CHAPTER 9

FIRST EVER DETECTIONS OF BATS MADE BY AN ACOUSTIC RECORDER INSTALLED ON THE NACELLE OF OFFSHORE WIND TURBINES IN THE NORH SEA

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Abstract

Several bat species are known to migrate long distances between summer and winter roosts. During this migration, a part of the population even crosses the North Sea. The development of offshore wind farms in the North Sea could therefore be a risk for migrating bats. The activity of bats at sea at turbine rotor height is unknown. We therefore installed eight acoustic bat detectors at four turbines in the Belgian part of the North Sea. Four were installed on the platform of the transition piece (17 m amsl) and four were installed on the nacelle of the turbines in the center of the rotor swept area (94 m amsl). A total of 98 recordings of bats were made by all eight Batcorders during 19 different nights during the entire study period (from the end of August 2017 until the end of November 2017). The detections at nacelle height were around 10% of the detections made at low altitude. The observations made by the detectors at nacelle height give an indication of the activity of bats at that altitude, but do not allow to make sound conclusions about the collision risk for bats, especially not in the lower part of the rotor swept zone.

1. Introduction

Several species of bats in northern Europe undertake seasonal migrations between their summer roosts and wintering areas. Most species only travel short to moderate distances, up to several hundred kilometres per season. However, some species such as Nathusius' pipistrelle (*Pipistrellus nathusii*), common noctule (*Nyctalus noctula*), parti-coloured bat (*Vespertilio murinus*) and Leisler's bat (*Nyctalus leisleri*) are known to migrate long distances of up to 2000 km from Scandinavia and Central Europe to more temperate regions of western Europe, and back (Arthur & Lemaire 2015; Hutterer *et al.* 2005; Krapp & Niethammer 2011; Dietz *et al.* 2009).

During migration, bats have been found regularly in the southern North Sea, *e.g.*, on oil rigs (Boshamer & Bekker 2008; Russ 2000; Skiba 2009; Walter 2007; Brabant *et al.*

2016). In 2013, a Nathusius' pipistrelle specimen banded in the UK was found in the Netherlands, proving that bats can cross the North Sea (Leopold *et al.* 2014). Lagerveld *et al.* (2014) report regular occurrences of bats in the Dutch offshore wind farms. The reported bat activity offshore was generally limited to periods with calm weather suitable for long-distance migration.

Most research on the spatio-temporal patterns of bats at sea was based on detections made by acoustic detectors, registering the echolocation calls of bats, installed well below rotor height *in casu* at an altitude between 15 and 26 m above mean sea level (amsl; *e.g.*, Lagerveld *et al.* 2014, 2017; Hüppop & Hill 2016). Hüppop & Hill (2016) state that migrating bats might be missed in such studies as they, presumably, fly at altitudes above 100 m under tailwind conditions. The activity of bats at sea at turbine rotor height hence remains unknown (Lagerveld *et al.* 2017).

Taking account of the increase of wind farms in the Belgian part of the North Sea (BPNS) and the entire North Sea, there is an urgent need to gain insight in the altitudinal distribution of bats at sea and the associated collision risk for bats, a taxon in global decline. Therefore, the Royal Belgian Institute of Natural Sciences studied the activity of bats at nacelle height on four turbines in the Belgian part of the North Sea (BPNS) in late Summer – Autumn 2017.

2. Material and methods

We installed eight ultrasonic recorders (Batcorder 3.0/3.1 EcoObs Ltd., Germany) on four different wind turbines in the C-Power wind farm on the Thornton Bank in the BPNS (fig. 1). Four batcorders were installed on the platform of the transition piece of the turbines, at approximately 17 m amsl, and four were installed on the helicopter winching platform at the back of the nacelle, at 94 m amsl (fig. 2). We made full spectrum recordings in .RAW format (sampling rate: 500 kHz; record quality: 20; threshold amplitude [sensitivity]: -27/-36 dB; post trigger: 400 ms; threshold frequency [sensitivity]: 16 kHz). The Batcorders were installed on 20 August 2017 and were operational until 30 November.

3. Results

Bats were registered throughout the entire study period, from the end of August until the end of November. A total of 98 recordings of bats were made by all eight Batcorders. All echolocation calls were identified as calls from the species Nathusius' pipistrelle *Pipistrellus nathusius*. Bat activity was recorded during 19 different nights (table 1 and fig. 3). All Batcorders recorded at least one bat, except for the recorder installed on the nacelle of turbine J1. Only nine recordings were made at nacelle height. The number of recordings made at nacelle height was significantly lower than the number of detections made at low altitude.

Table 1. Number of bat recordings per Batcorder from 22 August until 30 November 2017. Low, detections at 17 m amsl; high, detections at nacelle height (94 m amsl); records, number of bat recordings; DP10, detection positive 10 minutes

Turbine	Height	Records	DP10
G01	Low	23	11
	High	2	1
H02	Low	26	16
	High	6	4
I1	Low	17	10
	High	1	1
J1	Low	23	14
	High	0	0
	Total	**98**	**57**

To level off high numbers of recordings caused by one individual residing near the recorder, the recordings were converted to detection positive ten minutes (DP10) meaning that a ten-minute period is considered as positive if it contains at least one bat call (*e.g.*, a specimen producing 100 calls in 10 minutes and a specimen only calling

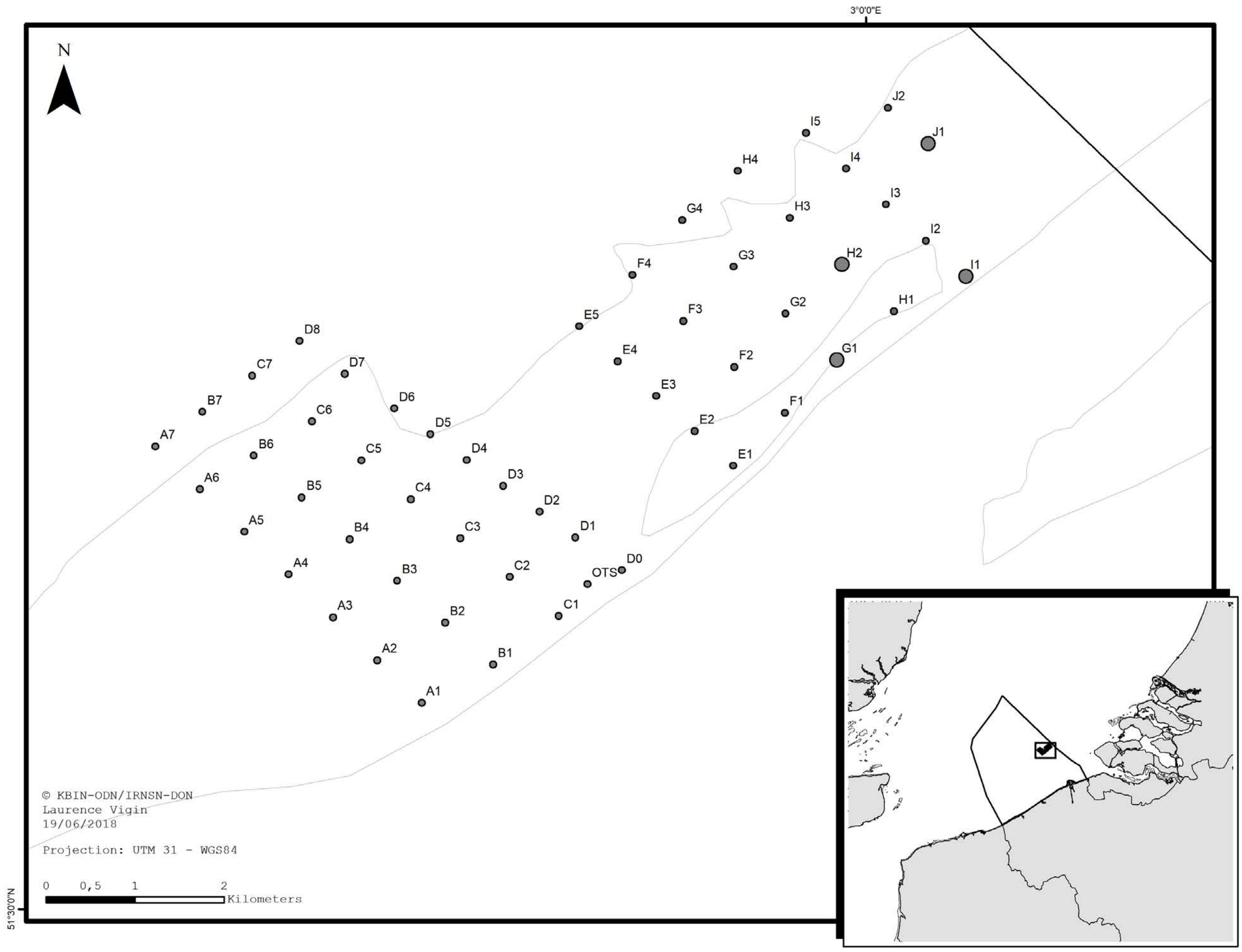

Figure 1. Lay-out of the C-Power wind farm on the Thornton Bank in the Belgian part of the North Sea. Each dot represents a wind turbine. Turbines G1, H2, I1, J1 (indicated by the large dots), in the North-East of the wind farm, were equipped with two Batcorders each (one on the transition piece – 17 m amsl and one on the nacelle – 94 m amsl).

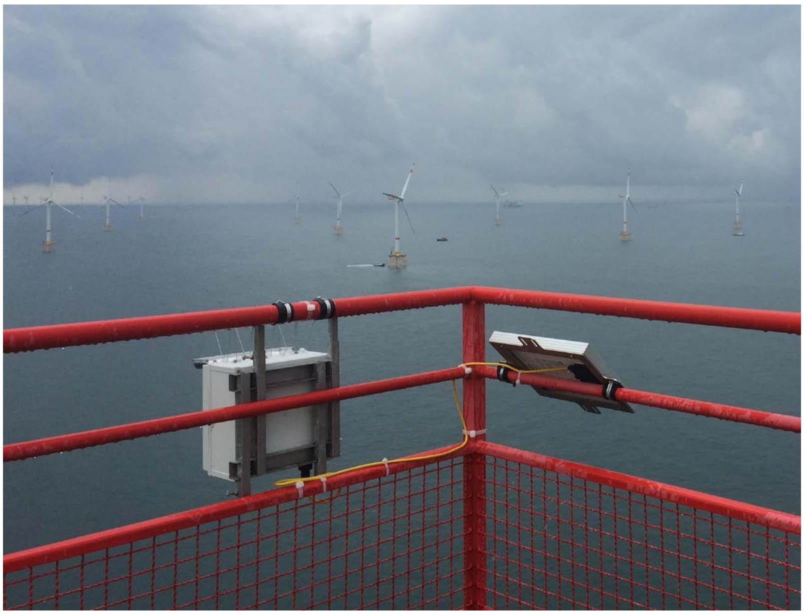

Figure 2. Batcorder installed on the helicopter winching platform at the back of the nacelle of turbine I1.

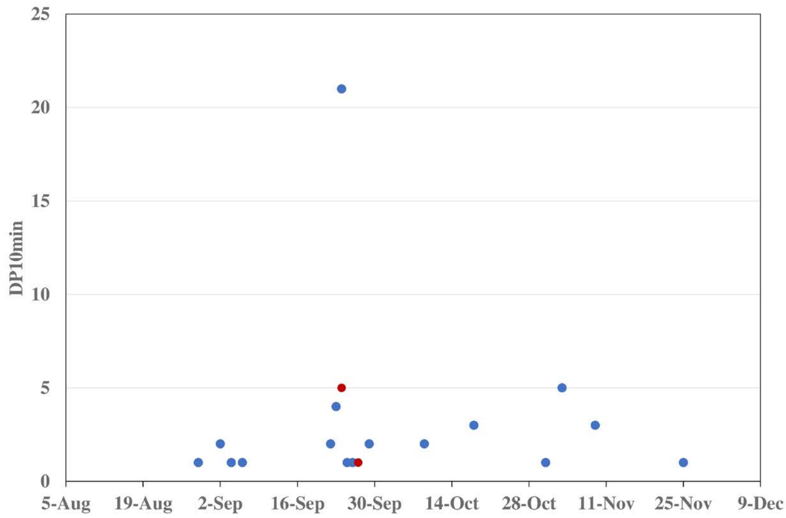

Figure 3. Detection positive 10 minutes (DP10) of the Batcorders at low altitude (blue) and at nacelle height (red), during the entire study period.

once are valued in the same way and render one DP10). The detections at nacelle height were around 10% of the detections made at low altitude (table 1). Figure 3 shows the occurrence of bats (DP10), as registered by the recorders at low altitude and the recorders at high altitude, throughout the monitoring season.

4. Discussion

All recordings made during this study concerned Nathusius' pipistrelle. This is in line with similar studies by Lagerveld *et al.* (2014; 2017, textbox 1). Our results confirm that the majority of migratory activity of Nathusius' pipistrelle takes place from mid-August until the end of September (Lagerveld *et al.* 2014). Further analyses of these data will focus on the impact of environmental conditions (*e.g.*, wind speed, wind direction) and turbine activity on the activity of bats.

From this preliminary study we can conclude that bats are active at high altitude at sea, but that this activity is significantly lower than the activity at low altitude. However, it would be premature to conclude that the risk of a collision of bats with turbine blades is therefore negligible. The detection range of small bats like Nathusius' pipistrelle with a Batcorder is rather limited (15-25 m; Lagerveld *et al.* 2017). This means that a Batcorder installed on a nacelle, at best, covers a range from 70 to 130 m amsl. The rotor of the C-Power turbines reaches from 31 m to 157 m amsl. The observations made by the detectors at nacelle height give an indication of the activity of bats at that altitude, but do not allow to make sound conclusions about the collision risk for bats, especially not in the lower part of the rotor swept zone. Therefore, there is a need for studies assessing bat activity at the lowest point of the rotor, *e.g.*, by installing acoustic detectors at different altitudes on wind turbine masts.

Textbox 1

Spatial and temporal occurrence of bats in the Southern North Sea area

This text is the summary of the report with reference: Sander Lagerveld, Daan Gerla, Jan Tjalling van der Wal, Pepijn de Vries, Robin Brabant, Eric Stienen, Klaas Deneudt, Jasper Manshanden & Michaela 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, 52 p.

The Royal Belgian Institute of Natural Sciences (RBINS), the Research Institute for Nature and Forest (INBO) and the Flanders Marine Institute (VLIZ) were involved in facilitating this study at the Belgian locations at sea and at the coast, and provided general ecological expertise.

The full report can be downloaded from https://doi.org/10.18174/426898

Since a few years, it is known that bats migrate over sea on a regular basis. As numerous land-based studies have shown that wind turbines can cause high fatality rates amongst bats, Rijkswaterstaat started a bat monitoring programme for 2015 and 2016 in order to reduce uncertainties about possible impacts. At the same time, Eneco commissioned a bat monitoring programme for 2015 and 2016 as part of the Monitoring and Evaluation Programme (MEP) for the offshore wind farm Luchterduinen. In 2016, Gemini conducted a bat monitoring campaign in wind farm Buitengaats and Wageningen Marine Research executed a bat monitoring programme at Wintershall platform P6-A and offshore research station FINO3 in the same year. The joint monitoring effort included 12 different offshore locations and 5 locations at the coast.

The specific aims of these monitoring programmes are an assessment of:

1. the species composition at sea and at the coast;
2. the spatiotemporal pattern of occurrence, including the flight height;
3. the relation between environ mental conditions and the occurrence of bats;
4. the function of the Dutch Territorial Sea for bats;

The monitoring results at the coast showed that Nathusius' pipistrelle is very common during both spring and autumn migration, but is also regular throughout the summer. It is also the most frequently recorded species at sea, albeit much less frequently recorded in comparison to the coast. At sea, it was recorded from late August until late October (and one observation in November), and – to a lesser extent – from early April until the end of June. There were no records in July until mid-August. The observed pattern of occurrence matches previous offshore monitoring studies in the German and Dutch North Sea. Due to a limited amount of data in spring, we analysed the presence/absence of Nathusius' pipistrelle per night from mid-August until late October. In this period bat activity was recorded during 11% of the nights at sea and during 66% of the nights at the coast. The higher number of nights at the coast may reflect the relative proportion of bats migrating at the coast and over sea, but the numbers at the coast are likely to be higher due to funneling, whereas migration over sea is likely to follow a broad front due to the absence of guiding landscape features. However, locally densities at sea may also be inflated as bats are likely to be attracted to offshore structures. Consequently, based on bat detector data alone, we cannot estimate the proportion of bats migrating along the coast and over sea.

Due to the differences in occurrences at sea and at the coast, we developed one statistical model for the offshore stations and one for the coastal stations. We modelled the presence/absence per night as a function of various weather parameters, the moon illumination, the spatial coordinates and the night in year in the period mid-August until late October. The most important predictor for the occurrence of Nathusius' pipistrelle in autumn at sea and at the coast are low to moderate wind speeds, followed by night in year (the date). At the coast their presence increases rapidly from mid-August and continues to be high subsequently. At sea the occurrence is strongly peaked. The first wave of migrating animals occurs late August/early September and the second late September. Next, high temperatures increase significantly the presence of bats, both at the coast and at sea. Wind direction is also important; at sea wind directions between NE and SE (with a peak at 94 degrees) result in highest presence, whereas this is the case with wind directions between E and SW (with a peak at 170 degrees) at coastal locations. The observed optimal wind direction at sea (94 degrees) implies that bats crossing over sea choose tailwind conditions, whereas the presence at the coast seems to be shaped by funnelling. Therefore, it seems unlikely that wind drift or storms cause its presence off our western coastline. However, it has been suggested that wind drift is the main cause for the occurrence of bats north of the Wadden Islands. We also found a moon illumination effect in both models. Increasing moon illumination raised the probability of presence at sea and at the coast. Rain reduced probability of the presence of bats at the coast. In contrast, we did not find an effect for rain at sea; thus, bats were recorded with and without rain at sea. High cloud cover was negatively correlated with the presence of bats at sea, but was positively correlated with the presence of bats at the coast.

The sea model predicts a higher probability of presence in the north-western corner of the study area. However, we think that this is an artefact caused by the relatively high number of nights with bat activity at the P6A platform, in comparison to the presence at the other offshore monitoring locations. This may be just be a coincidence, but it is also possible that a spatial pattern of occurrence at sea is actually present. For example, if bats follow their general migration direction (WSW) after leaving the Afsluitdijk, they will pass closely to P6-A. The recorded bat activity at nearshore monitoring locations (between 22 and 25 km from the coast) peaks approximately 4 h after dusk. It seems likely that these animals departed the same night from the coast. However, bat activity at the locations further offshore (between 58 and 69 km from the coast) starts often close to dusk. This means that these animals must have spent the day at the monitoring location at sea, or in its vicinity. This pattern of occurrence means that the observed bat activity at a particular night may depend on their departure decision in the previous night, or even earlier. Other species recorded during this study included Common pipistrelle which was occasionally recorded offshore, but was common at the coast throughout the monitoring season. Nyctaloids were recorded uncommonly offshore from June until October and from May until late October at the coast. Nyctaloids identified to species level included Common noctule, Particoloured Bat, Leister's Bat, Northern Bat and Serotine Bat. Pond bats were not recorded offshore but were regular at the Afsluitdijk and rare elsewhere along the coast. Finally, there were some occasional records of Daubenton's bats and Soprano pipistrelles at the coast.

The results of this study show that the occurrence of bats at sea is highly seasonal which indicates that individuals recorded at sea are on migration. The peak period runs from late August until the end of September. After that it levels off throughout October. Spring migration is much less pronounced but the duration seems to be quite extensive; from late March until the end of June. Records of bats in July and early August are rare. At the coast bats are much more common in general and their presence is both shaped by migratory movements and the presence of foraging individuals from local populations. Therefore, the relevant period to consider the presence of bats at sea off the western coast of the Netherlands and Belgium seems to be from 15 March until 30 June and from 15 August until 31 October, whereas bats should be considered the entire active season at the coast. Based on the monitoring results of the 2012-2014 studies, a precautionary mitigation measure was issued using 5 m/s as cut-in wind speed for the wind farms in the Borssele area in the period 15 August until 1st October. The current study, however, shows that other environmental parameters, in addition to the wind speed, are important as well. The model developed in this study is likely to predict the presence of bats at sea more accurately, despite the fact the model can be improved. In order to improve the sea model, it is recommended to continue monitoring offshore to increase the number of observations in the dataset. The model can, furthermore, be improved by monitoring in a denser grid to reveal spatial patterns and include information on the availability of insects (bat migration fuel). In addition, we urgently need monitoring data from higher altitudes as bat migration may occur at altitudes beyond the detection range of the current monitoring network at sea.

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