., Mages, J., Korner Nievergelt, F., Reinhard, H., Simon, R., Stiller, F., Weber, N., Nagy, M. (2018). „Bestimmung des Kollisions risikos von Fledermäusen an Onshore Windenergieanlagen in der Planungspraxis (RENEBAT III)", Universität Erlangen Nürnberg, Lehrstuhl für Sensorik.

Behr, O., Brinkmann, R., Korner Nievergelt, F., Nagy, M., Niermann, I., Reich, M., Simon, R. (2015). „Reduktion des Kollisionsrisikos von Fledermäusen an Onshore-Windenergieanlagen (RENEBAT II)", Umwelt und Raum, Band 7.

Behr, O., Barré, K., Bontadina, F., Brinkmann, R., Dietz, M., Disca, T., Froidevaux, J. S. P., Ghanem, S., Huemer, S., Hurst, J., Kaminsky, S. K., Kelm, V., Korner-Nievergelt, F., Lauper, M., Lintott, P., Newman, C., Peterson, T., Proksch, J., Roemer, C., Nagy, M. (2023). Standardised and referenced acoustic monitoring reliably estimates bat fatalities at wind turbines: Comments on 'limitations of acoustic monitoring at wind turbines to evaluate fatality risk of bats'. *Mammal Review*, 53(2), 65–71. https://doi.org/10.1111/mam.12310

BIJ12 (2024). Kennisdocument Ruige dwergvleermuis *Pipistrellus nathusii*, versie augustus 2024.

Boonman, M. (2018). Mitigerende maatregelen voor vleermuizen in offshore windparken. Evaluatie en verbetering van stilstandvoorziening. Bureau Waardenburg Rapportnr. 18-278. Bureau Waardenburg, Culemborg.

Boshamer J.P.C. & Bekker J.P. (2008). Nathusius' pipistrelles (Pipistrellus nathusii) and other
species of bats on offshore platforms in the Dutch sector of the North Sea. Lutra 51: 17-36.

Cryan P.M., P.M. Gorresen, C.D. Hein, M.R. Schirmacher, R.H. Diehl, M.M. Huso, D.T.S. Hayman, P.D. Fricker, F.J. Bonaccorso, D.H. Johnson, K. Heist & D.C. Dalton (2014). Behavior of bats at wind turbines.
http://www.pnas.org/cgi/doi/10.1073/pnas. 1406672111.

Brabant, R., Y. Laurent, B. Jonge Poerink & S. Degraer (2019). Activity and behaviour of nathusius´ pipistrelles *Pipistrellus nathusii* at low and high altitude in a North Sea offshore wind farm. Acta Chiropterologica 21 (2): 341-348.

Brabant, R.; Laurent, Y.; Jonge Poerink, B.; Degraer, S. (2021). The Relation between Migratory Activity of Pipistrellus Bats at Sea and Weather Conditions Offers Possibilities to
Reduce Offshore Wind Farm Effects. Animals 2021, 11, 3457.
https://doi.org/10.3390/ani11123457

Brinkmann, R., Behr, O., Niermann, I., Reich, M., (Hrsg.) (2011). „Entwicklung von Methoden zur Untersuchung und Reduktion des Kollisionsrisikos von Fledermäusen an Onshore-Windenergieanlagen (RENEBAT I)", Umwelt und Raum, Band

Diffendorfer, J.E., Beston, J.A., Merrill, M.D., Stanton, J.C., Corum, M.D., Loss, S.R., Thogmartin, W.E., Johnson, D.H., Erickson, R.A., Heist, K.W. (2017). A Method to Assess the Population-Level Consequences of Wind Energy Facilities on Bird and Bat Species, in: Köppel, J. (Ed.), Wind Energy and Wildlife Interactions. Springer International Publishing, Cham: pp. 65–76.

Guest, Emma E., Brittany F. Stamps, Nevin D. Durish, Amanda M. Hale, Cris D. Hein, Brogan P. Morton, Sara P. Weaver, and Sarah R. Fritts (2022). "An Updated Review of Hypotheses Regarding Bat Attraction to Wind Turbines" Animals 12, no. 3: 343

Jonge Poerink B., Lagerveld S. & Verdaat H. (2013). Pilot study Bat activity in the Dutch offshore wind farms OWEZ and PAWP 2012. IMARES report C026/13.

Jonge Poerink, B. & Dekker, J. (2018). Migratieperioden ruige dwergvleermuis in Nederland. RWS rapport MN0818tp349

Klop, E., Lagerveld, S., Boonman, M., Jonge Poerink, B., Halters, S. & Epe, M. J. (2024). Monitoring van vleermuizen in windparken op land. Zoogdiervereniging; rapport no. 2023.41, Nijmegen

Korner-Nievergelt F, R. Brinkmann, I. Niermann & O. Behr (2013). Estimating Bat and Bird Mortality Occurring at Wind Energy Turbines from Covariates and Carcass Searches Using Mixture Models. PLoS ONE 8(7): e67997.
doi:10.1371/journal.pone.0067997.

Lagerveld, S., B. Jonge Poerink & P. De Vries (2015). Monitoring bat activity at the Dutch EEZ in 2014. IMARES Report No. C094/2014: 33 Seiten.

Lagerveld, S., B. Jonge Poerink, H. Verdaat & R. Haselager (2014a): Bat Activity in Dutch offshore wind farms in autumn 2012. Lutra 57 (2): 61-69.

Lagerveld, S., B. Jonge Poerink & H. Verdaat (2014b). Monitoring bat activity in offshore wind farms OWEZ and PAWP in 2013. IMARES Report C165/14.

Lagerveld, S. D. Gerla, J.T. van der Wal, P. de Vries, R. Brabant, E. Stienen, K. Deneudt, J. Manshanden & M. Scholl (2017). Spatial and temporal occurrence of bats in the southern North Sea area. Wageningen Marine Research (University & Research centre), Wageningen Marine Research report C090/17.

Lagerveld, S., Jonge Poerink, B. & Geelhoed, S.C.V. (2021). Offshore Occurrence of a Migratory Bat, Pipistrellus nathusii, Depends on Seasonality and Weather Conditions. Animals, 11, 3442. https:// doi.org/10.3390/ani11123442.

Lagerveld, S., R. Janssen, K. Stienstra, J. Boshamer, M. van Puijenbroek, B. Noort & S.C.V. Geelhoed. (2021). Home range and habitat use of common noctules in the Dutch coastal zone. Wageningen Marine Research report C057/21.

Lagerveld, S., S.C.V. Geelhoed, T. Wilkes, B. Noort, M. van Puijenbroek, J.T. van der Wal, H.
Verdaat, M. Keur & J. Steenbergen (2022). Spatiotemporal occurrence of bats at the southern North Sea 2017-2020. Wageningen Marine Research report C031/22.

Lagerveld, S., de Vries, P., Noort, B., Stienstra, K., Sonneveld, C., Vallina, T., Keur, M. & Steenbergen, J. (2024), Coastal and offshore movements of Nathusius' pipistrelle during autumn migration. Wageningen Marine Research report; no. C030/24.

Leopold, M.F.; Boonman, M.; Collier, M.P.; Davaasuren, N.; Fijn, R.C.; Gyimesi, A.; de Jong, J.; Jongbloed, R.H.; Jonge Poerink, B.; Kleyheeg-Hartman, J.C.; Krijgsveld, K.L.; Lagerveld, S.; Lensink, R.; Poot, M.J.M.; van der Wal. J.T.; Scholl, M. (2014). A first approach to deal with cumulative effects on birds and bats of offshore wind farms and other human activities in the Southern North Sea. IMARES Report C166/1 https://www.noordzeeloket.nl/publish/pages/123314/kader_ecologie_en_cumulatie_t_b_v_uitrol_windenergie_op_zee_-_deelrapport_b_-_bijlage_imares_onderzo.pdf

Lehnert LS, Kramer-Schadt S, Schönborn S, Lindecke O, Niermann I, Voigt CC (2014). Wind Farm Facilities in Germany Kill Noctule Bats from Near and Far. PLoS ONE 9(8): e103106. https://doi.org/10.1371/journal.pone.0103106

Ministerie van Economische Zaken & Ministerie van Infrastructuur en Milieu, 2016. Kader Ecologie en Cumulatie t.b.v. uitrol windenergie op zee

Runkel V. (2020). Acoustic surveys of bats – possibilities and limitations during the planning and
operation of wind turbines. In: Voigt CC (ed.) Evidenzbasierter Fledermausschutz in Windkraftvorhaben, 3–28. SpringerSpektrum, Berlin, Germany. https://doi.org/10.1007/978-3-662-
61454-9_4.

RWS.(2019). Kader Ecologie en Cumulatie 3.0: Beschrijving en beoordeling van cumulatieve effecten bij uitvoering van de routekaart windenergie op zee tot 2030.

Seebens-Hoyer, A., L. Bach, P. Bach, H. Pommeranz, M. Göttsche, C. Voigt, R. Hill, S. Vardeh, M. Göttsche & H. Matthes (2020). Fledermausmigration über der Nord- und Ostsee., BfN-Skripten 631, Bundesamt fuer Naturschutz, Bonn

Voigt C.C., A.G. Popa-Lisseanu, I. Niermann, S. Kramer-Schadt (2012). The catchment area of windfarms for European bats: A plea for international regulations. Biological Conservation 153 (2012) 80–86.

Voigt, Christian C., Katharina Rehnig, Oliver Lindecke, en Gunārs Pētersons (2018). 'Migratory Bats Are Attracted by Red Light but Not by Warm-White Light: Implications for the Protection of Nocturnal Migrants'. *Ecology and Evolution* 8, nr. 18: 9353-61. https://doi.org/10.1002/ece3.4400.

Voigt, C. C., Scherer, C.,& Runkel, V. (2022). Modeling the power of acoustic monitoring to predict bat fatalities at windturbines. Conservation Science and Practice e12841.https://doi.org/10.1111/csp2.12841

Wellig S.D., S. Nusslé, D. Miltner, O. Kohle, O. Glaizot, V. Braunisch, M.K. Obrist & R. Arlettaz
(2018). Mitigating the negative impacts of tall wind turbines on bats: Vertical activity profiles
and relationships to wind speed. PLoS One. 2018 Mar 21;13(3):e0192493. doi: 10.1371/journal.pone.0192493. eCollection 2018.