

Pilot study Bat activity in the dutch offshore wind farm OWEZ and PAWP

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CONTENTS

1. INTRODUCTION	4
2. METHODS	6
2.1 STUDY AREA	6
2.2 EQUIPMENT.....	7
2.3 DATA MANAGEMENT AND INTERPRETATION	9
3. RESULTS	11
3.1 OWEZ	11
3.2 PAWP	13
3.3 TEMPORAL ACTIVITY.....	14
3.4 MIGRATION AND FORAGING RATES	14
3.5 BAT ACTIVITY AND WEATHER CONDITIONS.....	16
4. DISCUSSION	17
5. CONCLUSIONS	18
6. RECOMMENDATIONS FOR FUTURE RESEARCH	19
7. ACKNOWLEDGEMENTS	20
8. REFERENCES	21
9. JUSTIFICATION	22

1. INTRODUCTION

Various species of bats in northern Europe show seasonal migrations between their breeding areas and winter quarters. Most of them travel only short distances, up to a few hundred kilometre per season. Some species however, like Nathusius' pipistrelle *Pipistrellus nathusii*, Noctule *Nyctalus noctula* and Particoloured bat *Vespertilio murinus*, are long distance migrants, travelling up to 2000 kilometres from Scandinavia and eastern Europe to the more temperate zone of western Europe and vice versa.



Photo.1 Nathusius' pipistrelle *Pipistrellus nathusii* (photo: Klaus Bogon)

A study in southern Sweden (Ahlen, 2007) revealed that migrating bats regularly forage around the offshore wind turbines because of the accumulation of flying insects. In addition, non-migratory bats used the wind farms as a foraging area.

In the past decades there have been several records of bats found on oil platforms in the Southern North Sea (Bekker & Boshamer, 2008, Russ (2000), Skiba (2007) Walter (2007)) and some offshore sightings of bats during bird surveys at sea (personal observation SL & HV). The presence of bats in the Southern North Sea however has never been investigated systematically. Therefore it is not known if these records refer to regular migrants, stragglers who got lost or blown off course during migration, or even animals that use the North Sea as a foraging area. If and how offshore wind farms in the North Sea are used by bats is a relevant question for policy makers and wind farm developers, considering that the number of offshore wind farms in the North Sea will be increasing and that several (onshore) studies have shown that wind turbines can cause high fatality rates amongst bats. For all wind farms in Germany combined Voigt (2012) estimated approximately 200.000 bat fatalities each year.

The Fieldwork Company and IMARES Wageningen UR have joined forces to carry out a pilot study on bat activity in wind farms in the Dutch part of the North Sea. NUON and ENECO contributed by giving their permission and cooperation to install ultrasonic recorders in their offshore wind farms 'Offshore Wind farm Egmond aan Zee (OWEZ)' and 'Prinses Amalia Windpark (PAWP)'.

The main objective of this pilot study is to assess whether bats are present in the two Dutch offshore wind farms, as well as to assess the feasibility of ultrasonic bat recorders under offshore circumstances on the North Sea. An additional objective was to see whether indications for bat migration could be found in the recorded data.

2. METHODS

2.1 Study area

This study was conducted in two wind farms in the Dutch part of the North Sea:

- Offshore Wind Farm Egmond aan Zee (OWEZ)
- Princess Amalia Windpark (PAWP)

The positions of both wind farms are shown in figure 1. OWEZ lies approximately 15 km off the coast, PAWP approximately 23 km.

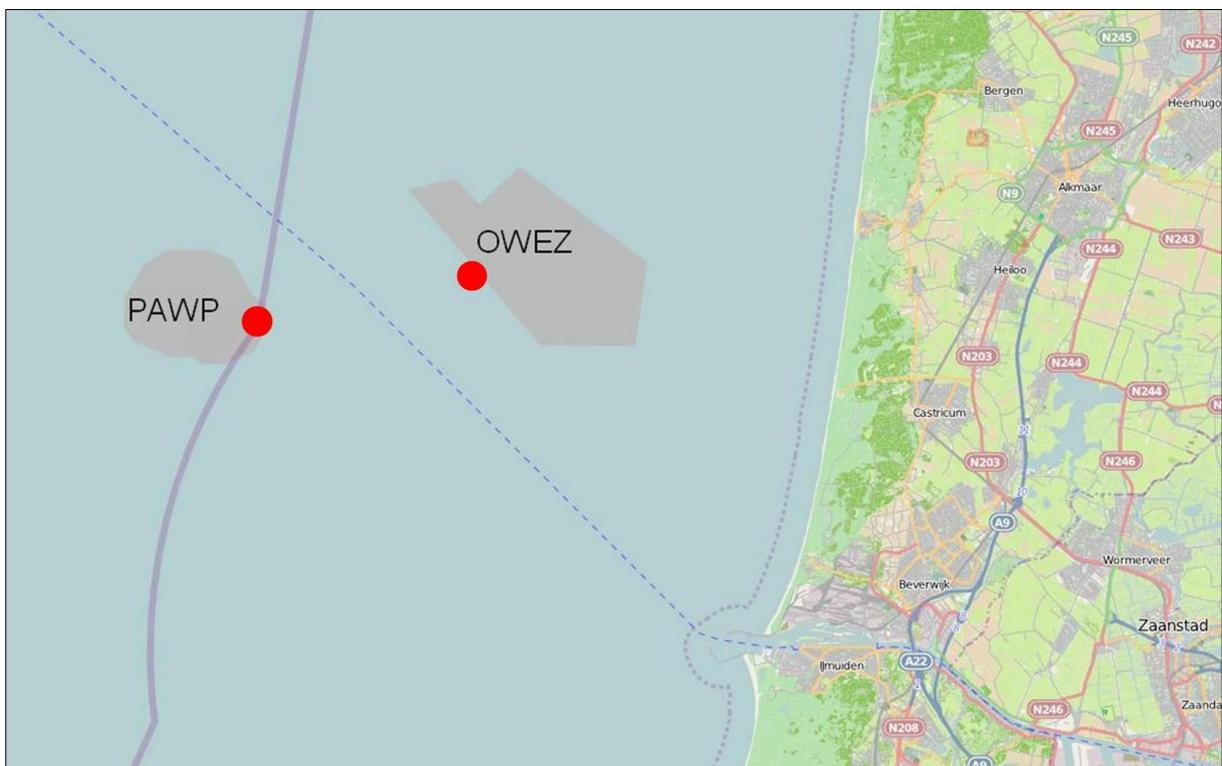


Figure 1 Geographical positions of the OWEZ and PAWP wind farms, and the position of the recorders

2.2 Equipment

The monitoring was carried out with the so-called Batcorder, a device for automated recording of ultrasonic bat sounds. The technical specifications of the Batcorder system are summarised in table 1.

Table 1. *Technical specifications of the Batcorder*

Batcorder technical specifications	
Type of recorder	Call triggered, automatic bat recorder
Type of recording	real-time
Sampling rate	500 kHz
Amplitude-resolution	16 bit
Sensitivity	16 - 150 kHz (ca. 32 dB loss at 150 kHz)
File type	RAW
Memory type	SDHC-card (max. 64GB)
type of microphone	Electret, power-supply 1,3 V
signal-to-noise ratio (SNR)	ca. 60 dB
Overall-gain calibrated	40 kHz @ 96 dB SPL = full gain

Although the Batcorder is a rugged system, a modification of the standard configuration was made to make it more suitable for use in offshore conditions. The Batcorder constantly scans the environment for ultrasonic bat calls in the range of 16-150 kHz. Depending on the bat species flying by, bats are recorded at a maximum distance of 15 to 50 meters from the recorder. The threshold frequency for recording was 15 kHz. The power supply for the Batcorder system consisted of a 12V battery connected to a solar panel. The microphone sensitivity level, battery condition, number of recorded files and remaining storage capacity were monitored remotely via a GSM unit.

At the OWEZ wind farm the recorder was attached to the OWEZ METEO mast (Photo 2). At PAWP a recorder was installed at a wind turbine entrance platform (Photo 3). Details on the positions of the recorders and the period of monitoring are given in table 2.

Table 2. *Positions and monitoring period of the ultrasonic recorder*

Wind Farm	Geographical Position recorder	Distance to shore [km]	Height [m] above sea level	Direction microphone	Recording period
OWEZ	52° 36' 22.9" N, 004° 23' 22.7" E	15	15	East	29 August – 20 October 2012
PAWP	52° 34' 15" N 004° 15' 60.3"E	23	15	East	4-23 September 2012



Photo.2 Ultrasonic recorder at the OWEZ wind farm METEO mast. (Photo: Hans Verdaat)



Photo.3 Ultrasonic recorder at the PAWP wind farm WTG 22. (Photo: Andrew Ford)

2.3 Data management and interpretation

Species identification

Bat sounds consist of sequences of individual sonar calls, so-called call sequences. Bats have species-specific calls. Therefore it is possible to identify bat species from their sound by measuring call shape parameters like frequency in a sonogram, a graphical representation of a call, and call sequence characteristics (time intervals, calls per second etc.).

All sound files (bat calls as well as ultrasonic noise) were recorded real time onto an SD card. With real time recordings, the original sonar call properties can be used for the assessment of the collected sound files. The recorded sound files containing bat calls were shifted automatically by

BcAdmin software. All single bat call recordings were analysed and identified using the automated identification software Batident. Uncertain call identifications were evaluated and identified additionally by interpreting bat call sequence characteristics. Detailed background information on bat calls and bat call analysis is given by Skiba (2009) and Russ (2012).

Weather data

The weather data recorded by the weather station on the OWEZ METEO mast during the recording period were used for the analysis. The weather data were logged at 10 minute intervals.

3. RESULTS

3.1 OWEZ

A total of 189 bat call sequences containing 1477 individual bat calls were recorded at OWEZ in the period from the 29th of August until the 20th of October 2012. Within this period bats were recorded during 9 nights. Relatively high bat activity was recorded during the nights from 3-4 September, 8-9 September, 22-23 September and 8-9 October (figure 2).

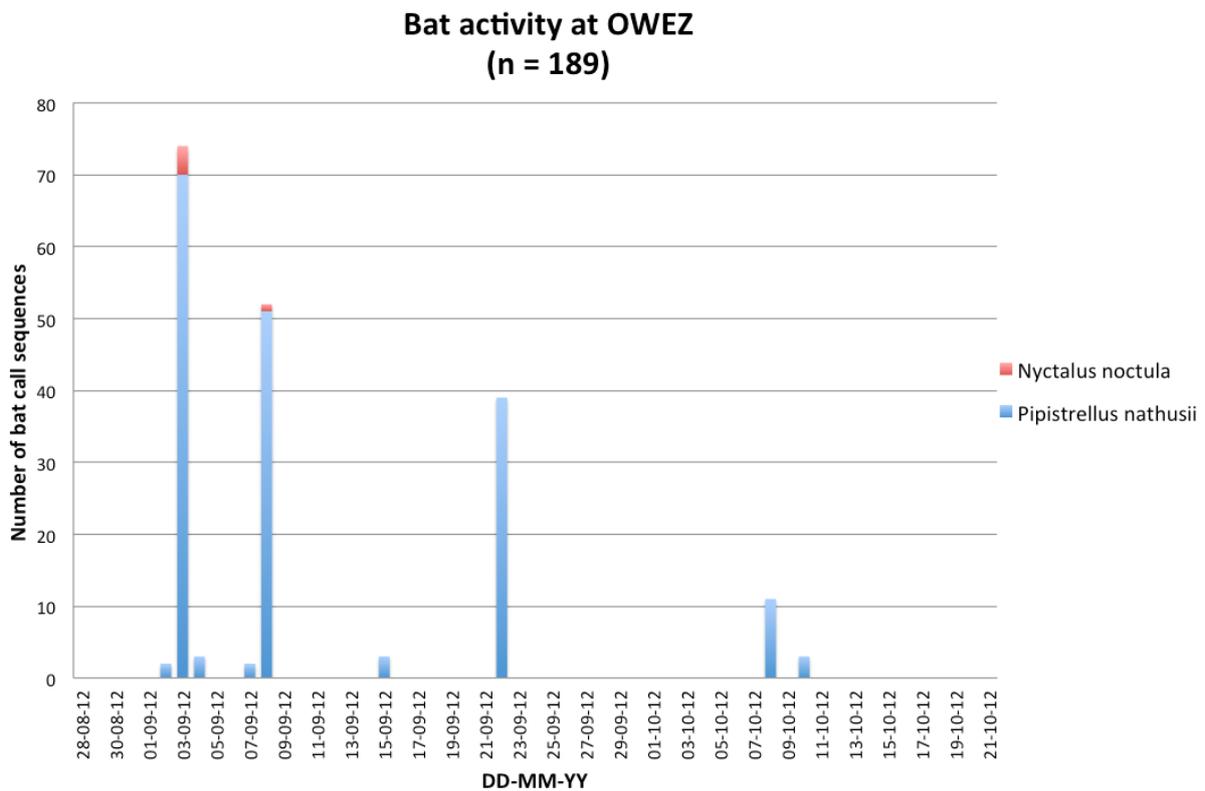


Figure 2 Bat activity at OWEZ 29 August - 20 October 2012 expressed as number of call sequences per night.

Two species of bats were recorded at OWEZ, the Nathusius' pipistrelle *Pipistrellus nathusii* and the Noctule *Nyctalus noctula*. Nathusius' pipistrelle calls represent 98% of all recordings from OWEZ, while Noctule calls represent only 2%. Noctules were recorded during the nights of 3-4 September and 8-9 September 2012.

Examples of sonograms of Nathusius' pipistrelle and Noctule, recorded at OWEZ, are shown in figures 3 and 4. For both species transit/migration calls and foraging calls were recorded.

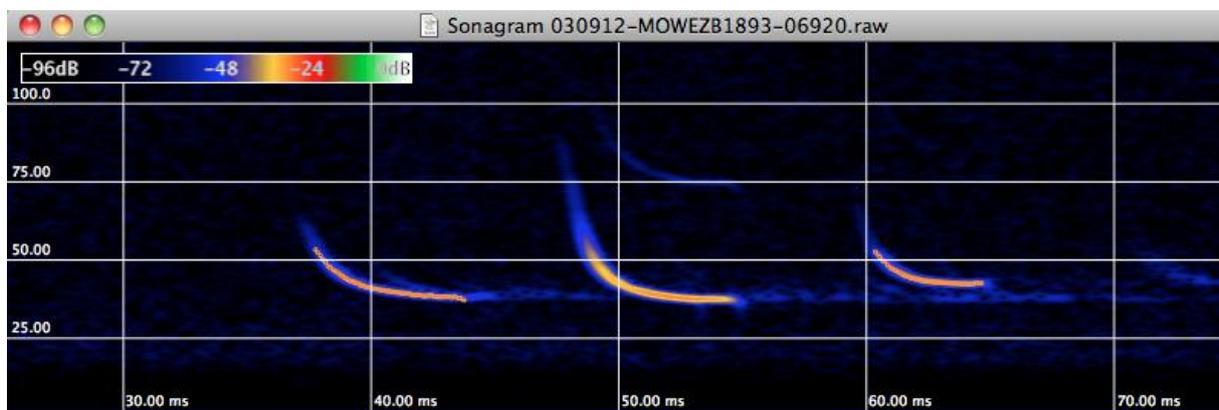
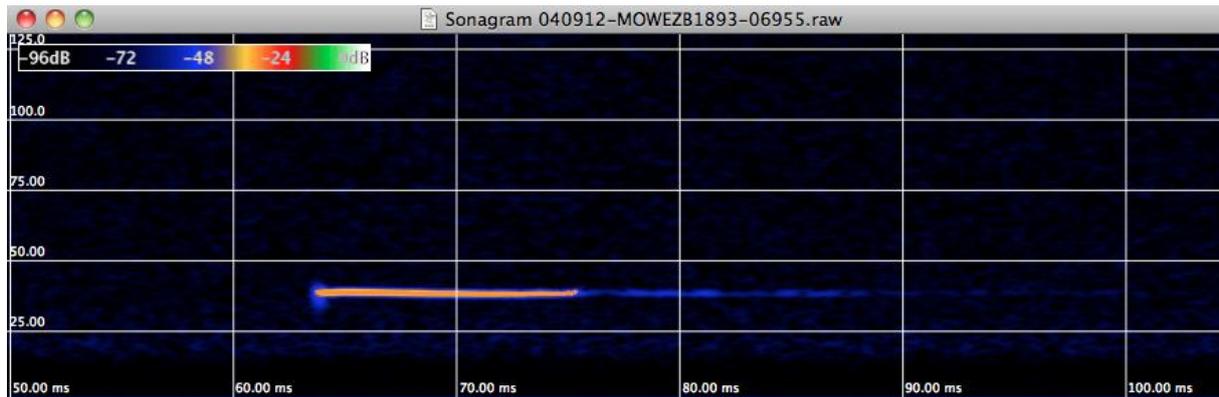


Figure 3 Sonograms of *Nathusius' pipistrelle* *Pipistrellus nathusius* recorded at OWEZ. (above: transit call, below: foraging calls). The transit call has a relatively constant frequency with a maximum frequency at 35 – 39 kHz. The frequency of the foraging calls is modulated ($F_{begin} \gg F_{end}$) with a maximum frequency above 40 kHz.

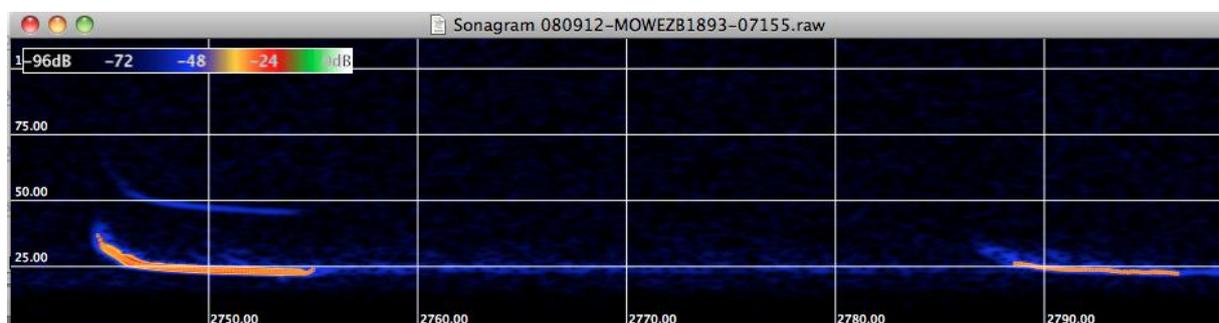
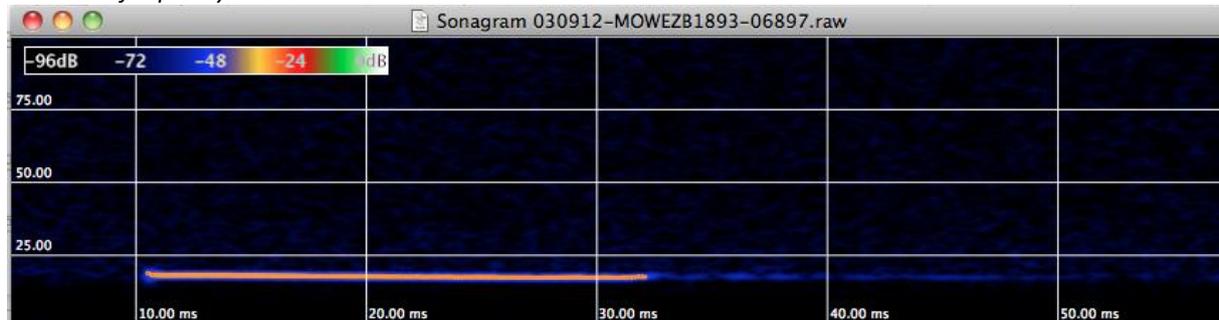


Figure 4 Sonograms of *Noctule* *Nyctalus noctula* recorded at OWEZ. (above: transit call, below: foraging calls). The transit call has a constant frequency with a maximum frequency (F_{max}) at 17 - 21 kHz. The frequency of the foraging call is quasi constant ($F_{begin} > F_{end}$) with a maximum frequency (F_{max}) above 21 kHz.

3.2 PAWP

A total of 25 bat call sequences containing 110 individual bat calls were recorded at PAWP in the period from 4th to 23rd of September 2012 (figure 5). It should be noted that compared to OWEZ the monitoring at PAWP was restricted to a short period of time. Within this period bats were recorded during 3 nights. High bat activity was recorded during the nights from 8-9 September and 22-23 September, this corresponds with high activity nights at OWEZ. Bat activity at PAWP was a factor 4 to 7 times lower than in OWEZ. All records at PAWP are Nathusius' pipistrelle calls, Noctules were not recorded at PAWP.

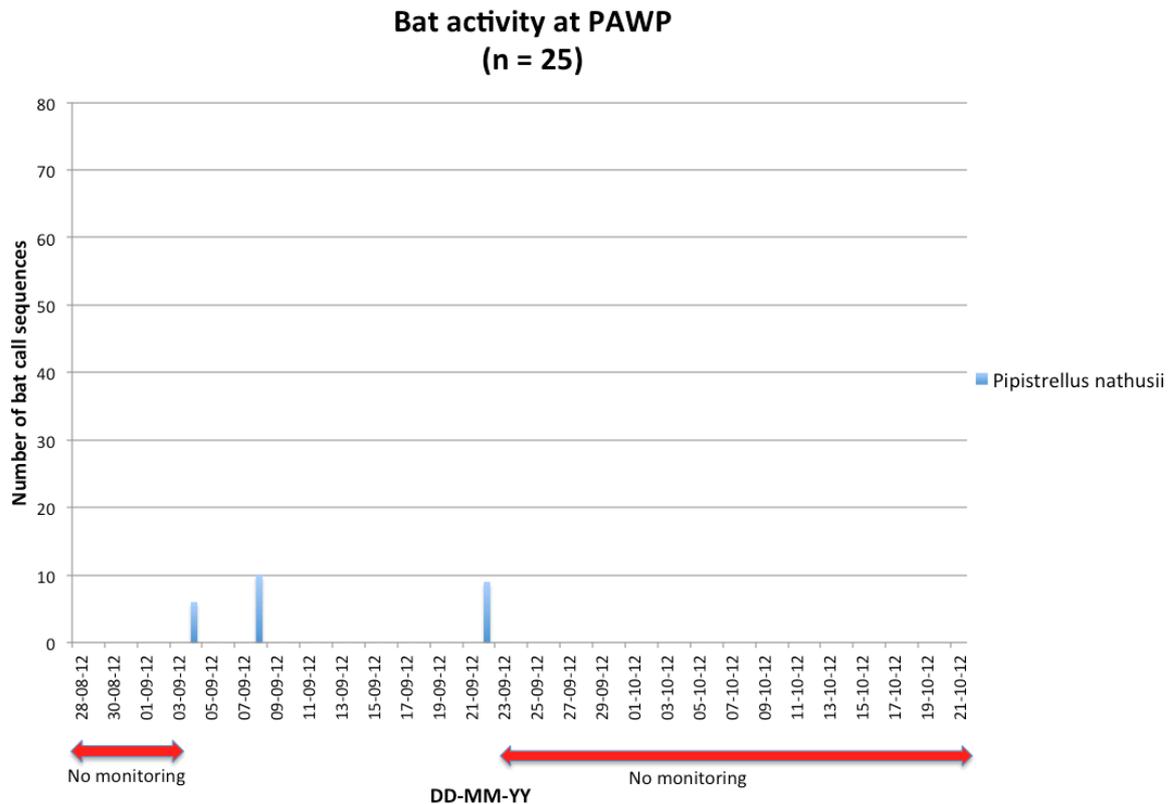


Figure 5 Bat activity at PAWP 4 – 23 September 2012. expressed as number of call sequences per night.

3.3 Temporal activity

The time of recording of all records in the period from 4 to 9 September 2012 were related to the time of sunset to assess the temporal activity pattern. The results are shown in figure 6.

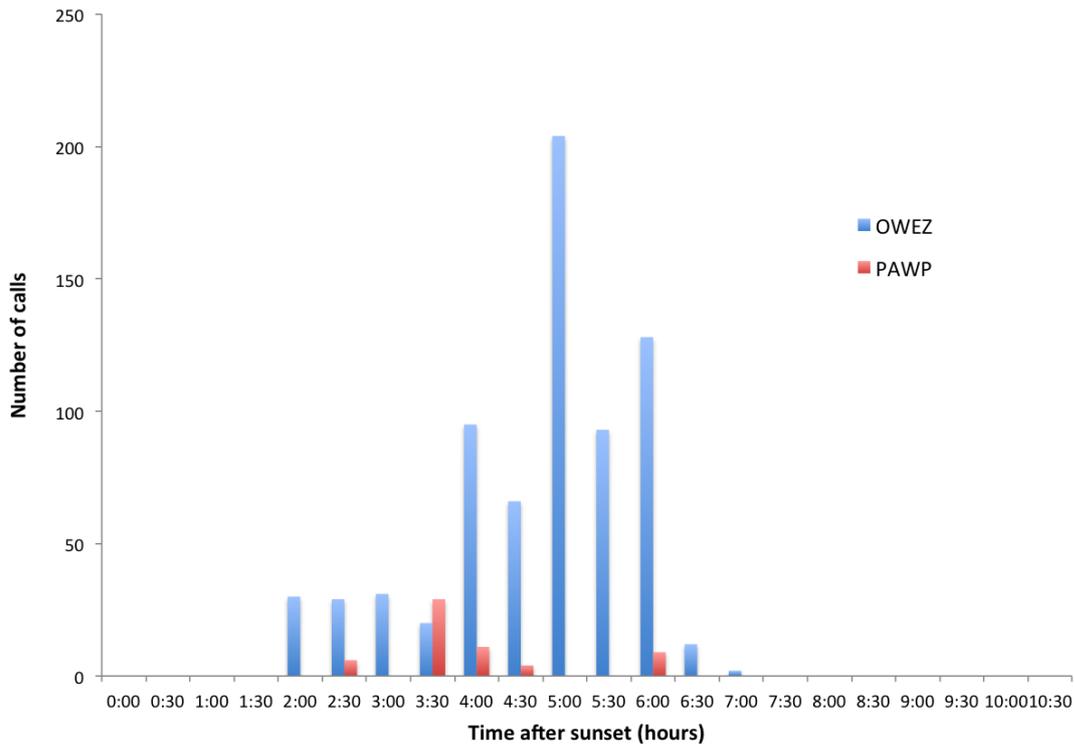


Figure 6 Nocturnal activity of *Nathusius' pipistrelle* at OWEZ and PAWP wind farms in the period from 4 to 9 September 2012.

Bat activity in both wind farms started approximately 2-3 hours after sunset and lasted until 6-7 hours after sunset (or 3-4 hours before sunrise). The maximum bat activity was recorded between 4 and 6 hours after sunset in OWEZ and in PAWP between 3.5-4 hours after sunset.

3.4 Migration and foraging rates

The peak frequency (Fmax) of transit and migration calls is lower compared to the Fmax of foraging calls. Skiba (2009) reported Fmax ranges for both call types (see table 2).

Table 2 Fmax (Frequency with maximum power) ranges for migrating and foraging *Nathusius' pipistrelle* and *Noctule* (after Skiba, 2009)

Species	Fmax transit/migration range (in kHz)	Fmax foraging range (in kHz)
<i>Pipistrellus nathusii</i>	35 – 39	> 40
<i>Nyctalus noctula</i>	17 – 21	> 21

In figures 7 and 8 the proportional rates of migration/transit calls and foraging calls of *Nathusius' pipistrelle* are given for OWEZ and PAWP.

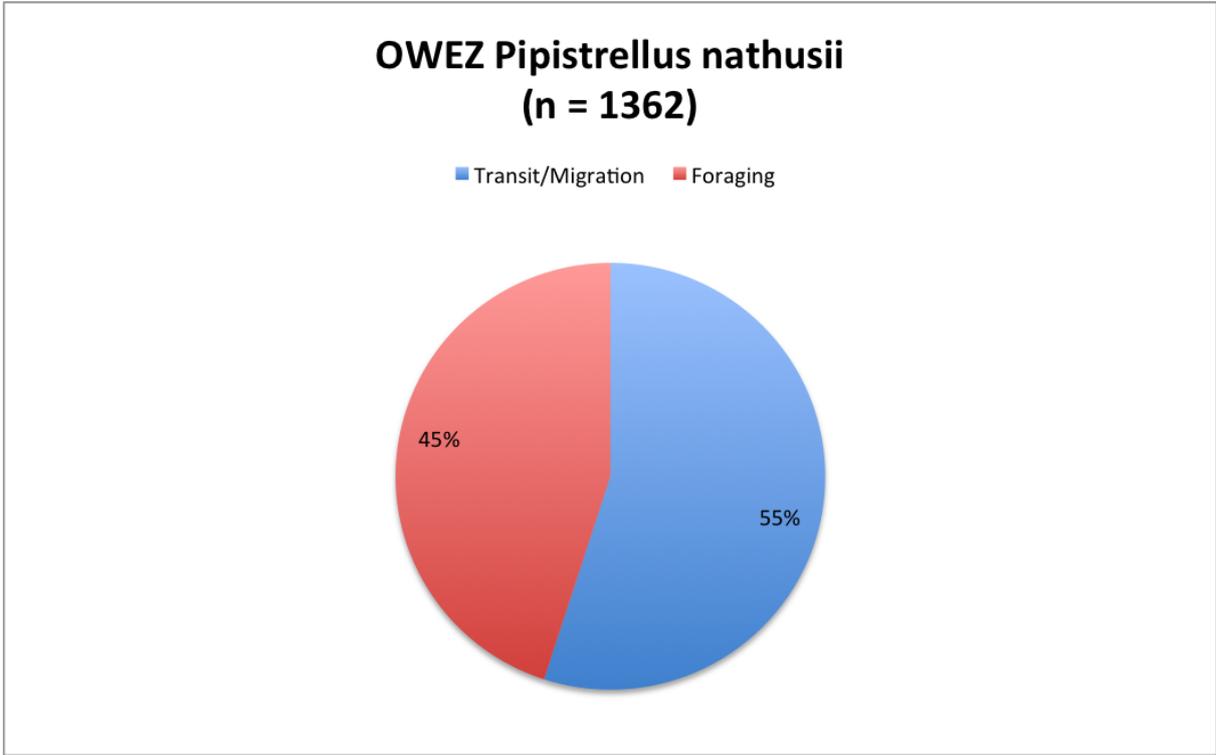


Figure 7 Proportional rates of migration/transit calls and foraging calls of *Nathusius' pipistrelle* recorded at OWEZ.

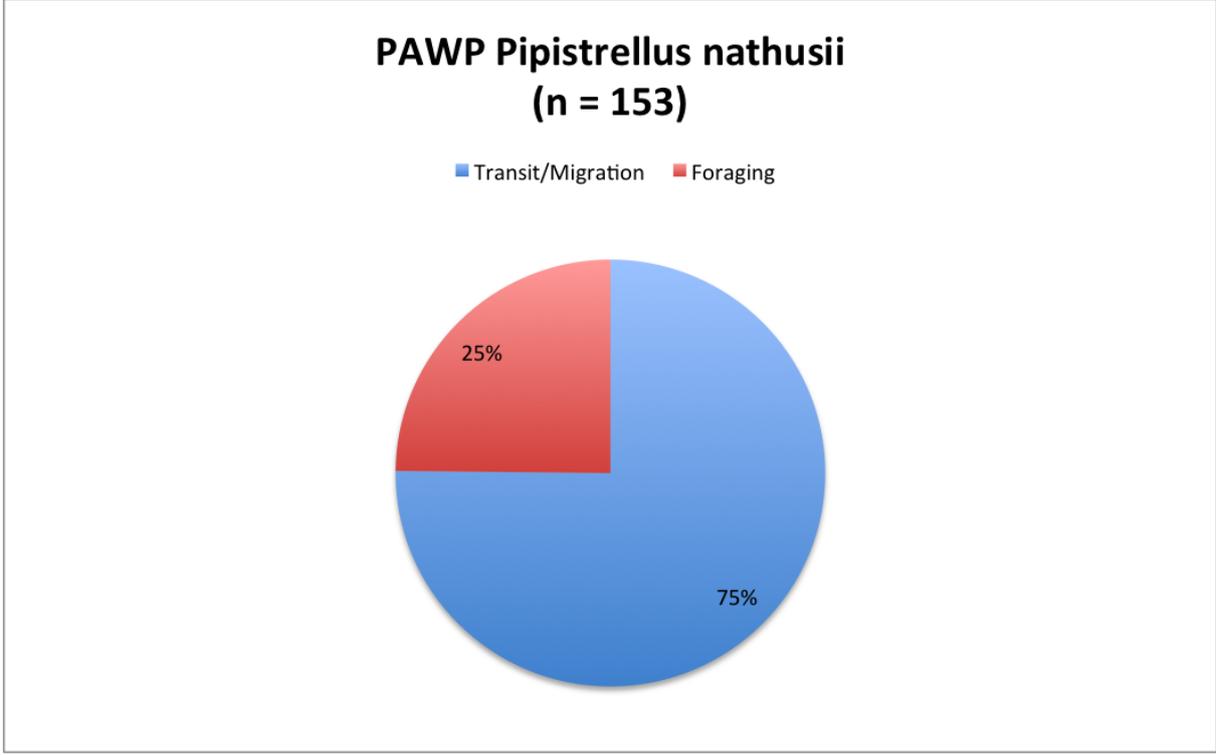


Figure 8 Proportional rates of migration/transit calls and foraging calls of *Nathusius' pipistrelle* recorded at PAWP.

At PAWP transit calls are representing approximately 75% of all Nathusius' pipistrelle calls. The Nathusius' pipistrelle calls recorded at OWEZ consist of approximately 55% transit calls.

The number of Noctule call sequences is relatively low (n=5) and too limited to examine Noctules with respect to migration and foraging behaviour.

3.5 Bat activity and weather conditions

Several studies at onshore wind farms show a relation between bat activity and weather conditions. Wind speed shows the strongest correlation with bat activity (Behr, 2011). Figure 9 shows the bat activity and average wind speed per night at OWEZ and PAWP.

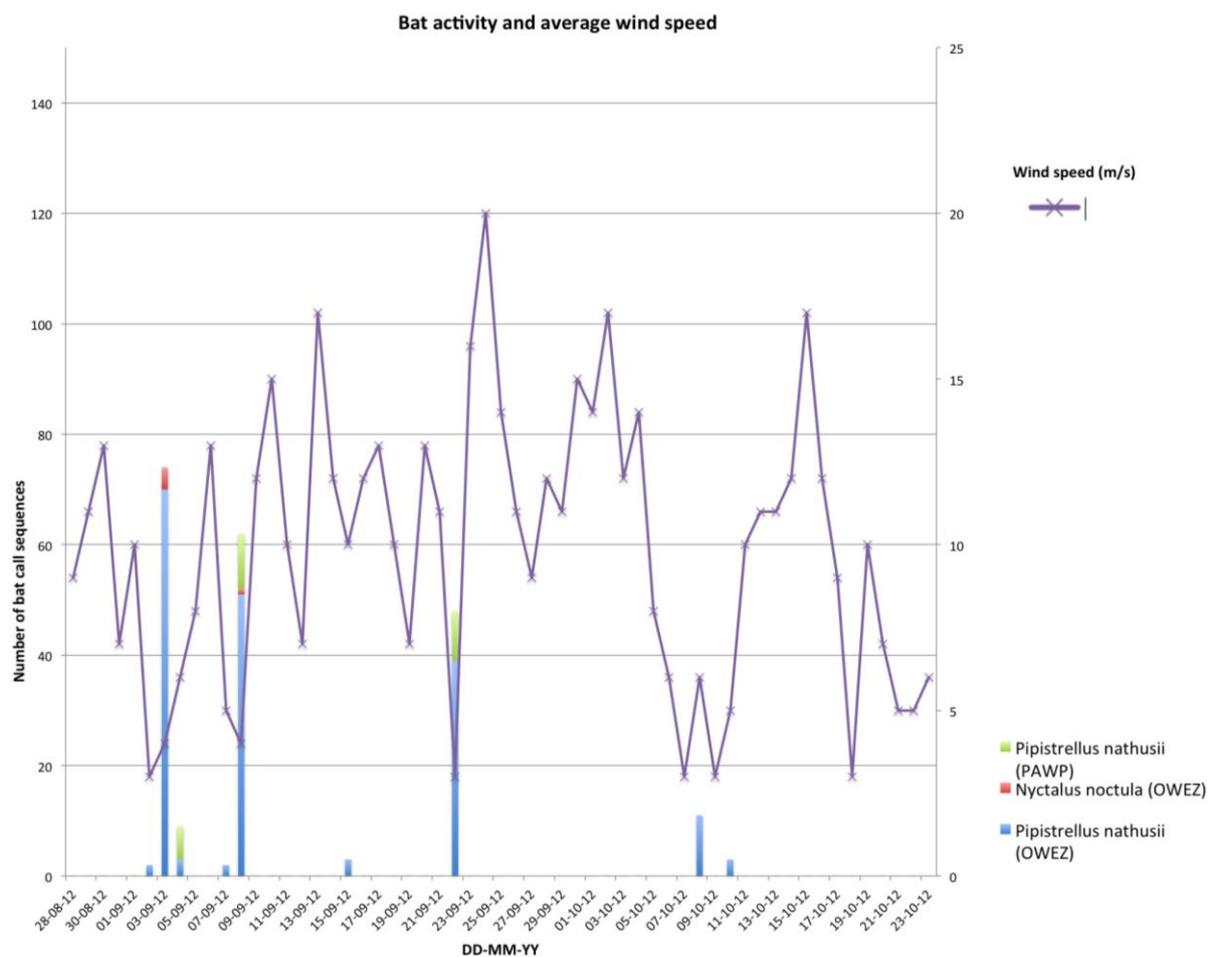


Figure 9 Bat activity and average wind speed at OWEZ and PAWP.

Figure 9 indicates that bat activity is relatively high during nights with low wind speeds. This is in accordance with previous findings at onshore wind farms (Behr, 2011).

4. DISCUSSION

Disturbance by artificial noise

The recordings could have been disturbed by artificial noise within the wind farm. The Batcorder is analysing the characteristics of ultrasonic sounds and stores sounds with bat call characteristics onto the SD card. Wind turbines are emitting ultrasonic noise as well and normally these sounds are not recorded. Sometimes however, noise resembles bat call characteristics and the Batcorder will save these files as well. As the wind turbine can constantly produce this type of noise, the Batcorder is also constantly busy to record and save noise files. This is especially the case during windy circumstances. Especially the recorder at PAWP recorded a high number of noise files. This could be related to the position of the recorder on the entrance platform of the wind turbine. The number of noise files recorded at the METEO mast of the OWEZ wind farm was limited compared to the number at PAWP. It is not clear whether the uninterrupted process of recording noise files has influenced the recording of bat call files, but this can certainly not be excluded.

Number of bats

It should be noted that the number of recordings is not equal to the number of bats. Sometimes the same bat may fly several times in the vicinity of the recorder (especially when foraging) and trigger the recorder several times, resulting in an overestimate. A group of bats however may trigger the recorder only once and this will lead to an underestimate. Therefore, it is not possible to give an actual number of bats. In this study we use the number of sequences as an indication of the bat activity around the recorders.

Extend of the pilot-study

The extent of the pilot-study was very limited. Only one recorder was installed in each wind farm. The Batcorder is detecting bat calls in an area within a radius of approximately 15 – 50 meters from the microphone. This is less than 0,001 % of both wind farm areas.

Migration, foraging or roosting?

At this stage it is not clear why the bats recorded at OWEZ and PAWP were flying offshore. The data collected during this pilot-study is too limited for this purpose. Four scenarios (or a mixture of these scenarios) seem feasible:

- Bats are flying from the mainland to forage within the wind farm and are returning to the mainland afterwards.
- Bats are flying in a very broad migration flyway parallel to the coast
- Bats are migrating across the North Sea towards the UK.
- Bats are roosting within the wind farm

As bat activity didn't start immediately after sunset no indication was found for the presence of a nearby roost within the wind farm. *Nathusius pipistrelles* normally leave their roost immediately after sunset (Russ, 2012).

5. CONCLUSIONS

- During this pilot-study, the ultrasonic recorders (Batcorders) installed at the wind farms OWEZ and PAWP, have proven to be feasible for the monitoring of offshore bat activity.
- The pilot study at the OWEZ and PAWP wind farms provides the first evidence that bats are present in offshore wind farms in The Netherlands.
- Bat activity was recorded in both the OWEZ and the PAWP wind farms. More bat activity was recorded at the OWEZ compared to the PAWP.
- At OWEZ two bat species were recorded: Nathusius' pipistrelle (*Pipistrellus nathusii*) and the Noctule (*Nyctalus noctula*). Nathusius' pipistrelle calls represent 98% of all recordings from OWEZ, while the Noctule calls represent only 2%. At PAWP only Nathusius' pipistrelles were recorded.
- Bat activity was irregularly spread over the monitoring period. Bat activity was confirmed from the beginning of September until mid-October. The highest activity was measured in the beginning of September.
- Bat activity started in both wind farms approximately 2-3 hours after sunset and lasted until 6-7 hours after sunset (or 4-5 hours before sunrise). The maximum bat activity was recorded between 4 and 6 hours after sunset.
- Bat activity is relatively high during nights with low wind speeds.
- The recorded bat calls indicated both migrating (transit) and foraging behaviour of bats. At PAWP transit calls are representing approximately 75% of all calls. The calls recorded at OWEZ consist of approximately 55% transit calls.

6. RECOMMENDATIONS FOR FUTURE RESEARCH

For offshore wind farms bats are not considered within the Environmental Impact Assessment and the license to operate. Consequently monitoring of bats at offshore wind farms so far has not been implemented in The Netherlands. On a European level, UNEP issued guidelines for the consideration of bats in wind farms projects (Rodrigues, 2008). These guidelines are applicable for both onshore and offshore wind farms.

This pilot study at the OWEZ and PAWP wind farms has given first evidence of bat activity in offshore wind farms in The Netherlands. Future research is needed to better understand bat distribution and migration over the North Sea. This could also contribute to a better understanding of the effects that offshore wind farms might have on bats and to assess implications for offshore wind farm planning and management.

An important question is how offshore wind farms are used by bats. This pilot study shows that the recorded bat calls indicated both migrating (transit) and foraging behaviour of bats, so the use of the wind farms as a foraging area cannot be excluded. Therefore, it would be relevant to know whether bats are also present during the summer months (outside the migration season) and whether bats are also present during the spring migration period (March – April). In addition, it would be interesting to know if there is a relation with bat activity at the coastline.

This study indicates that bat activity is relatively high during nights with low or moderate wind speeds. However, these findings are based on a limited dataset. In order to draw firm conclusions about the relation of bat activity and weather conditions more data needs to be gathered.

It is not clear whether bats fly in the vicinity of the rotor blades. A study with Batcorders at various heights may reveal the presence or absence of bats at the height of the blades.

7. Acknowledgements

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9. Justification

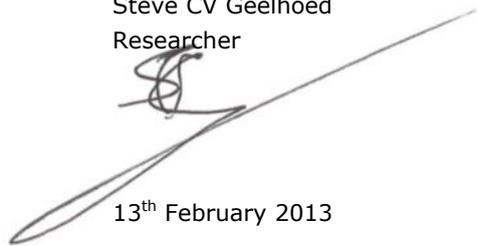
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The scientific quality of this report has been peer reviewed by a colleague scientist and the head of the department of IMARES.

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Researcher

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Date: 13th February 2013



Approved: Han Lindeboom
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Date: 13th February 2013

