Bat activity at offshore wind farms LUD and PAWP in 2015

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Report number C001/16

IMARES Wageningen UR

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Publication date: 13 January 2016

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Cover photograph:
Passive acoustic recorder at the OHVS Luchterduinen ©Renzo Schildmeijer

Recommended format for purposes of citation: Lagerveld *et al.* (2015) Bat activity at offshore wind farms LUD and PAWP in 2015. IMARES Report C001/2016.

Acknowledgements

This study was funded by Eneco. Many thanks to Sytske van den Akker and Renzo Schildmeijer for facilitating this study.

Contents

1 Introduction

For quite some time there have been indications of bat movements at the North Sea. Observers of bird migration at the Dutch coast regularly report bats flying in from sea (Lagerveld *et al.* 2014b). Bats have also been observed during ship-based bird surveys in the North Sea and have been found on oil and gas platforms, ships and remote islands (Walter *et al.* 2007, Boshamer and Bekker 2008). In 2013, a Nathusius' pipistrelle (*Pipistrellus nathusii*) which was banded three years earlier in the United Kingdom was found in the Netherlands (pers. comm. Teddy Dolstra), providing the first evidence that bats are able to cross the North Sea.

Numerous studies have shown that onshore wind turbines can cause high fatality rates amongst bats. Therefore it cannot be ruled out that offshore wind turbines can also have a negative impact on bat populations, if these animals regularly use the North Sea as fly zone, thus taking the risk of collision with a turbine. To gain a better understanding of bat activity at the North sea, several research studies have been carried out in recent years. In 2012-2014 offshore bat activity in the North Sea was monitored with passive acoustic ultrasonic recorders at three different locations (Jonge Poerink *et al.* 2013, Lagerveld *et al.* 2014a, Lagerveld *et al.* 2015). During these studies bats were regularly recorded, in particular during the migration season in spring and autumn. The observed species-specific patterns of their occurrence indicate that most offshore bat activity is caused by migratory bats.

In view of the planned rollout of new offshore wind farms (the co-called SER farms) and given the fact that bats across Europe have a strictly protected legal status, 'Rijkswaterstaat' (RWS) commissioned a bat monitoring program in 2015 (hereafter referred to as 'RWS-project') in order to reduce uncertainties about possible impacts. The present study, executed as part of the Monitoring and Evaluation Programme (MEP) for the Eneco offshore wind farm Luchterduinen, contributes to the 'RWS-project'. Both projects, the 'Eneco-project' and 'RWS-project', are linked to each other to make maximum use of available resources and facilities. The scope of the Eneco-project includes the passive acoustic monitoring of bat activity at two offshore locations: the wind farm Luchterduinen (LUD) and Princess Amalia (PAWP), and the analysis of the bat data obtained in relation to publicly available data on the weather conditions.

This progress report presents the results of the monitoring effort at offshore wind farms LUD and PAWP in 2015. The analysis of the weather conditions in relation to the offshore occurrence of bats will be presented as part of the more comprehensive RWS report.

2 Materials and Methods

2.1 Study area

In this study, bat activity was monitored at two locations; offshore wind farm Luchterduinen (LUD) and Prinses Amalia Wind Park (PAWP).

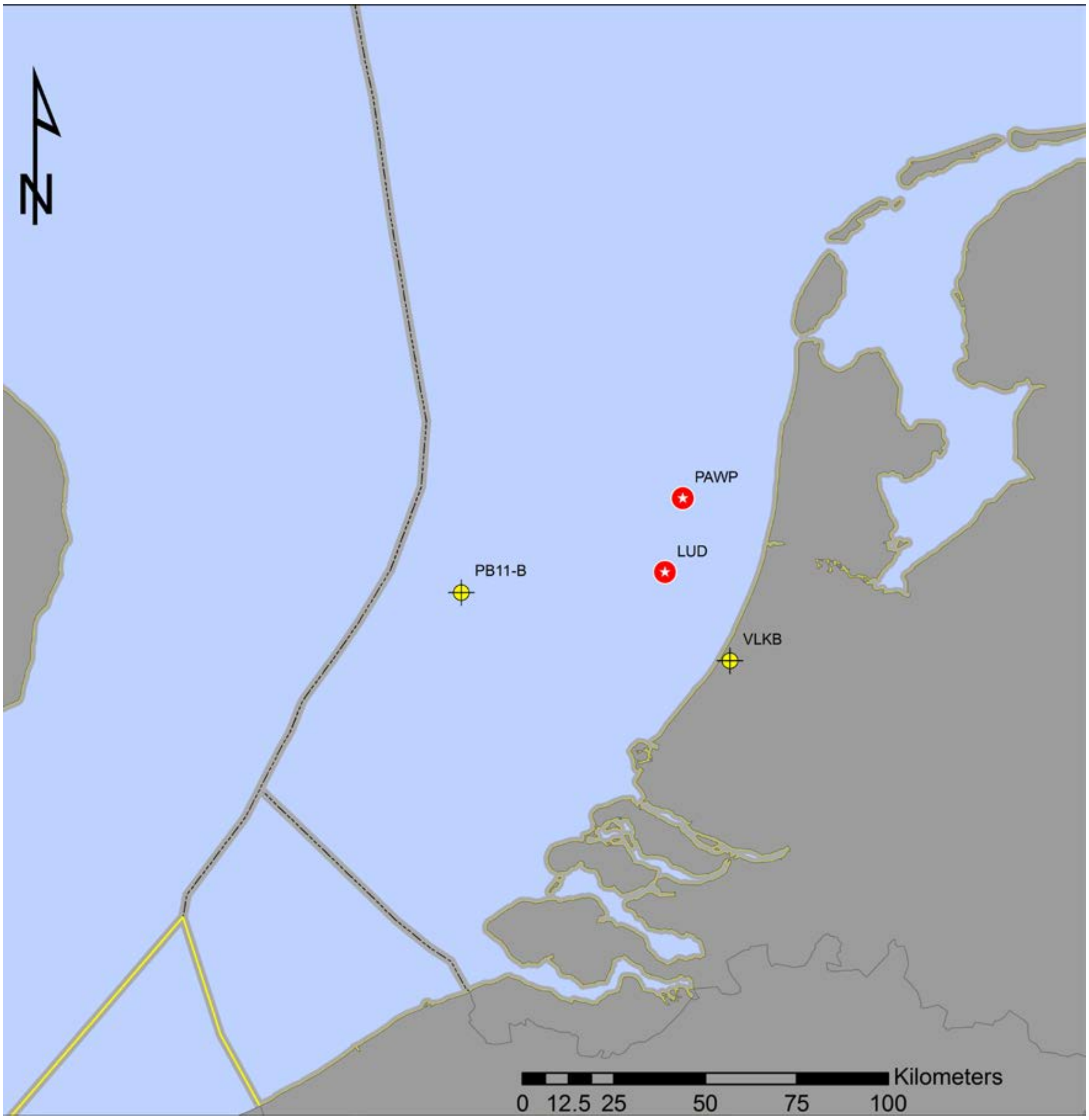


Figure 1: Monitoring locations LUD and PAWP, and the weather stations PB11-B and Airport Valkenburg (VLKB).

- LUD consists of 43 Vestas V112-3MW wind turbines and an Offshore High Voltage Station (OHVS). The wind farm covers an area of 16 km^2 and is located approximately 24 km off the Dutch mainland (Figure 1). The recorder was installed at the rail of the OHVS (Figure 2). Monitoring was done from 2 March 2015 until 9 October 2015.

Figure 2: The recorder at the OHVS of LUD (Photo: Renzo Schildmeijer).

- PAWP consists of 60 Vestas V80-2 MW wind turbines and an OHVS. The wind farm covers an area of 17 km^2 and is located approximately 25 km off the Dutch coast (Figure 1). The recorder was installed at the OHVS (Figure 3). Monitoring was done from 23 March 2015 until 20 October 2015.

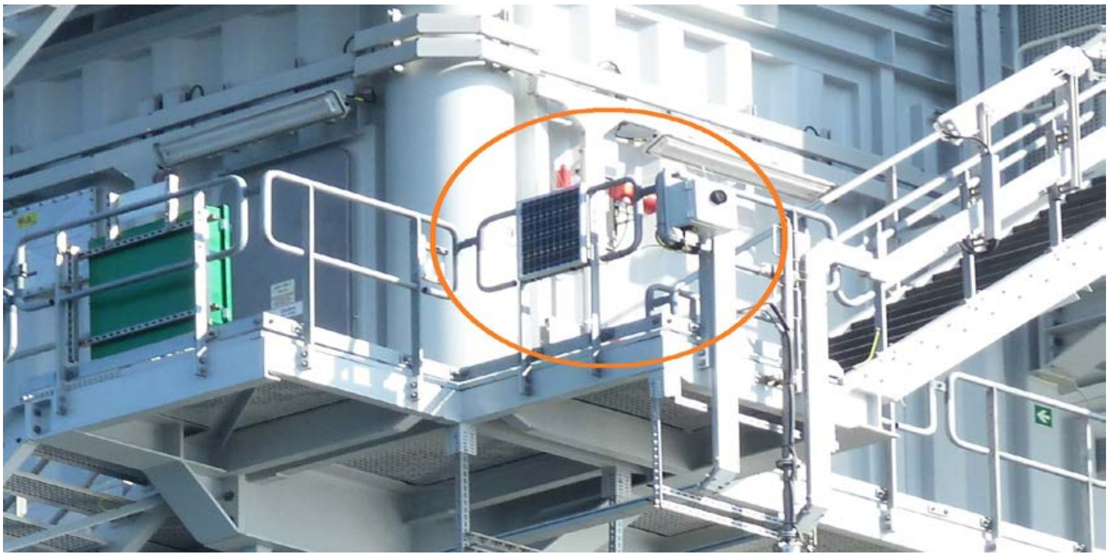


Figure 3: The recorder at the OHVS of PAWP (Photo: Renzo Schildmeijer).

Details on the locations of the recorders are given in Table 1.

Table 1: Monitoring locations.

Monitoring location	Geographical location (WGS 84)	Distance to shore [km]	Approximate height above sea level [m]	Direction of microphone
LUD – OHVS	N 52.40, E 4.17	23	15	East
PAWP – OHVS	N 52.59, E 4.24	25	15	East

2.2 Equipment

Bat activity was monitored with a Batcorder 3.0 (EcoObs GmbH); an automated ultrasonic recorder that is able to record sounds in the range of 16-150 kHz. The recorders do not record continuously but only after being triggered by a batcall, or batcall-like ultrasonic sound. Sounds are recorded at a maximum distance of 15 - 50 meters from the recorder, depending on their specific sonar characteristics, the actual environmental conditions, and the recorder settings (Barataud 2015).

The threshold amplitude was set to -36 dB in order to gain microphone sensitivity (default setting is -24 dB). For all other parameters the default settings of the recorder were used: post-trigger 400 ms, threshold frequency 16 kHz and recording quality 20.

Every morning when the recorder automatically switches off, it sends a status message via SMS, consisting of:

- Identifier of the bat detector
- Free memory on the SDHC-card
- Total number of recordings
- Number of recordings previous night
- Microphone-signal-level: TSL [%]
- Warning messages, such as *low battery*, *memory card (almost) full*, *read or write error memory card*.

The recorder is replaced during the monitoring season when the capacity of memory card has reached its limits, low TSL levels or other technical issues. Table 2 shows the different monitoring periods per recorder, including the time on and time off (Coordinated Universal Time: UTC).

Table 2: Monitoring period per recorder

Location	Serial number recorder	Start monitoring period	End monitoring period	Time on	Time off
LUD	566	15.02.2015 12:00:00	02.10.2015 12:00:00	16:00	7:30
	381	02.10.2015 12:00:00	09.10.2015 08:46:18	6:45	6:30
PAWP	563	23.03.2015 12:00:00	28.03.2015 09:46:07	6:45	6:30
	560	02.04.2015 12:00:00	21.08.2015 12:00:00	6:45	6:30
	559	21.08.2015 12:00:00	20.10.2015 12:00:00	6:45	6:30

2.3 Sound analysis

Echolocating bats emit ultrasonic pulses to gain information about their environment. Ultrasonic sound however is also produced by offshore structures. All sound files were recorded real-time onto a Secure Digital (SD) memory card. The recorded sound files that contained bat calls, were separated from the noise files by BcAdmin 3.4 (EcoObs GmbH), and individual bat call recordings were analysed and identified using the automated identification software Batident 1.5 (EcoObs GmbH). All identifications were checked manually and evaluated using the criteria provided by Skiba (2009) and Barataud (2015).

2.4 Data analysis

For the analysis of the data we used the date and time (UTC) of each call sequence. Since bats are nocturnal it makes more sense to analyse its occurrence per night instead of per calendar day. Therefore we shifted the date limits with 12 hours for the analysis of the data; e.g. 14 April runs from 14 April 12:00 (UTC) until 15 April 12:00 (UTC).

In previous monitoring reports (Jonge Poerink *et al.* 2013, Lagerveld *et al*. 2014a) we used the number of call sequences as an indicator of the bat activity. Differences in behaviour however (e.g. foraging versus passing by) may result in huge differences in the number of recorded call sequences, which do not reflect the relative abundance of bats. An alternative indicator of bat activity which limits (but does not solve) this issue, is the presence in a certain time frame, or the ratio between the presence and absence. In this study we use the number of 10 min intervals in which bats have been present as indicator of bat activity (for each species), just like the 2014 monitoring study (Lagerveld *et al.* 2015). For completeness, we have included the graphs with the recorded call sequences as well (Appendix A).

We obtained weather data from the KNMI stations PB-11B offshore (N 52.37 E 3.35), 80 km west of Zandvoort aan Zee, and at Valkenburg Airport (N 52.18 E 4.42), 3 km inland from Katwijk aan Zee. In this study only the wind speed was used, which was averaged per night (from sunset to sunrise).

3 Results

3.1 Performance of the equipment

Figure 4 shows the TSL value, an indicator of the microphone performance, of the recorders at PAWP and LUD. At PAWP, the monitoring period was interrupted from 29 March until 2 April 2015 due to a SD-card error.

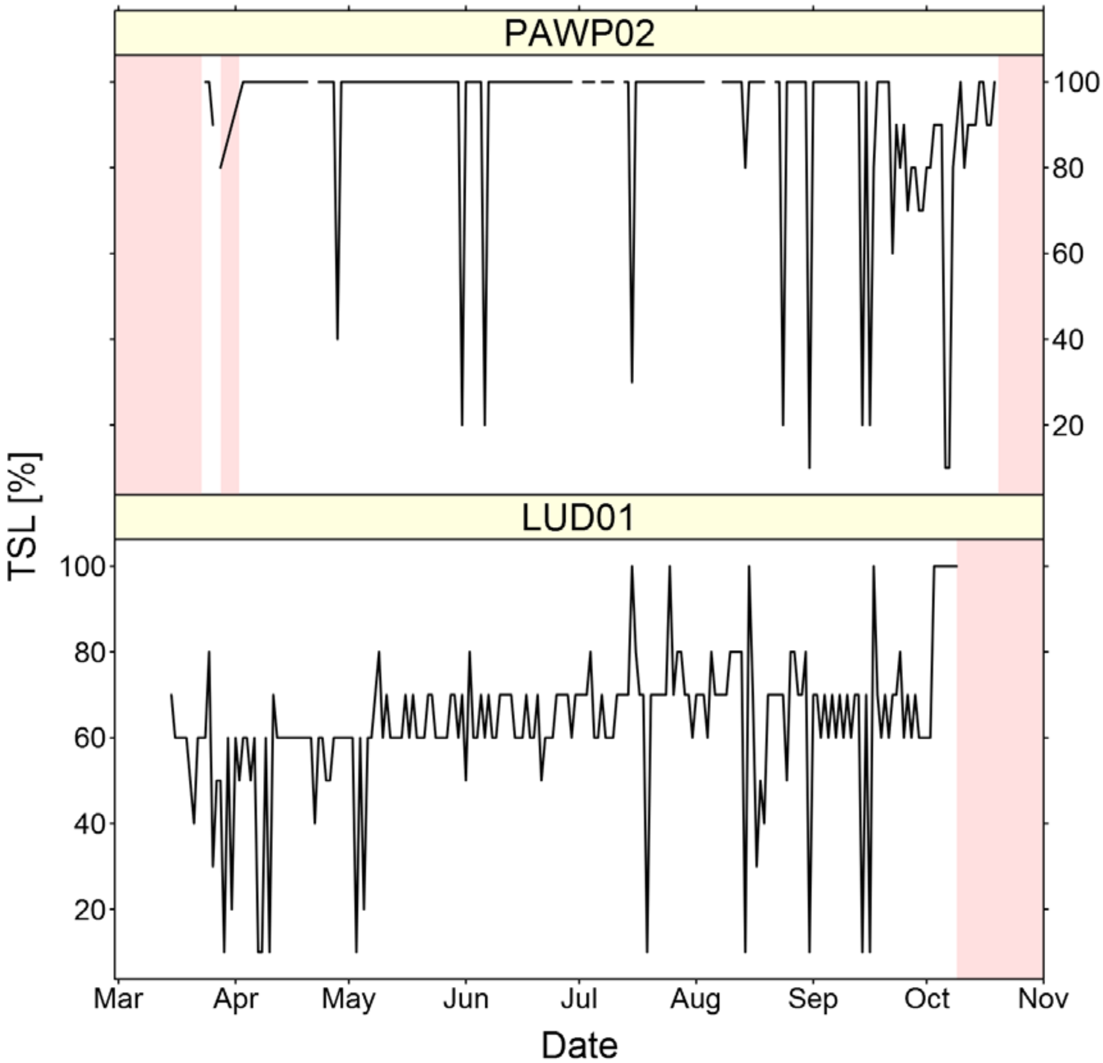


Figure 4: TSL value of the microphone at the monitoring locations PAWP (above) and LUD (below). X-axis label indicates beginning of the month.

As mentioned before, bat detectors do not exclusively record bat sounds but also bat-like sounds. In general, ultrasonic sounds can also be produced by vibrations in (offshore) structures or passing rotor blades, and this so-called 'noise' is recorded as well. Table 3 shows the total number of noise files per location and the average number per day.

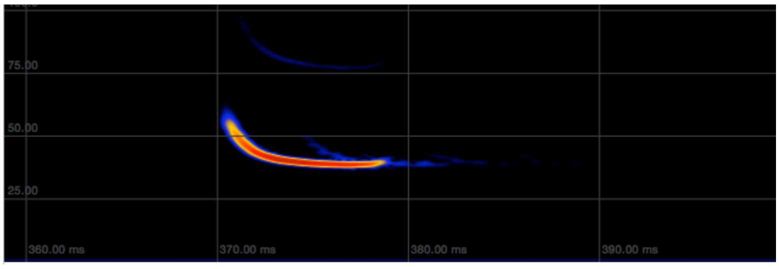
Table 3: Recorded noise files per location.

Monitoring location	Number of noise files	Number of monitoring days	Average number of noise files per day
LUD	6389	220	29
PAWP	7918	205	39

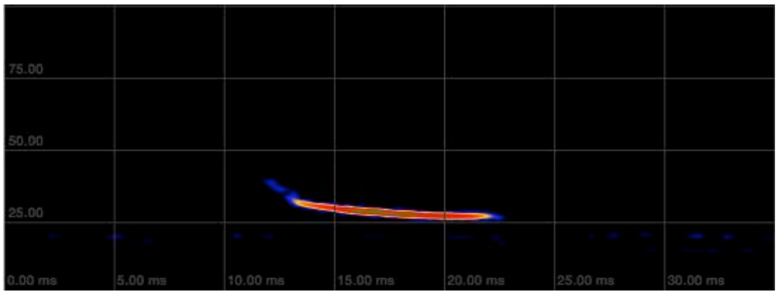
3.2 Bat activity

3.2.1 Species composition

Two species (groups) were recorded of which Nathusius' pipistrelle (*Pipistrellus nathusii*) could be identified to species level. In addition, we recorded the species group 'Nycaloid', which includes the genera Nyctalus, Vespertilio, and Eptesicus. Nathusius' pipistrelle was recorded in 14 (10-minute) intervals and Nyctaloids in 3. Examples of spectrograms are shown in Figure 5.



Nathusius' pipistrelle
29-08-2015
LUD



Nyctaloid
5-06-2015
LUD

Figure 5: Examples of spectrograms of Nathusius' pipistrelle and 'Nyctaloid' calls.

3.2.2 Temporal occurrence

Figures 6 and 7 show the observed bat activity at PAWP from March to June 2015 and from July to October 2015 respectively. At this location only Nathusius' pipistrelle was recorded. There were no observations in spring, two observations in late June, and six in autumn.

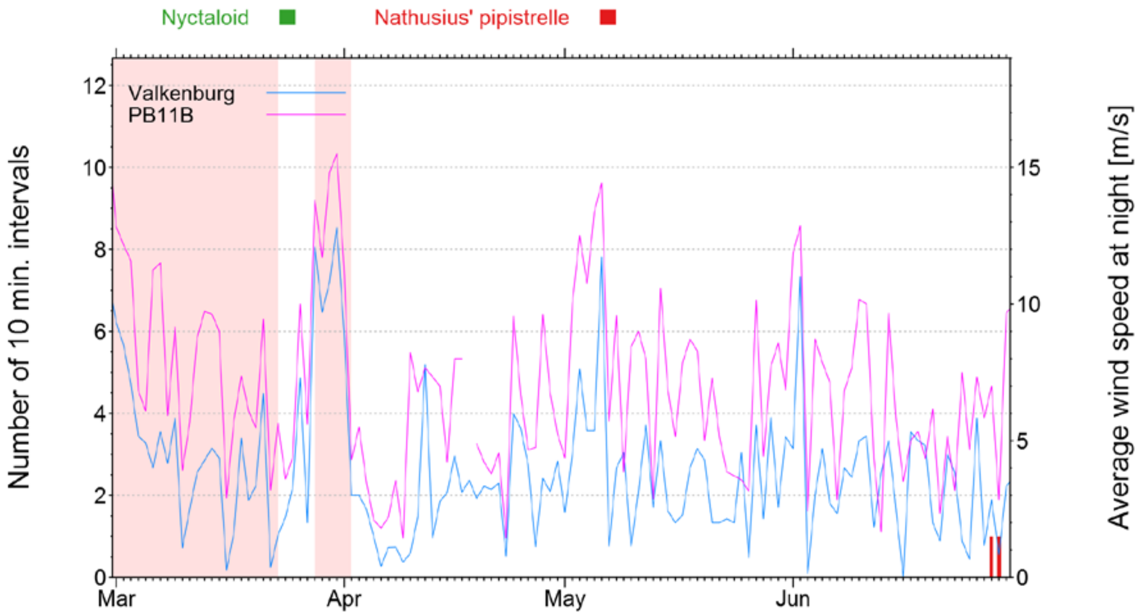


Figure 6: The number of 10-minute intervals per species per night at PAWP (March – June), including the average wind speed per night (from sunset to sunrise) at Valkenburg Airport and offshore weather station PB11B. The actual monitoring period is indicated by a white background. X-axis label indicates beginning of the month.

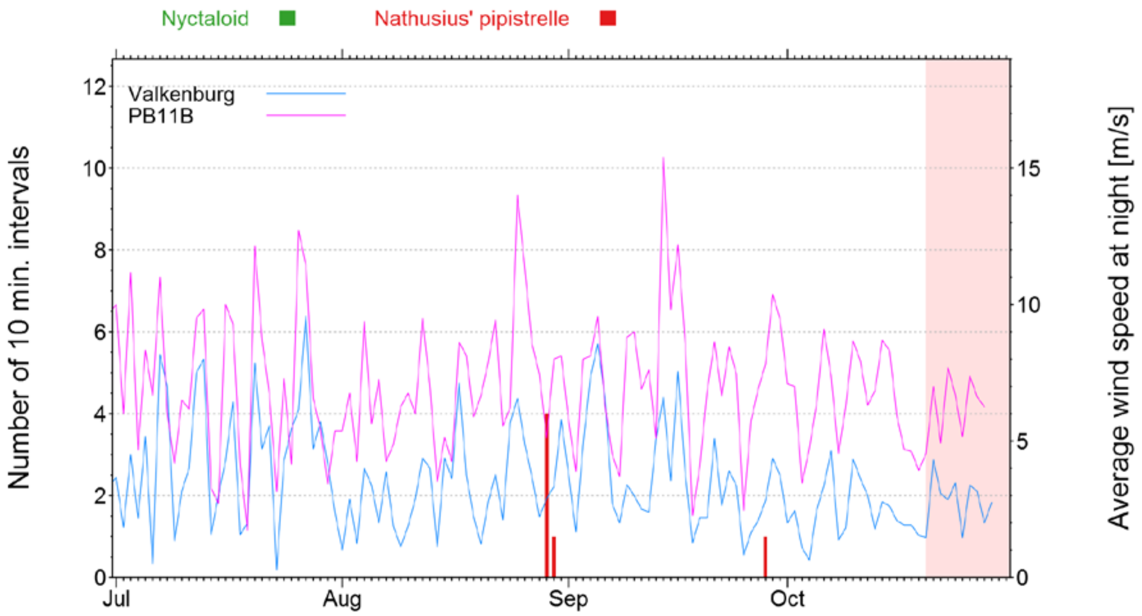


Figure 7: The number of 10-minute intervals per species per night at PAWP (July – October), including the average wind speed per night (from sunset to sunrise) at Valkenburg Airport and offshore weather station PB11B. The actual monitoring period is indicated by a white background. X-axis label indicates beginning of the month.

In Figures 8 and 9, the observed bat activity at LUD is shown from March to June 2015 and from July to October 2015 respectively. Also here, no bats were observed in spring. There were two records of Nyctaloids in June and another one in late August. Nathusius' pipistrelle was only observed in autumn.

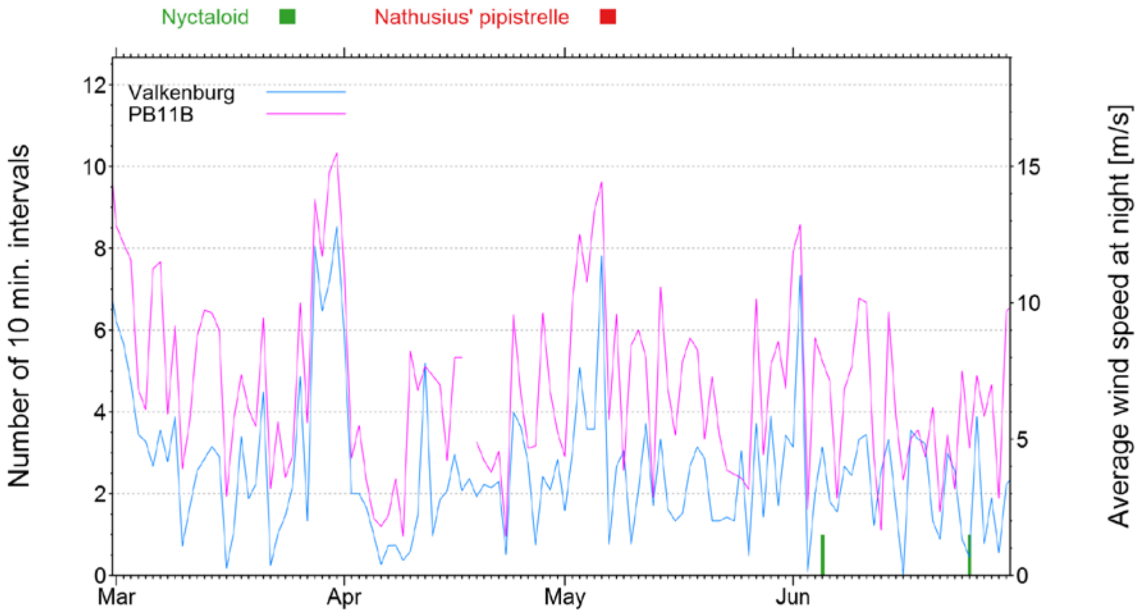


Figure 8: The number of 10-minute intervals per species per night at LUD (March – June), including the average wind speed per night (from sunset to sunrise) at Valkenburg Airport and offshore weather station PB11B. The actual monitoring period is indicated by a white background. X-axis label indicates beginning of the month.

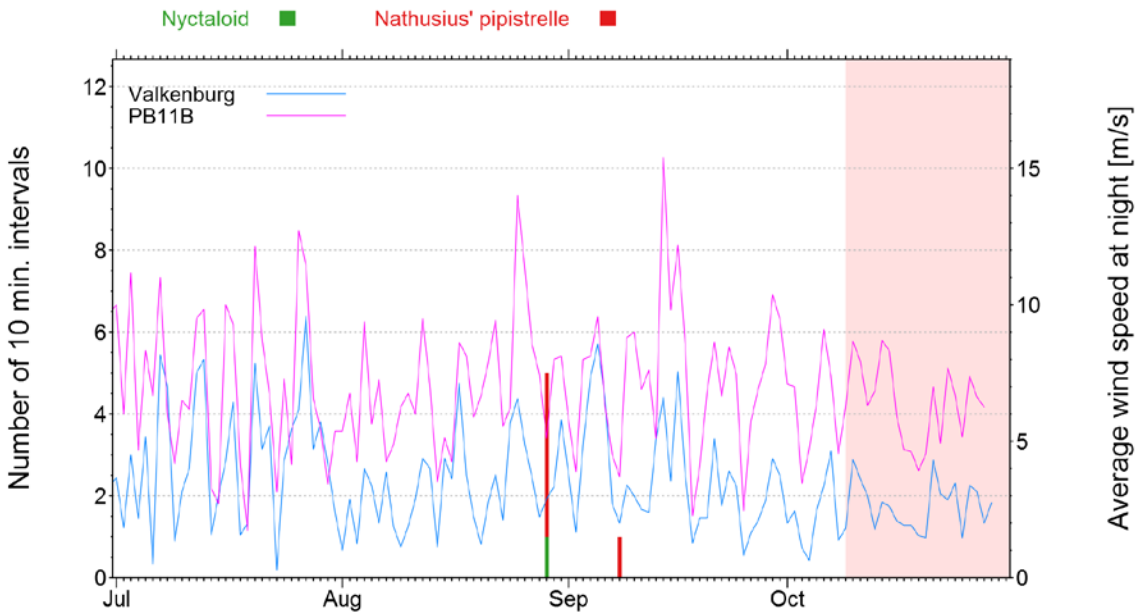


Figure 9: The number of 10-minute intervals per species per night at LUD (July – October), including the average wind speed per night (from sunset to sunrise) at Valkenburg Airport and offshore weather station PB11B. The actual monitoring period is indicated by a white background. X-axis label indicates beginning of the month.

Figures 10 and 11 show the temporal occurrence throughout the night at the monitoring locations. At PAWP Nathusius' pipistrelle was recorded early in the morning, just after sunrise, on 29 June 2015 and again in the evening around sunset. In autumn most activity occurred between 2-4 hours after sunset.

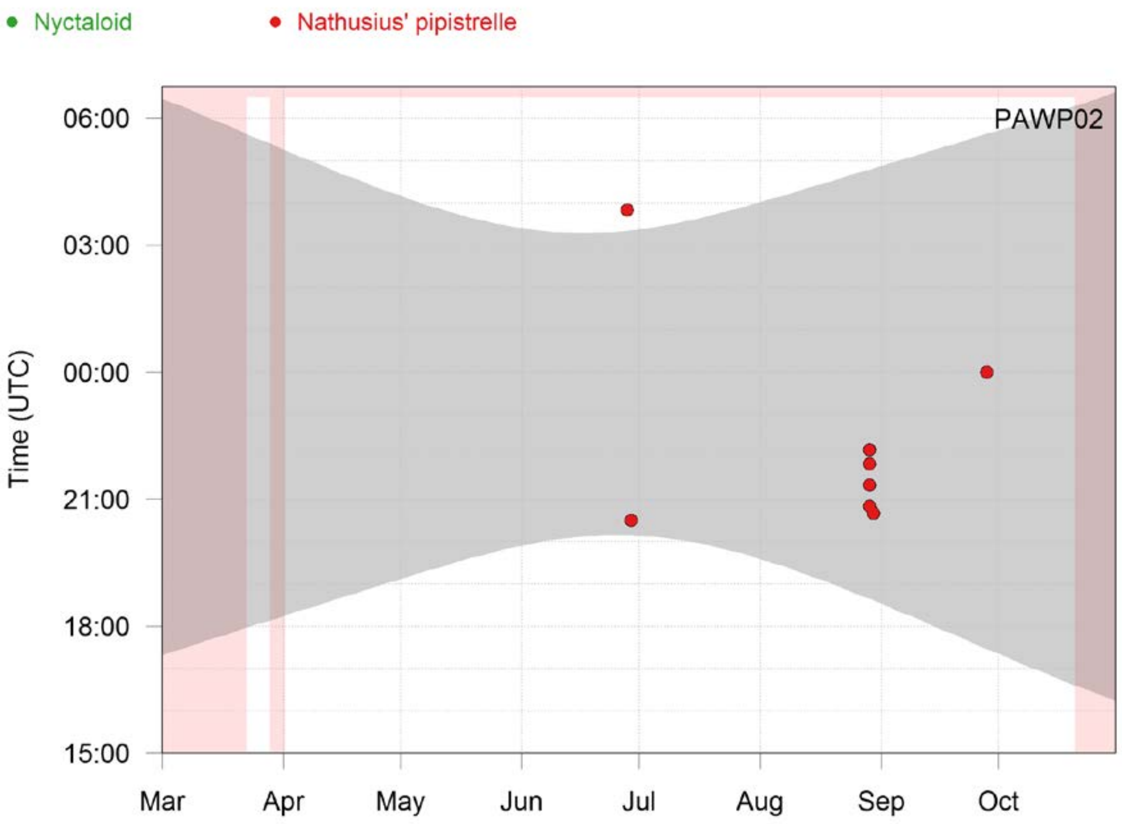


Figure 10: Timing of occurrence (10-minute intervals) during the night (grey) at PAWP. The actual monitoring period is indicated by a white background. X-axis label indicates beginning of the month.

At LUD a Nyctaloid was recorded in early June, 45 min after sunset; the other records of Nyctaloids occurred approximately 3 hours after sunset. Nathusius' pipistrelle was only recorded in autumn, and all activity occurred between 3-6 hours after sunset.

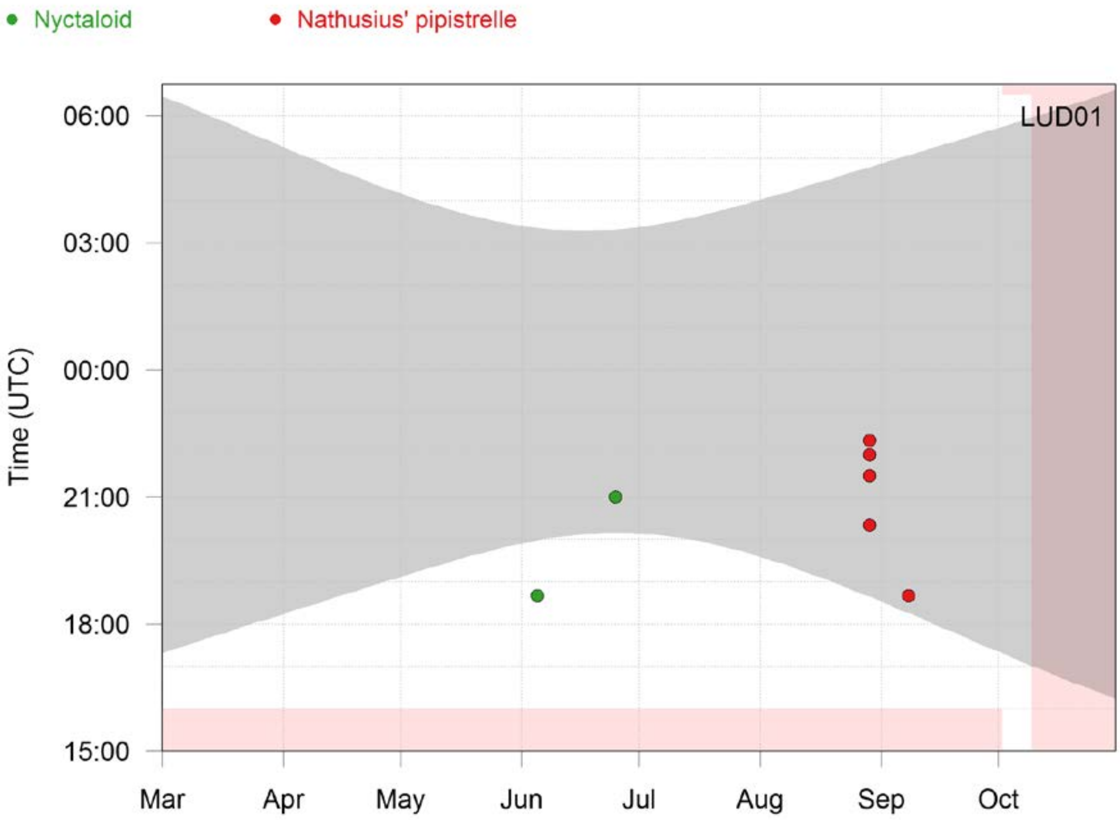


Figure 11: Timing of occurrence (10-minute intervals) during the night (grey) at LUD. The actual monitoring period is indicated by a white background. X-axis label indicates beginning of the month.

3.2.2 Spatial occurrence of Nathusius' pipistrelle and wind speed

Nathusius' pipistrelle was the most commonly recorded species (in 82% of all 10-minute intervals, n = 14). Figures 12 and 13 show its occurrence during the season at PAWP and LUD. In autumn, the offshore occurrence of bats at both locations exhibits a strong similarity.

The occurrence of Nathusius' pipistrelle seems to be associated with the wind speed. During this study all recordings occurred during nights with an average wind speed as measured (land-based) at Airport Valkenburg of well below 5 m/s. When referring to the (sea-based) weather station PB11-B, most offshore bat activity also occurs during nights with an average wind speed of less than 5 m/s, although on some occasions during this study bat activity has been recorded at wind speeds of up to 8 m/s.

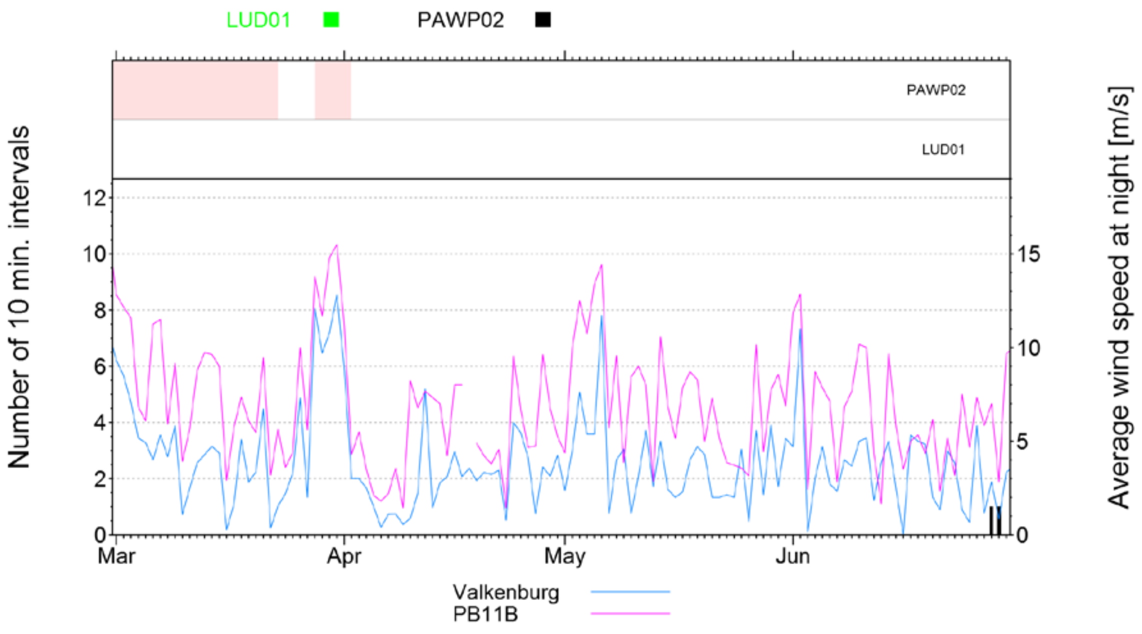


Figure 12: The number of 10-minute intervals per night of Nathusius' pipistrelle at PAWP and LUD (March – June 2015), including the average wind speed per night (from sunset to sunrise) at Valkenburg Airport and offshore weather station PB11B. The actual monitoring periods at LUD and PAWP are indicated by at the top of the graph (pink = no monitoring). X-axis label indicates beginning of the month.

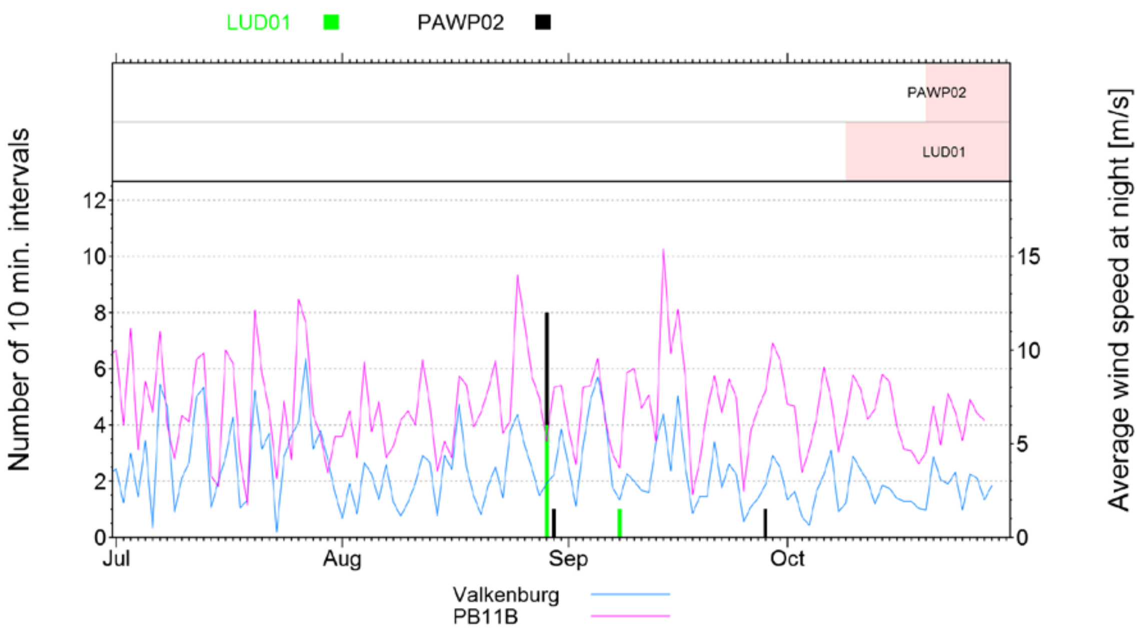


Figure 13: The number of 10-min intervals per night of Nathusius' pipistrelle at , PAWP and LUD (July – October), including the average wind speed per night (from sunset to sunrise) at Valkenburg Airport and offshore weather station PB11B. The actual monitoring periods at LUD and PAWP are indicated at the top of the graph (pink = no monitoring). X-axis label indicates beginning of the month.

4 Discussion

4.1 Performance of the equipment

One SD-card error occurred early in the spring migration season at PAWP. In this period (29 March until 2 April 2015) bats may have been missed.

During the monitoring, the microphone of a bat detector may lose its sensitivity, in particular when it is exposed to humidity or frost. To follow this, every time when a Batcorder (EcoObs Gmbh) is switched off, the microphone sensitivity level (TSL) is determined by comparing a test signal with a calibrated reference value. The TSL, however, should not be considered as an absolute performance indicator. Values that are considerable lower than 100%, frequently occur as well as strong fluctuations (e.g. caused by fog or rain). TSL values below 30%, and occasionally below 10%, can be considered normal. Only when the TSL drops to values between 0-10% during several days, the microphone requires replacement (EcoObs GmbH).

In this study, prolonged periods with TSL levels between 0-10% did not occur. Therefore we can assume that the recorders performed properly during the monitoring periods.

Besides bat calls, we also recorded ultrasonic noise (which is normal when monitoring bat activity with passive acoustic detectors) that might mask bat calls. The average number of noise files per day at PAWP was 39, which is higher than in 2014 when the daily average was 17 (Lagerveld *et al.* 2015), but much lower than the average per day in 2013 (1156) when the bat recorder was installed at an offshore wind turbine (Lagerveld *et al.* 2014a). At LUD on average 29 noise files were recorded per day.

4.2 Bat activity

With the current knowledge and techniques it is impossible to estimate the actual number of bats based on sound recordings. Ahlén *et al.* (2007, 2009) observed that migrating bats often interrupt their flight to forage around offshore wind turbines because of the accumulation of flying insects. When foraging, an individual bat may stay in the vicinity of the recorder for a prolonged period of time, resulting in a sequence of several 10-minute intervals. Because it can also happen that more than one bat is present at the same time (Lagerveld *et al.* 2014b), it is not possible to give an estimate of how many individual bats have been present in the vicinity of the recorders.

A recorder is detecting bat echolocation calls with a maximum distance of 15 – 50 meters from the microphone (Barataud 2015). The actual area surveyed is relatively small and it seems likely that the overall bat activity at sea must have been much higher. On the other hand, it seems also likely that the observed bat activity near the recorders is higher than at the open sea, because of the potentially perceived feeding opportunities near offshore structures (Ahlén *et al.* 2007 & 2009). At present, it is not known how the presence of bats near offshore structures can be extrapolated to larger areas.

In previous monitoring studies, bat activity at sea (and at the coast) was strongly linked with the wind speed. Most bat activity was observed during nights with wind speeds of less than 5 m/s and occasionally of up to 10 m/s. This matches the observed pattern of this study and reconfirms that our observations do not refer to individuals blown off-shore by strong winds.

There was considerably less bat activity at PAWP as compared to the 2014 monitoring results. The number of 10-minute intervals in which Nathusius' pipistrelle was recorded at PAWP in autumn was 50 in 2014 and 6 in 2015 (a decrease of 88%). The activity in 2012 and 2013 (respectively 14 and 25) was higher than in 2015 but lower than in 2014 (Jonge Poerink *et al.* 2013, Lagerveld *et al.* 2014a). Note however that in 2012 and 2013 monitoring was done at a different location (an offshore wind turbine) and the 2012 monitoring period was restricted from 4 until 23 September.

In 2015 Nathusius' pipistrelle was recorded twice late June; once early morning just after sunrise, one again in the evening around sunset. It seems likely that this concerned the same individual who roosted during the daylight hours at or near the PAWP transformer station. At LUD bats were also rarely recorded; Nathusius' pipistrelle during 6 time intervals and Nyctaloids during 3 time intervals.

The occurrence of bats at the offshore monitoring locations LUD and PAWP occurred mainly in autumn from late August until late September. This is consistent with the monitoring results of previous years. There were a few recordings during the summer months and none was observed in spring.

5 Conclusions

During this study we recorded considerably less bat activity at PAWP as compared to the 2014 monitoring season (a decrease of 88%). Bat activity at LUD was comparable to that at PAWP.
Bats were mainly recorded from late August until late September, and on a few occasions in June. None were observed in spring.

Our observations in 2012, 2013, 2014, and 2015 combined with findings of stranded individuals on oil rigs and ships (Boshamer and Bekker 2008) and sightings during coastal migration counts and surveys at sea (Lagerveld *et al.* 2014b) indicate that bats regularly fly over the North Sea. In particular from late August until late September during nights with calm weather (wind speeds usually well below 5 m/s, occasionally up to 10 m/s). It seems unlikely that the observed bat activity was caused by individuals that were blown off-course by storms.

Nathusius' pipistrelle is the most common recorded species at sea during consecutive monitoring years. 'Nyctaloids' (including Noctule and probable Particoloured Bat) have also been observed with some regularity. Common pipistrelle has been recorded occasionally in previous monitoring years.

The observed species-specific patterns of occurrence indicate that most offshore bat activity is caused by migratory bats.

6 Quality Assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 124296-2012-AQ-NLD-RvA). This certificate is valid until 15 December 2015. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Fish Division has NEN-EN-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 1th of April 2017 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

References

Ahlén I., Bach L., Baagøe H.J. & Pettersson J. 2007. Bats and offshore wind turbines studied in Southern Scandinavia. Swedish EPA, Report 5571, Stockholm.

Ahlén I., Baagøe H.J. & Bach L. 2009. Behavior of Scandinavian bats during migration and foraging at sea. Journal of Mammalogy 90: 1318–1323.

Barataud M. 2015. Acoustic Ecology of European Bats. Species identification, habitat studies and foraging behaviour. Biotope - National Museum of Natural History, Paris.

Boshamer J.P.C. and 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.

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.

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

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

Lagerveld S., Jonge Poerink B, de Vries P. 2015. Monitoring Bat activity at the Dutch EEZ in 2014. IMARES Report C094/15.

Skiba R. 2009. Europäische Fledermäuse. Westarp Wissenschaften, Hohenwarsleben.

Walter G., Matthes H. and Joost M. 2007. Fledermauszug über Nord- und Ostsee — Ergebnisse aus Offshore-Untersuchungen und deren Einordnung in das bisher bekannte Bild zum Zuggesschehen. Nyctalus (N.F.), 12.

Justification

Rapport number: C001/2016
Project number: 431.51000.08

The scientific quality of this report has been peer reviewed by the a colleague scientist and the head of the department of IMARES.

Approved: S.C.V. Geelhoed
Researcher

Signature:

Date: 13th of January 2016

Approved: F. Groenendijk
Head of the Maritime Department

Signature:

Date: 13th of January 2016

Appendix A. Bat activity presented as number of recorded call sequences

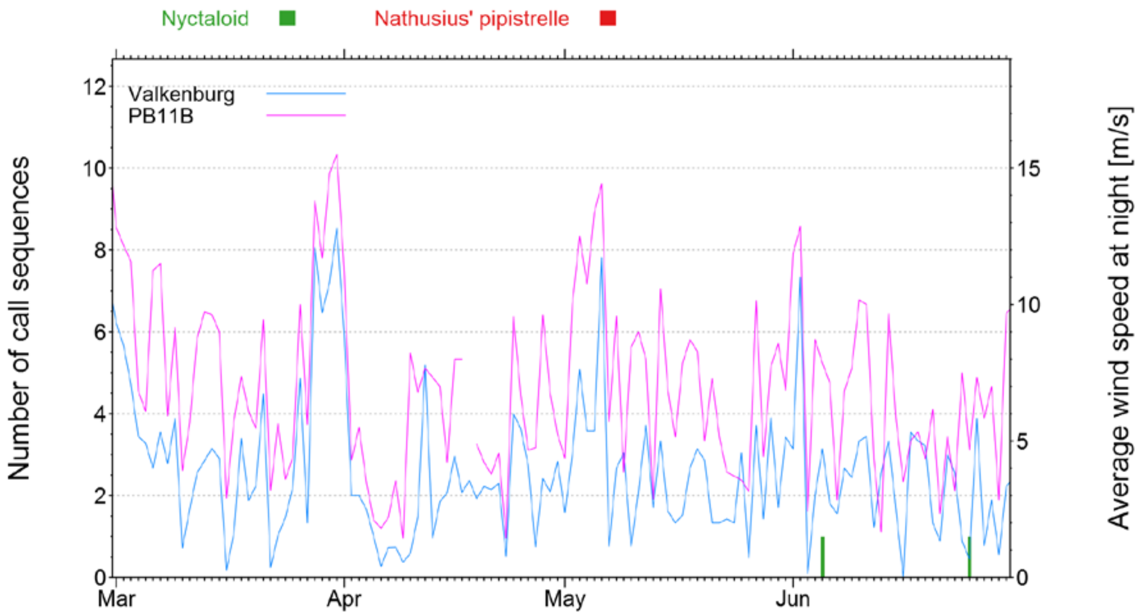


Figure A1: The number of recorded call sequences per species per night at LUD (March – June), including the average wind speed per night (from sunset to sunrise) at Valkenburg Airport and offshore weather station PB11B. The actual monitoring period is indicated by a white background.

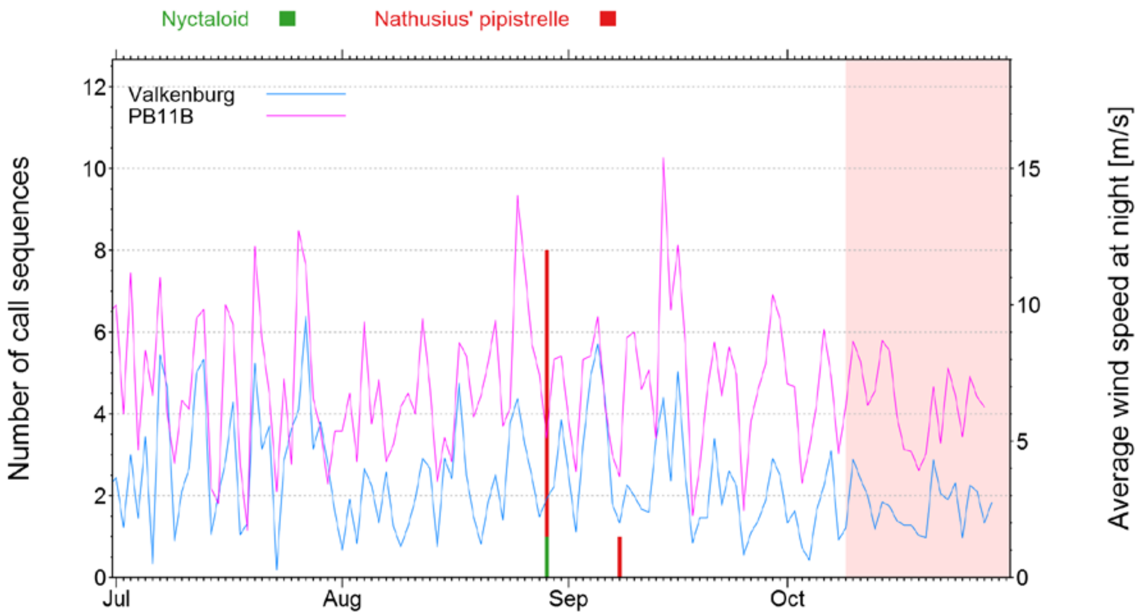


Figure A2: The number of recorded call sequences per species per night at LUD (July – October), including the average wind speed per night (from sunset to sunrise) at Valkenburg Airport and offshore weather station PB11B. The actual monitoring period is indicated by a white background.

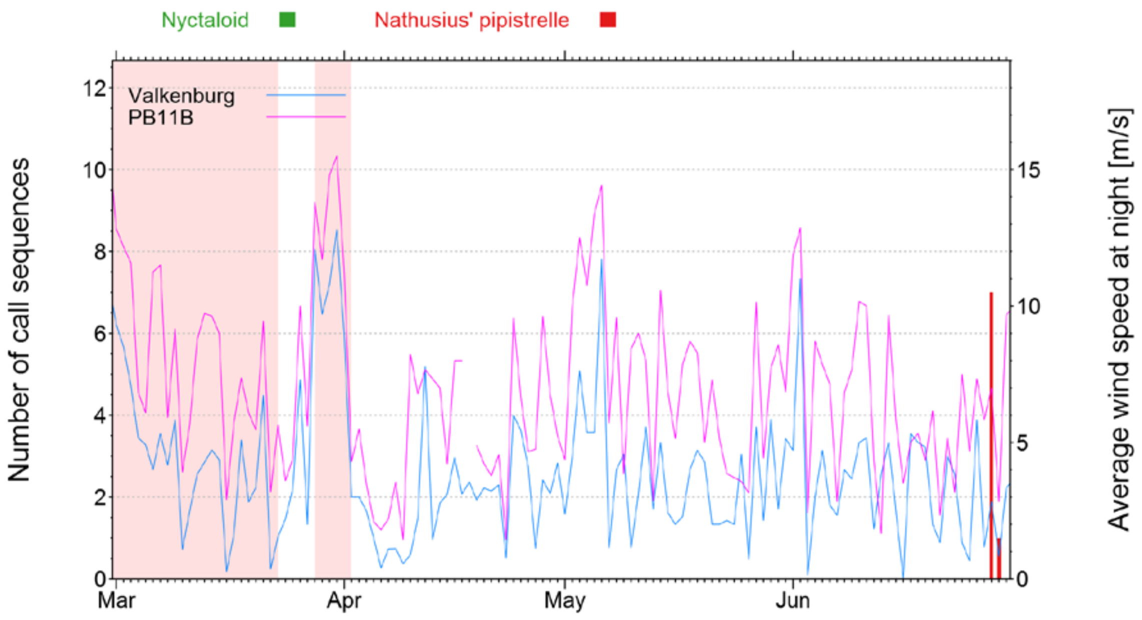


Figure A3: The number of recorded call sequences per species per night at PAWP (March – June), including the average wind speed per night (from sunset to sunrise) at Valkenburg Airport and offshore weather station PB11B. Note that the actual monitoring period is indicated by a white background.

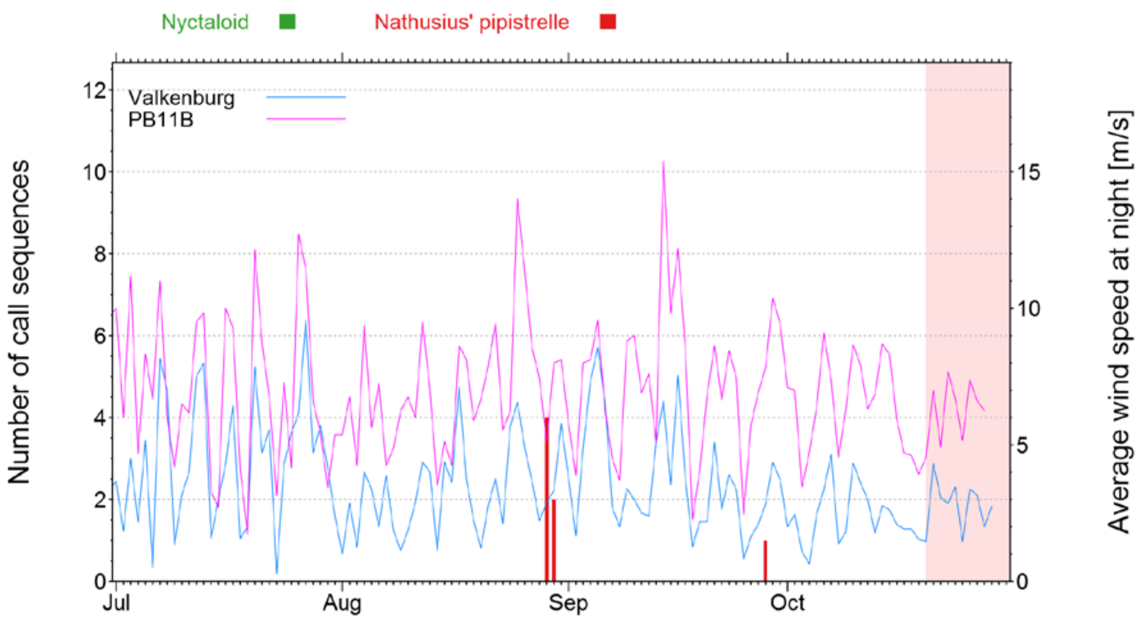


Figure A4: The number of recorded call sequences per species per night at PAWP (July - October), including the average wind speed per night (from sunset to sunrise) at Valkenburg Airport and offshore weather station PB11B. Note that the actual monitoring period is indicated by a white background.