Nathusius' pipistrelles (*Pipistrellus nathusii*) and other species of bats on offshore platforms in the Dutch sector of the North Sea

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Abstract: Between 1988 and 2007, 34 reports of bats were received from offshore platforms in the Dutch sector of the North Sea. These reports involved Nathusius' pipistrelle (*Pipistrellus nathusii*) (26x), noctule (*Nyctalus noctula*) (2x), northern bat (*Eptesicus nilssonii*) (2x), serotine (*Eptesicus serotinus*) (1x) and parti-coloured bat (*Vespertilio murinus*) (3x). Their distribution over the 65 offshore platforms in the Dutch sector of the North Sea is described. A population of Nathusius' pipistrelle on the mainland, monitored in bat boxes located in the north of North Holland Province was used to compare sex ratio, age composition, body condition and biometrics with the bats found on offshore platforms. Since the first report of a bat on a platform in the Dutch sector of the North Sea in 1988, there has been an increase in the number of bats reported from offshore platforms over five yearly periods, with the maximum number (15) occurring between 1998-2002. The records of Nathusius' pipistrelle and most other bat species (with the exception of the noctule) on offshore platforms show no demonstrable bias towards platforms closer to the shore (most were recorded as distances of 60-80 km from the shore). Eighteen adult Nathusius' pipistrelles have been recorded on offshore platforms in the Dutch sector of the North Sea, and 6 in their first calendar year. Half of the males (50%) were juveniles, while 87% of the females were adults. The sex ratio of Nathusius' pipistrelles was biased to males during the autumn migration, whereas in spring most bats were females. No significant correlation was found in the numbers of reported Nathusius' pipistrelles in autumn or spring and wind speed or prevailing wind directions, suggesting the bats were not blown off course. The body mass of both male and female Nathusius' pipistrelles from offshore platforms was on average lower than for those from bat boxes in mainland North Holland.

Keywords: bats, oil platform, oil rig, offshore platform, Nathusius' pipistrelle, noctule, northern bat, parti-coloured bat, serotine, The Netherlands, North Sea, distribution, migration.

Introduction

Since the mid 1980s, there have been reports of the presence of various bat species from offshore platforms in the Dutch sector of the North Sea. These reports included recoveries of Nathusius' pipistrelle (*Pipistrellus nathusii*), noctule (*Nyctalus noctula*), northern bat (*Eptesicus nilssonii*), serotine (*Eptesicus serotinus*) and parti-coloured bat (*Vespertilio murinus*) (Boshamer 1993 & 1998). With the exception of the *Eptesicus* genus, these are all migratory species; the serotine is known to be a non-migrant species, while the northern bat is capable of long distance flights that could be interpreted as migration (Dietz et al. 2007).

The discovery of a bat on a platform usually starts with visual observations of the bat flying around the structure. When the bat's hiding place is found it can normally readily captured, in contrast to bats found in hides on the mainland.

There are very few published accounts of bats on offshore installations in the North Sea. In this paper, we report on the frequency of occurrence of bats on offshore platforms in the Dutch sector of the North Sea and describe the spatial pattern of their offshore distribution in

terms of the distances (km) from the coast. We examined the prevailing weather conditions when the bats were recorded, evaluating wind directions and speeds to investigate the hypothesis that the bats may have been blown off course during their natural migration and ended up seeking refuge at offshore platforms (Swift 1998). In addition, we address other questions, particularly with regard to the Nathusius' pipistrelle, about any possible differences in the sex ratio, age composition, body condition, or biometrics of bats found on offshore platforms and on the adjacent mainland. These issues are relevant in revealing the origin of the bats involved (i.e. whether they are an identifiable subpopulation of this species), or to see if a particular type of bat is more prone to drift into the open sea. For example, individuals with longer forearms may have a greater flight capacity (Bogdanowicz 1999). A population of Nathusius' pipistrelles, monitored in bat boxes in the north of the province of North Holland, was used to compare the results.

We provide a description of the migration patterns of the Nathusius' pipistrelle and other bats (as far as these are currently understood) to aid the interpretation of the offshore results. We also studied data collected from the Dutch Wadden Islands and other islands in the North Sea to get an idea of any further species of bats that are likely to be encountered on offshore platforms in the Dutch sector of the North Sea.

The Nathusius' pipistrelle and other bats are listed under the Convention on the Conservation of Migratory Species of Wild Animals (Bonn 1997; Agreement on the Conservation of Bats in Europe). This status, and the duty to take care of individual animals, should stimulate efforts to protect and rescue these animals when they have landed on offshore platforms. Requests were made to the oil-producing companies to capture and report bats and to organise proper care prior to rehabilitation attempts and release on land. Bat conservation organisations could help in this by drafting a protocol for staff on offshore platforms, describing how to handle and keep bats while they remain on board and how the animals should be transported to the coast.

Material and methods

Study area

This paper lists the bats recorded and captured at offshore platforms in the Dutch sector of the North Sea (the prime study area), situated at 51°-56°N latitude and 2°-7° E longitude. Since 1975 there has been a gradual increase in number of oil and gas producing platforms in the North Sea. In 2006 there were approximately 270 platforms and 15 light vessels or semi submersible crane vessels in the North Sea at large (figure 1). In interpreting the results we do not make any difference in this paper between platform type: oil platforms, gas platforms, and other semi submersible crane vessels are all referred to as 'offshore platforms' or 'offshore installations'. Within the study area, there were approximately 61 offshore installations in 2006, in the Zuidwal, Ameland, De Ruyter and Hanze oil fields, located in quadrants E, F, K, L, P and Q. The geographical positions of these offshore platforms were taken from a nautical chart of the North Sea (Charts and Publication 2001, with supplements up to 2006) and were measured with a chart compass (degrees and minutes N latitude and W longitude / E longitude). Some of these offshore platforms have subsequently been moved for maintenance or exploration.

Material

Between 1988 and the end of 2007 all bats reported on offshore platforms in the Dutch sector of the North Sea were captured by hand and directly transported to Den Helder Airport by helicopter. The first named author has been responsible for receiving the animals and taking them into care. After care (water and meal-worms), the animals were identified using Schober and Grimmberger (1987, 2001). Standard data has been collected about the species, date of capture, sex, forearm length, body mass and overall condition of all these captured bats. Age categories were determined according to the pattern of closure of the cartilaginous epiphyseal growth plates in long

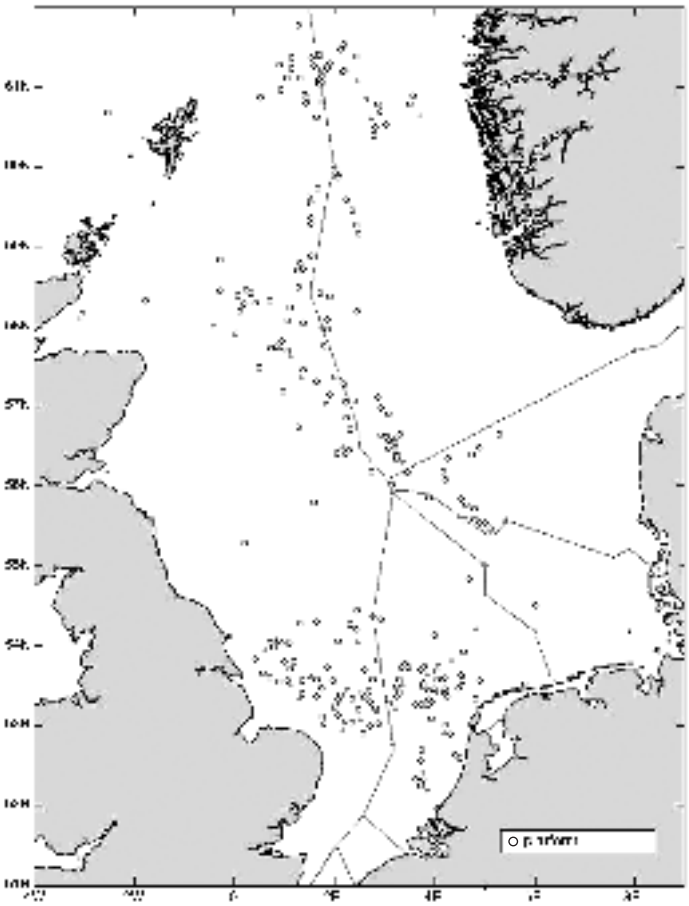


Figure 1. Positions of offshore platforms in the North Sea, with territorial borders of the Netherlands, the UK, Norway, Denmark and Germany.

bones, the shape of the finger joints and dental wear. The body mass of all animals was determined with a Pesola 20 grams (eventually 100 grams) steelyard and the length of the forearm was measured with vernier callipers (accuracy 0.05 mm). The names and geographical positions of the offshore platforms where the bats came from were provided by the Airport Authority. From 1991 through to 2006, all Nathusius' pipistrelle bats were ringed and set free in Julianadorp (52º 53'N 4º44'E). The distances (km) between the offshore platform and the nearest shore have been determined using Google Earth.

Since 1987 a population of mainly Nathusius' pipistrelles (*n*=1431) has been monitored in bat boxes in the north of North -Holland Province (photo 1). In the summer of 1990, 175 bat boxes were set out over six areas of forest. Since 1991, the sex, age, and some biometrics of the bats in these boxes have been recorded, including body mass and right forearm length. All these bats were banded (with the Bat ring developed by the Natural History Museum, Bonn, Federal Republic of Germany). Currently, there are six areas with 180 bat boxes that are checked every month (and more often during the autumn migration period). The locations are Robbenoordbos (State Forestry Service; 52º54' N 5º02' E, 30 bat boxes), Eendenkooi 't Zand (Landschap Noord-Holland; 52º49' N 4º47' E, 25 bat boxes), Noorderhaven

(Foundation 's Heerenloo; 52°53' N 4°46' E, 50 bat boxes), Eendenkooi Callantsoog (State Forestry Service; 52°50' N 4°42' E, 25 bat-boxes), 't Wildrijk (Landschap Noord-Holland; 52°47' N 4°41' E, 40 bat boxes), and Het Paardenweitje (State Forestry Service/Forestry Schoorl; 52°41' N 4°40' E, 10 bat boxes) (Boshamer 2005). The data gathered during this study formed the background material to interpret data collected from Nathusius' pipistrelles from offshore platforms. Body mass and forearm length of other bats have been compared with the measurements as described in Dietz et al. (2007).

Completeness of material

Since 1998 the first author has kept records of the numbers and species of bats reported on offshore installations within the Dutch sector of the North Sea. Figure 1 shows that the offshore platforms are unevenly distributed over the North Sea and this spatial pattern may have influenced the number of reported animals form different parts of the study area. Relatively more reports have been received from the L10 grouping of offshore platforms (Gaz de France) where several staff members seem to have a genuine interest in birds and bats. This could skew the results since interested people are more likely to send in specimens than those who are indifferent. To stimulate wider interest, some articles were published in the offshore industry newsletters, highlighting recent sightings and attempts to rescue bats found on board offshore installations. The sightings should be considered as incidental ones since it is not possible to make any observer-effort correction for any of the trends and patterns described in this paper.

Analyses

Vierhaus (2004) mentions migratory routes of Nathusius' pipistrelles along coasts, following linear landscape elements and roosting by day in groves. They mostly travel from the northeast to the southwest in autumn (and in the opposite direction in spring), mostly following an assumed path along the North Sea coast, with a highest

Photo 1. Nathusius' pipistrelle (*Pipistrellus nathusii*) from a bat box in Noorderhaven, August 2003. *Photograph: Rollin Verlinde*.

density near the shoreline. Dietz et al. (2007) mentioned travelling distances of 29-48 (up to 80) km night^{-1} for Nathusius' pipistrelles during migration. Nathusius' pipistrelles, as other bats, prefer to migrate at night, but sometimes do so by day, at periods of low wind-speed flying at 3-20 m altitude over the water. Our own observations during migration in autumn confirm this behaviour. Experienced birdwatchers know that many migrating passerines (Deelder 1949) and other flying migratory species, such as beetles and butterflies (Heydemann 1968) prefer to travel during periods of low wind-speeds, or with (strong) tailwinds. When flying into headwinds migrants fly closer to the surface, while tailwinds let them fly higher (Krüger & Garthe 2001). Migrants may drift into the North Sea during strong sidewinds.

Hence, strong southeast winds may blow migratory Nathusius' pipistrelles, travelling along the coast, off course and leading them to seek refuge at offshore installations. Bats tend to seek refuge during strong winds (>6B). Ahlén (2006) observed that foraging activity of bats around offshore windmills (3-10 km from the shore) ceased at 5 Beaufort or more, with peak activities recorded at 3 Beaufort.

Nathusius' pipistrelles, as well as other migrating bats, migrate along the coast in autumn and in spring. Prevailing wind direction and speed are clearly the only weather conditions that can act as a vector (wind-drift). Therefore we made the assumption that prevailing wind conditions, during the three full days prior to a bat's discovery on an offshore platform, may have influenced its whereabouts. If wind-drift were responsible for most of the offshore encounters, we would expect that many of the bats would have been found after periods of prevailing (strong) southeast ($\geq 90^{o}$ and $\leq 180^{o}$) winds and high daily wind-speeds (in m/s). Meteorological data were obtained from De Kooy weather station in Den Helder (KNMI 2007).

Apart from the wind direction and wind-speed, precipitation has also been taken into account. We have assumed that bats cannot fly during prolonged and heavy rain, that they only travel to sea when the weather is sufficiently dry or that they are more likely to seek refuge onboard offshore installations in rainy weather.

Autumn and spring migration periods of the Nathusius' pipistrelle movements have been defined as running between from 15 August to 1 November and from 15 March to 1 July.

Differences in the means of the continuous variables were tested by using the Student's t-test (two-tailed). χ^2 statistics were used to test differences in categorical data (Wijvekate 1976). Spearman's rank correlation test was used to test for correlation between a sequence of pairs of values (Boon 1979), with the upper and lower limits of the coëfficients retrieved from tables compiled by Diem & Lentner (1968). For all tests, the significance level was set at $P<0.05$.

Results

Between 1988 and 2007, 34 bats were received from offshore platforms in the Dutch sector of the North Sea (table 1). Most of the reports involved Nathusius' pipistrelle (26x); with some reports of noctules (2x), northern bats (2x), serotine (1x) and parti-coloured bats (3x).

Of these bats 14 were brought in during the spring migration and 18 during the autumn. Two bats were brought in outside of the prime migration seasons: a serotine on 28 July 1995 and a parti-coloured bat on 10 January 2006. Three Nathusius' pipistrelles were dead on arrival (2 and 4 October 2000, 10 October 2002) and a parti-coloured bat, received on 7 May 2006 had a fracture in the right forearm and was euthanized.

Since the first report of a bat on a platform in the Dutch sector of the North Sea in 1988 there has been an increase in the number of bats reported from offshore platforms in each five year period, with the most recorded between 1998 and 2002 (figure 2).

The mean distances between all offshore platforms in the Dutch sector of the North Sea and the Dutch coast is 66.2 km (min 5.3 km; max 168.5 km). Recordings of Nathusius' pipistrelle

Table 1. Reports of bats from offshore platforms in the Dutch part of the North Sea: 1988-2006.

Date	Species	Sex	Age category	Name of platform
16-9-1988	Nathusius' pipistrelle	M	adult	Dan Earl
17-9-1993	Nathusius' pipistrelle	F	adult	Dan Earl
25-9-1993	northern bat	M	adult	K 12 B
1-10-1993	Nathusius' pipistrelle	F	adult	Meetpost Noordwijk
6-10-1993	Nathusius' pipistrelle	F	adult	J 6 A Markham AWG 1 Ameland
5-9-1994	noctule	F	adult	Westgat
10-9-1996	noctule	F	adult	L15 A
13-6-1997	Nathusius' pipistrelle	F	adult	Ensco 72
30-4-1998	Nathusius' pipistrelle	F	adult	Hoorn platform
10-6-1998	northern bat	F	adult	Unocal Horizon
19-4-2000	Nathusius' pipistrelle	F	adult	P 15 E Amoco
27-4-2000	Nathusius' pipistrelle	F	adult	L 10 F
20-5-2000	Nathusius' pipistrelle	M	adult	K 12 BP
22-9-2000	Nathusius' pipistrelle	M	1st year	K 12 E
2-10-2000	Nathusius' pipistrelle	M	1st year	P 6 Clyde
4-10-2000	Nathusius' pipistrelle	F	adult	L 7 Q Petroland
9-5-2001	Nathusius' pipistrelle	F	adult	F 3 B
5-6-2001	Nathusius' pipistrelle	F	adult	L 7 Q Petroland
31-3-2002	Nathusius' pipistrelle	F	adult	L 10 AD
18-5-2002	Nathusius' pipistrelle	M	adult	L 7 B Total Fina Elf
6-9-2002	Nathusius' pipistrelle	M	1st year	F 2 Hanse
11-9-2002	Nathusius' pipistrelle	M	1st year	L 8 P 4 Wintershall
10-10-2002	Nathusius' pipistrelle	M	adult	K 12 Bravo
6-10-2003	Nathusius' pipistrelle	M	adult	L 8 P 4 Wintershall
9-6-2004	Nathusius' pipistrelle	F	adult	D 15 A
23-8-2004	parti-coloured bat	M	adult	K 12 B
4-10-2004	Nathusius' pipistrelle	M	1st year	L 10 B
28-7-2005	serotine	F	1st year	K 15 B
2-9-2005	Nathusius' pipistrelle	F	1st year	K 15 B
10-1-2006	parti-coloured bat	F	adult	L 10 Alpha
3-5-2006	Nathusius' pipistrelle	F	1st year	L 10 Alpha
7-5-2006	parti-coloured bat	F	adult	K 4 B E
10-5-2006	Nathusius' pipistrelle	F	adult	L 10 Alpha
27-10-2006	Nathusius' pipistrelle	F	1st year	De Ruyter-rig

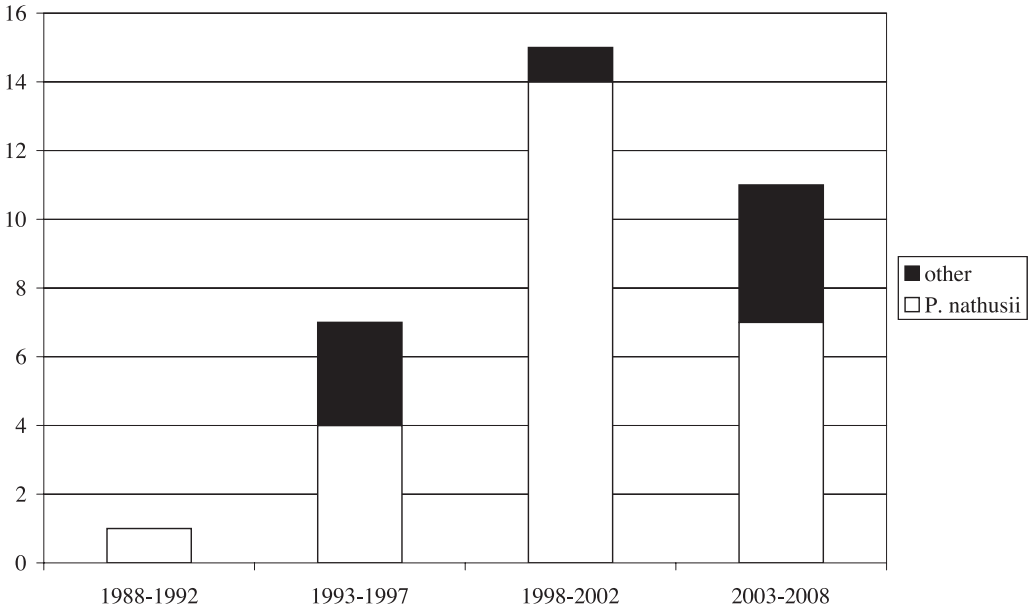


Figure 2. Numbers of reports of bats from offshore platforms in the Dutch sector of the North Sea.

Table 2. Mean distances in kilometres between offshore platforms in the Dutch Sector of the North Sea and the Dutch coast for Nathusius' pipistrelles and other species of bats; number (*n*) and probability of differences of mean distances between all offshore platforms and offshore platforms with species of bats in last column (Student's T-test; $P<0.01$).

	mean distance	*n*	*P*
All offshore platforms	66.20	61	1.00
Nathusius' pipistrelle males in autumn	55.80	8	1.00
Nathusius' pipistrelle females in autumn	67.13	5	0.12
Nathusius' pipistrelle males in spring	61.72	2	0.97
Nathusius' pipistrelle females in spring	65.39	11	0.96
Noctule	6.51	2	<0.01**
Northern bat	59.54	2	0.28
Serotine	61.44	1	-
Parti-coloured bat	83.34	3	0.49

and most other bat species show no obvious bias towards those offshore platforms closest to the shore. The exception to this was the noctule, which was more frequently reported from platforms closer to the Dutch coast (mean distance 8.1 km; n=2, Student's t-test: 10.02; P<0.01) (table 2).

Nathusius' pipistrelle

Most Nathusius' pipistrelles were received from offshore platforms situated between 60 and 80 km from Den Helder (figure 3). Of the 26 reported Nathusius' pipistrelles, 12 were collected during the spring migration and 14 during autumn (see table 1, figure 4).

Eighteen Nathusius' pipistrelles were adults and 6 animals were in their first calendar year. Males (n=10) and females (n=16) were found in spring and in autumn, but most females were captured earlier (April) and later (October) in the year than males, with male captures peaking in September. Half of the males (50%) were juveniles, while 87% of the females were adults (table 3). The sex ratio of Nathusius' pipistrelles

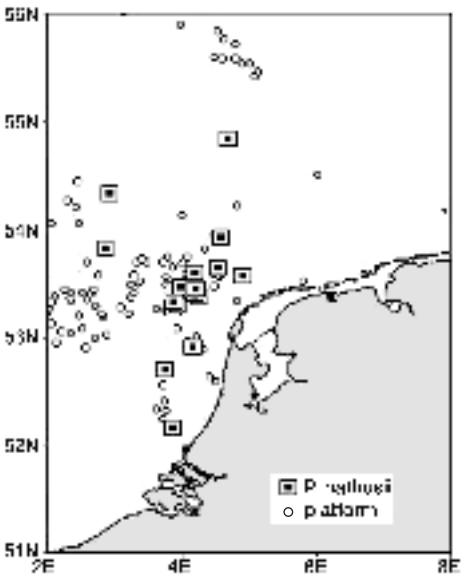


Figure 3. Distribution of reported Nathusius' bat (*Pipistrellus nathusii*) from offshore platforms in the Dutch sector of the North Sea.

was biased towards males during the autumn migration, whereas in spring most bats were females (table 4).

Correlation between body mass and distance of the offshore platform to the Dutch shore was compared using Spearman's rank correlation test. No positive nor negative correlations were found for the whole sample of Nathusius' pipistrelles (n=23, R=2684, 0.1<P<0.9), for males (n=8, R=88, 0.1<P<0.9), females (n=15, R=704,5, 0.1<P<0.9), or for specimens found in autumn (n=9, R=181.5, 0.1<P<0.9) or spring (n=14, R=526, 0.1<P<0.9).

The autumn migration periods (15 August and 1 November) between 1988 and 2007 contain a total of 1,519 days. On 309 of those days the prevailing winds were from the south-east and on 1,210 of those days the winds were non-south-easterly. 14 Nathusius' pipistrelles were found on offshore platforms in autumn, so the reports of prevailing wind directions were checked for 42 days (=14*3). The expected prevailing wind directions were 2.85 (=14*309*1,519^{-1}) from the south-east and 11.15 (=14*1,210*1,519^{-1}) from non-south-east directions. The observed prevailing wind directions were 5.67 (17*3^{-1}) from the south-east and 8.33 (25*3^{-1}) from non-south-east directions. Applying Chi-square test, there was no significant difference in the numbers of reported bats in autumn and the prevailing wind directions (south-east and non-south-east - χ^2=2.01, df=1, P=0.07).

The daily mean wind-speed for the 14 Nathusius' pipistrelles in autumn on offshore platforms was on average lower, but not significantly so, than for the rest of the days (5.03 m/s, n=42 respectively 5.45 m/s, n=1519; Student's t-test: 1.53, P=0.13). However, selected for prevailing wind directions from the south-east (n=17 respectively n=309 days) the average daily mean wind-speed was (almost significantly) higher than for other days (5.10 and 4.49 m/s respectively; Student's t-test: 1.89, P=0.07).

Migration periods in spring between 15 March and 1 July, total 2,124 days. On 246 days the prevailing winds were from the south-east: non-south-east wind directions accounted for the other 1,875 days. The 12 Nathusius' pipistrelles

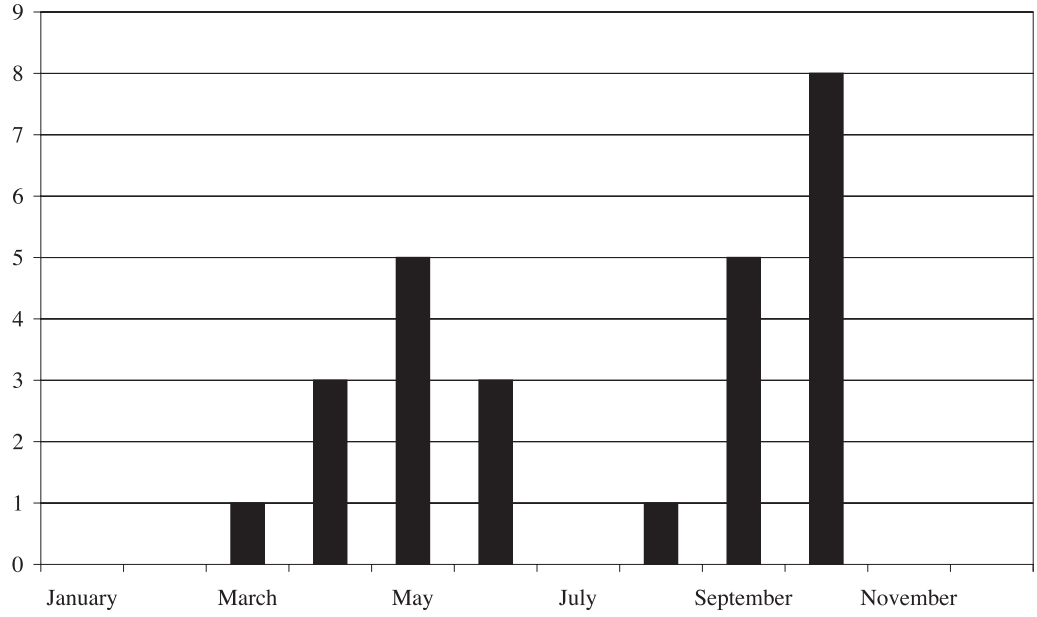


Figure 4. Monthly distribution of reported Nathusius' bat (*Pipistrellus nathusii*) from offshore platforms in the Dutch sector of the North Sea.

on offshore platforms in spring resulted in 36 (=12*3) prevailing wind direction reports. The number of expected prevailing wind directions were 1.39 (=12*246*2,124^{-1}) from the south-east and 10.61 (=12*1878*2,124^{-1}) from non-south-east directions. The numbers of observed prevailing wind directions were 3.00 (9*3^{-1}) from the south-east and 9.00 (27*3^{-1}) from non-south-east directions: the difference in the numbers of reported bats in spring between prevailing wind directions from the south-east and non-south-east was not significant (χ^2=2.01, df=1, *P*=0.16).

The daily mean wind-speed at the time that the 12 Nathusius' pipistrelles were recoded on offshore platforms in spring was on average equal to that on other days (5.42 m/s, *n*=36 respectively 5.44 m/s, *n*=2,124; Student's t-test: 0.06, *P*=0.95). Selected for prevailing wind directions from the south-east (*n*=9 respectively *n*=246 days) the average daily mean wind-speed was higher than for the other days, however, the difference was not significant (4.93 and 4.77 m/s respectively; Student's t-test: 0.35, *P*=0.74).

The body mass of male Nathusius' pipistrelles from offshore platforms (excluding specimens dead when received) was on average lower than for males from bat boxes in mainland North Holland (5.46 g, *n*=8 and 7.90, *n*=699 respectively; Student's t-test: 10.95, *P*<0.01). For female Nathusius' pipistrelles the average body mass was also lower among those from offshore platforms than from bat boxes (6.04 g, *n*=15 and 9.17 g, *n*=738 respectively; Student's t-test: 13.19, *P*<0.01). Figures 5a and 5b illustrate the monthly percentiles in body mass of Nathusius' pipstrelles from bat boxes in North Holland with those from offshore platforms. Both box plots indicate that the Nathusius' pipistrelles from offshore platforms in all months had, on average, lower body masses compared to the animals found in bat boxes. Between April and October, six of the eight live males were under the 5th percentile and two were between the 5th and 25th percentile of animals found in bat boxes. Four of the fifteen live females brought from offshore platforms between March and October were be-

Table 3. Reported Nathusius' pipistrelles (*Pipistrellus nathusii*) from offshore platforms; showing differences in the age categories and sex (χ^2=4.06, df=1, *P*=0.04*).

Age category	Male	Female	Total
Adult	5	13	18
1st year	5	3	8
Total	10	16	26

Table 4. Reported Nathusius' pipistrelles (*Pipistrellus nathusii*) from offshore platforms; showing differences between seasonal distribution and sex (χ^2=5.61, df=1, *P*=0.02).

Season	Male	Female	Total
Spring	2	10	12
Autumn	8	6	14
Total	10	16	26

low the 5th percentile and ten between the 5th and 25th percentile. The female with a body mass that was close to the median of animals found in bat boxes, was reported from Meetpunt Noordwijk, 10 km offshore.

The average length of the forearm of Nathusius' pipistrelles from the offshore platforms was on 33.61 mm and 34.17 mm, for males and females respectively, both within the ranges of male and female length of forearm (32.6-34.5 and 33.0-35.5 respectively) in Nathusius' pipistrelles from the mainland study area.

Noctule

One noctule (body mass 23 g, 11 km from the shore, wind: NW 3-4B, rainy weather) was received from platform L 15 A, another (body mass 20.5 g, 5 km from the shore, wind: NE 2B, dry weather; figure 6) from a survey station north of Ameland.

Northern bat

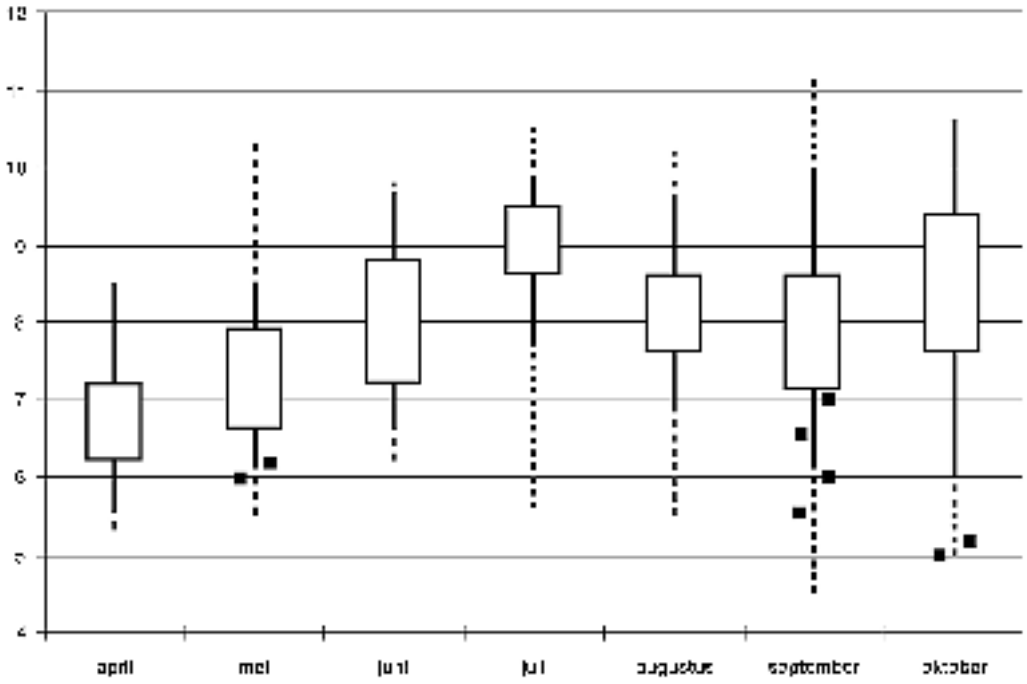
On 25 September 1993 an adult male northern bat (body mass 8 g, 69 km from the shore, wind: NE 2-3B, some showers) was found at platform K 12 Bravo. The bat was lean, but otherwise in good condition and this was the first documented case of this species in the Dutch sector of the North Sea (Boshamer 1993). In June 1998, an adult female (body mass 7.6 g, 50 km from the shore, wind: SW 4-6B, rainy weather; figure 6) was found at the Unocal Horizon Platform.

Serotine

On 28 July 2005 a first calendar year female serotine (body mass unknown) was collected from platform K 15B (61 km from the Dutch coast, wind: E→NW→W gentle breeze 2-3B, some rain; figure 6). This is the first documented case of this species in the Dutch sector of the North Sea. .

Parti-coloured bat

In August 2004 a male was brought in to Den Helder Airport from K 12 Bravo (69 km from the shore, wind: SW→N 2B, some rain). Eighteen months later a healthy female was reported from L 10 Alpha on 10 January 2006 (48 km from the shore, wind: E→SE 3B, -1 C°, no rain; photo 2). The last report from an offshore platform (figure 6) was from 7 May 2006 when an adult female was reported from K4BE (124 km from the shore,



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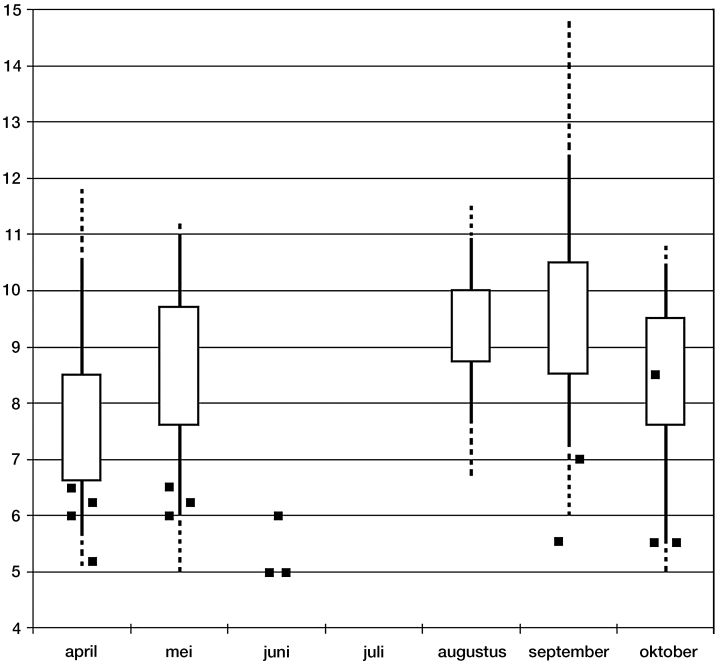

B

Figure 5. Box plots of the body mass of males (a) and females (b) Nathusius' pipistrelle (*Pipistrellus nathusii*) from on shore bat boxes (100%-95%-75%-25%-5%-0%) and from offshore platforms (black squares).

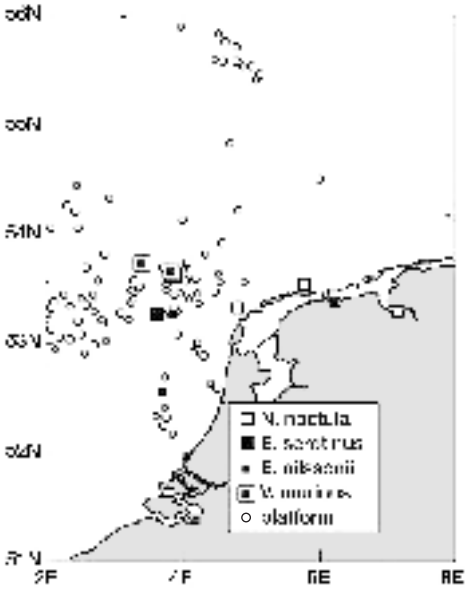

Figure 6. Distribution of noctule (*Nyctalus noctula*), northern bat (*Eptesicus nilssonii*), serotine (*Eptesicus serotinus*) and parti-coloured bat (*Vespertilio murinus*) reported from offshore platforms in the Dutch sector of the North Sea.

wind: E 3-4B, no rain). The body mass of the first two specimens was 11.5 and 12 g respectively, while that of the last one was not measured (normal range 10-15 g; Dietz et al. 2007). The oil offshore platforms where these recording were made were on average 83.3 km from the coast (n=3, sd=5.07).

Discussion

Bat spectrum

The species composition of bats found offshore differs greatly from those found in the adjacent coastal mainland area. Nathusius' pipistrelles and noctules are common species along the coast, but only the former was recorded in some numbers offshore. Records of northern bat represent new sightings within the Dutch sector of the North Sea (Boshamer 1993, Boshamer 1998). Common pipistrelles (*Pipistrellus pipistrellus*) common as a species on land, were not found on offshore installations.

Because of their position, and their orientation, which forms an extension of the Northern Dutch coastline The Wadden Islands are of particular interest for bats migrating along the coast. Table 5 compares all the species of bats (and their respective numbers) found on offshore platforms in the Dutch sector of the North Sea with the species of bats found on the Wadden Islands and the mainland of North Holland (numbers in km^2). The most common bats on the Wadden Islands are serotine and Nathusius' pipistrelle. Common pipistrelle and Daubenton's bat (*Myotis daubentonii*) occur in small numbers. Noctule and pond bat (*Myotis dasycneme*) are rare on the Wadden Islands. Daubenton's bats migrate over short distances at best, so it is understandable that this species, restricted to small, fresh waters, does not naturally occur over the sea. Pond bats are observed over large open water areas (such as the fresh-water IJsselmeer and the salt-water Wadden Sea) their migration to wintering areas up to 330 km away from their breeding grounds could lead to some individuals going astray in unfamiliar areas. Although by far the most numerous bat on the mainland, the common pipistrelle occurs only in low numbers on the Wadden Islands.

Photo 2. Parti-coloured bat (*Vespertilio murinus*) ♀, from platform L 10 A, 53°24'N, 04°12'E, 10 January 2006. *Photograph: Bert Pijs.*

Observations by other bat workers illustrate the diversity of bat species found along the Northern European coastlines. Ahlén (2006) recorded 104 foraging Nathusius' pipistrelles near offshore windmills, using automatic recording bat detector devices at Kalmarsund, a 15 km wide strip within the Baltic Sea, and at Öresund, a 3 km wide sea strait between Denmark and Sweden. He also recorded the ultrasonic signals of noctule (287x), northern bat (29x), serotine (34x), parti-coloured bat (44x) and other species (323x). Skiba (2007) used bat detectors to record bats on the island of Helgoland (Germany) (36 days between 2000 and 2006) and on the island of Borkum (8 days in 2006) during autumn migration (from one hour after sunset until 01.00 h). On Helgoland this resulted in recordings of Nathusius' pipistrelle (84x), noctule (12x), Leisler's bat (*Nyctalus leisleri*) (1x) and common pipistrelle (8x). In Borkum the recordings were of Nathusius' pipistrelle (37x), pond bat (3x), Daubenton's bat (2x), common pipistrelle (9x), northern bat (29x), serotine (1x) and parti-coloured bat (1x). It would be interesting to replicate these experiments and set up an automated system recording ultrasonic echolocation signals from offshore platforms all over the (Dutch part of the) North Sea. Such devices would not only produce considerably more 'sightings' of bats at sea, but also provide data that can be corrected for spatial and temporal patterns in observer effort.

Leisler's bat is another migratory species (Dietz et al. 2007), but there have been no reports from offshore platforms in the Dutch sector of the North Sea. On 5 September 1979 a dead adult female was reported on the Isle of Texel (53° 05' N, 4° 45' E; Boshamer 1991). In October 1990, the first named author obtained an adult female captured in Nieuw Den Helder (52° 56' N, 4° 44' E). Further south, an observation was made of a Leisler's bat on 28 September 1992 near the lighthouse on the Maasvlakte (Mostert & Wondergem 1993). This species is occasionally observed in the Netherlands in the eastern parts of Gelderland and Limburg provinces, but it is common in Britain. The Leisler's bats on the Wadden Islands and the Maasvlakte were far from their usual distribution range and their presence can be directly related to migration above and along the North Sea coast.

Walter et al. (2007) referred to a Leisler's bat found at the Uisge Gorm floating production and

Table 5. Species of bats in square kilometres on offshore platforms in the Dutch sector of the North Sea, the Wadden Islands and Noord-Holland. "Other species" of bats include whiskered bat (Myotis mystacinus), Natterer's bat (Myotis nattereri), greater mouse-eared bat (Myotis myotis) and greater noctule (Nyctalus lasiopterus) (after Kapteyn 1995, Vos 2007 and Kees Verschoor, personal communication).

	Offshore platforms	Wadden Islands	North Holland
Nathusius' pipistrelle	17	20	755
Noctule	2	7	237
Northern bat	2	0	0
Serotine	1	66	1032
Parti-coloured bat	3	0	4
Pond bat	0	5	546
Daubenton's bat	0	3	286
Common pipistrelle	0	10	1075
Leisler's bat	0	1	1
Brown long-eared bat	0	4	88
Other species	0	0	40

storage vessel in spring 2002. Skiba (2007) described a dead Leisler's bat from Memmert (East Frisian Isles - Germany) discovered on 11 June 1961. Corbet (1970) mentions this species being spotted at Nissetter, Shetland, on 24 July 1968. Baagøe and Bloch (1994) report an adult male observed on the landing strip of Mykines on the Far Oer (Denmark) on 28 June 1984. As this species has been reported on offshore platforms and islands in the North Sea (non Dutch sectors), it might be well possible that it will be found in the future on offshore platforms in the Dutch sector of the North Sea.

There have been incidental reports in British literature of brown long-eared bats (*Plecotus auritus*) being found far from the coast. Corbet (1970) mentions a group of brown long-eared bats 70 km off the coast of Yorkshire in November 1948 and a dead animal on a light ship (50 km east of Norfolk in October 1968). Hutson (1996) reports a brown long-eared bat on an offshore platform in the North Sea, 150 km off the coast in September 1996. Further afield, Barrett-Hamilton (1910-1911) reported two autumn records of brown long-eared bats on offshore lighthouses in Ireland. These observations suggest that this species might also be expected to be found on offshore platforms in the Dutch sector of the North Sea.

A grey long-eared bat (*Plecotus austriacus*) was found 18 km south of Bognor Regis (Sussex) in 1969 (Corbet 1971) in the British sector of the Channel. However, based on the distribution of this species in the Netherlands (where it is only found in the southern provinces of Zeeland, North Brabant and Limburg) its occurrence on offshore platforms in the Dutch sector seems unlikely.

Nathusius' pipistrelle

In this study the presence of Nathusius' pipistrelles on offshore platforms during migration cannot be explained as a result of the influence of prevailing south-easterly wind directions, nor of the daily mean wind speed. In autumn the daily mean wind speed during the relevant days on which the 14 Nathusius' pipistrelles were found was on average lower (though not significantly so) than on other days. However when selected for prevailing south easterly wind directions, the daily mean wind-speed was on average higher (almost, but not quite significant).

In our study strong winds (>5 and 6 Beaufort) occurred only occasionally in autumn and spring, on 12% and 28% respectively of the rest of the days when bats arrived at platforms, suggesting that wind-speed was not a major limiting factor for migration over sea. Vierhaus (2004)

mentions autumn migration peaks during periods with light to moderate breeze from a southerly or easterly direction. Nathusius' pipistrelles will seek refuge during periods of strong winds (Walter et al. 2007): offshore platforms or vessels are the only available options at sea.

In addition to records from offshore platforms, there are several records of bats visiting vessels travelling across the North Sea (all these instances concerned Nathusius' pipistrelles). In 1978 the first named author obtained a Nathusius' pipistrelle found onboard the hydrographical survey vessel Hr. Ms. Blommendal. On 14 September 2006, a Nathusius' pipistrelle flew in broad daylight towards a ship with bird observers and landed on board where it was caught, 22 km northwest of Den Helder (K. Mostert, personal communication). A male Nathusius' pipistrelle flew towards a beamtrawler (TX1), 60 km northwest of Den Helder (location 53˚ 07' N, 03˚ 05' E) in broad daylight on 13 October 2006. One week later, a Nathusius' pipistrelle landed on board beamtrawler TX 48, also in broad daylight (P. Bonnet, personal communication). Vauk (1974) recalls an incident with this species being captured onboard a vessel steaming between Amrum and Helgoland on 3 September 1927.

In November 1940, a male Nathusius' pipistrelle was found on Whalsay (Shetland Isles), the first ever sighting in Britain (Herman 1992). Until 1984 there had been only three documented observations in the British Isles (Stebbings 1988), but given recent reports of 'songflighting' males, copulating pairs and the presence of maternity colonies of Nathusius' pipistrelle, the species now must be regarded as a resident breeding species in this country (Russ et al. 2001).

Since 1984, several Nathusius' pipistrelles have been found on ships or offshore platforms in the British section of the North Sea (>10; Russ et al. 2001) and on remote British islands, particularly the Shetlands (more than twelve before 2000). There seems to be an increase in the number of Nathusius' pipistrelles observed in the British sector of the North Sea, which is consistent with developments in the Dutch sector. However, it has not been possible to make a correction for observer effort to confirm this trend.

More dispersed sitings of Nathusius' pipistrelles include records from 1971 (male) and 1985 (female) from the south west of Iceland (Petersen 1994) and one individual on a platform off from Brønnøysund, about 250 km north of Trondheim, Norway in September 2006 (van der Kooij, in prep.). The two specimens from Iceland were probably ship-assisted transports (Petersen 1994), but Van der Kooij (in prep.) assumes that the animal off Brønnøysund was a genuine migrant.

The increase of records of Nathusius' pipistrelle in Britain has been interpreted as an expansion of the range of this species (Stebbings 1988). Given the frequent occurrence of migratory Nathusius' pipistrelles along northern European coasts, it is not surprising that some individuals are found on offshore platforms or vessels at sea near the coast. The number of animals reported from offshore platforms is probably only a fraction of the actual number of animals that migrate over the North Sea.

The average body mass of male and female Nathusius' pipistrelles from the offshore platforms was substantially lower than that of bats from the mainland reference population. However, their structural size (forearm length), was similar, suggesting that the offshore animals must have been in a relatively poor condition. Despite the absence of a negative correlation between the body mass of the Nathusius' pipistrelles and the distance from the shore of the offshore platforms from where bats were recovered from this does not support the supposition that stranded Nathusius' pipistrelles used too much energy (and body mass) during this part of their migration.

Russ et al. (2001) concluded that "the occurrence of *P. nathusii* in May on North Sea platforms is consistent with migration in a north-easterly direction". The finding of two females half way between the UK and the Dutch coast during spring migration is in line with this view (Russ et al. 2001). However, not all Nathusius' pipistrelles migrate in spring. Russ et al. (1998) suggested that in Britain, where the winters are relatively mild, Nathusius' pipistrelle might relinquish its migratory behaviour in favour of a

more sedentary lifestyle, demonstrated by their forming nursery colonies. It is remarkable that two females were found at offshore platforms during the breeding period (June) since female Nathusius' pipistrelles usually migrate to breeding areas in northeastern Europe and only occasionally stay in the Netherlands, (reproduction has been verified on one occasion in Jisp, North Holland by Kapteyn & Lina 1994).

The results suggest that Nathusius' pipistrelles (as well as other bats) seek refuge on offshore platforms only after they became exhausted. They then need to stay in the vicinity of the platform and try and replenish their fat reserves to be able to leave again.

Noctule

Noctules were observed on offshore platforms during periods of onshore winds, so wind-drift is an unlikely factor in explaining their presence at sea. Racey (1990) reported a noctule from Fulmar Alpha (56º 30' N, 2º 10' E). This species is known on two of the Wadden Islands (Boonman et al. 1997) with incidental occurrences reported from the Shetlands and Orkneys (Racey 1977) and Helgoland in Germany (Mohr 1931, Vauk 1974). Because of the relative abundance of noctules during the migration periods along coastlines of northwestern Europe, we would expect this species more often than it was reported on offshore platforms.

Serotine

This paper documents the first case of this species in the Dutch sector of the North Sea. The serotine was found after a period of gentle, initial easterly, later westerly breezes, with showers. This animal could have been blown off course. Vauk (1974) recalled an old report of a serotine from Helgoland (Germany). Hutson (1991) reported the discovery of a serotine on the Shetlands which Baagøe and Bloch (1994) describe as a vagrant or a ship-assisted transport. The few other reports in the literature suggest that any future recordings from offshore platforms for this, generally numerous, species of bat in northwestern continental Europe will be quite rare.

Northern bat

The northern bats recorded from offshore platforms were seen in conditions that did not support the wind-drift theory (a slight north-easterly breeze preceding the first case, strong south-westerly winds prior to the second report). Baagøe (1981) reported a northern bat on a platform off of Aberdeen and Baagøe and Bloch (1994) found several specimens on the Faroe Islands. A possible migrant relation with the record of this species from Betchworth, Surrey (UK) (Gerell & Rydell 2001) remains open. The island reports and those of Greenway and Hill (1987) of the northern bat from the British Isles support the supposed vagrant status.

Parti-coloured bat

The first recorded parti-coloured bat was preceded by a wind direction that might have driven the animal off course, but given the low wind velocity and the excellent flying capacities of this species (Dietz et al. 2007) we are tempted to conclude that the animal should have been capable of withstanding the weather conditions. The second parti-coloured bat was found in winter, at quite a low temperature (-1.7°C) following moderate easterly winds (3 B). The weather conditions preceding observation of the last individual were characterised by a persistent easterly wind of 3-4 B. Given the wind directions, all the specimens that were obtained could have been blown off to sea. Since 1977, the parti-coloured bat has been found more regularly in the Netherlands up to 60 km from the coast. Between 1977 and 1995, nearly half (11 out of the 24) of the reports of this species in the Netherlands were obtained from coastal localities (Hollander & Limpens 1997). Stebbings (1977) mentions three records in mainland Britain, two of which date back to the early nineteenth century (Plymouth and Yarmouth) and one from 1927 (Whalsay, Shetlands).

In June 1965, a parti-coloured bat was reported from an oil platform in the British sector of the North Sea, 285 km east of Berwick (Stansfield 1966). Hill and Smith (1988) mention this spe-

cies in 1985, also reported from an oil platform. Racey (1990) records observations from the Shetlands (1981 and 1984). Baagøe and Bloch (1994) report a parti-coloured bat in Sandavágur on the Faroe Islands on 27 June 1988. The parti-coloured bat has reached the British Isles, and therefore has crossed the North Sea several times, however, up until now no breeding colonies in the UK have been reported. In northern Germany, Skiba (2007) recorded this species with a batdetector on Borkum.

The general direction of autumn migration of parti-coloured bats in Western Europe is from northeast to southwest. However, some populations are not migratory (Dietz et al. 2007). Migratory distances of up to 180 km night^{-1} have been documented (Strelkov 1969); thus the bats found on platforms in the Dutch sector of the North Sea may have come from further away than the Dutch coast. The specimens reported from offshore platforms on the (Dutch sector of the) North Sea, therefore have to be regarded as vagrants.

Insect availability over the sea

Even if most bats on platforms were underweight and probably in a relatively poor condition, it is worth investigating the possibility that bats voluntarily fly over the North Sea to feed. If so, what might attract them? Could, as Oddane (2001) inquires, the bats be attracted to forage on insects? Butterflies, moths, beetles and countless flying bugs are all known to travel across the North Sea, or to be blown over the sea by offshore winds (Hardy & Milne 1938). Heydemann (1967), investigating the spectrum of insects on the lightship in front of the Elbe in the North Sea, 30 km from the coast, found 90% of the catches, lured with coloured dishes, to be Diptera; Lepidoptera and Coleoptera were also present. He also found that more active flying insects were caught in low wind-speeds. With increasing winds, passively transported aeroplankton (such as drifting ballooning small spiders) were observed. Winter (1995), sailing in the Dogger Bank area, described the contents of pellets produced by a common gull (*Larus canus*) in which hoverflies (e.g. *Episyrphus balteatus*) were numerous. Observations onboard confirmed that the hoverflies were overabundant and taken in mid-air. Hoogendoorn (1997) reported black-headed gulls (*Larus ridibundus*) taking advantage of small spiders ballooning at sea, north of the Wadden Sea Islands. In exploring the phenomenon of insect migration, Drake and Farrow (1988) point to the importance of reverse circulation with alternating sea breezes at day and land breezes at night. Nocturnal flights of e.g. moths, several microinsects and ballooning small spiders are favoured by this situation. Most of these airborne insects fly for less than an hour, but other species fly for several hours, occasionally even all night.

The aerial plankton consist mainly of small or light-bodied insects with limited powers of flight but with a relatively large wing surface compared with body mass (Drake & Farrow 1988). It is unclear if this aerial plankton would be a suitable food source for bats flying above the sea or foraging from offshore platforms, due to the unpredictability of their presence. The low body mass of all bats found on offshore platforms may suggest that an adequate food supply over sea is very rarely available.

Predation

Various observers have reported bats flying onto ships in daytime. Bats at sea are very vulnerable to predatory birds and they are readily attacked. Bekker and Mostert (1991) report herring gulls (*Larus argentatus*) chasing and killing a bat flying near the sea surface in broad daylight. A similar incident was observed on 5 May 2006 near Huisduinen. An unidentified bat was chased by five herring gulls and was captured and eaten within ten minutes by one of the gulls (C. van der Vliet, personal communication). For bats, flying in broad daylight across the North Sea must be a risky business.

Light

The presence of 270 offshore platforms in the entire North Sea is one of many anthropogenic factors that may influence the presence and behaviour of fauna in various ways. Because offshore

platforms are stationary objects at sea, they are brightly illuminated, and thus have a clear beacon effect at night, being much more brightly lit than moving vessels. Although it is known that bats generally avoid artificial lighting, this raises the question of whether the brightly lit offshore platforms attract bats flying above the sea in the dark. Is the strong lighting as attractive to bats as it is to migrating birds? Another question raised is, whether, and to what extent, the lights attract insects in the summer, thereby providing an attractive source of food for bats travelling these waters? Incidental observations from ships show that bats leave ships by themselves once these vessels arrive at a harbour.

Answering these questions, and exploring relations with other (sub) populations of Nathusius' pipistrelle, as proposed by Dietz et al. (2007), will require a joint effort from all the countries surrounding the North Sea in conducting further research that can individually identify migrating bats with rings so and establishing the relations between different populations by means of tissue DNA samples from the wing membrane.

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Samenvatting

Ruige dwergvleermuizen (*Pipistrellus nathusii*) en andere vleermuissoorten op offshore-platforms in het Nederlandse deel van de Noordzee

In deze bijdrage worden de waarnemingen tussen 1988 en 2007 beschreven van vleermuizen afkomstig van offshore-platforms van het Nederlandse deel van de Noordzee. Het betreft merendeels ruige dwergvleermuizen (*Pipistrellus nathusii*) (*n*=26), maar ook rosse vleermuizen (*Nyctalus noctula*) (*n*=2), een laatvlieger (*Eptesicus serotinus*) en tweekleurige vleermuizen (*Vespertilio murinus*) (*n*=3) werden gemeld. Een voor het Nederlandse faunagebied nieuwe soort was de noordse vleermuis (*Eptesicus nilssonii*) (*n*=2). Alle vleermuizen werden aangeleverd via Den Helder Airport. Na ontvangst werden de dieren gedetermineerd, gesekst, opgemeten en gewogen. Tevens werd een indicatie van de leeftijd gemaakt aan de hand van de verbening van de epifysen en tandslijtage. Er blijkt, over periodes van vijf jaar gemeten, een toename van de aantallen aangebrachte vleermuizen met een piek in de periode 1998-2002. Voor ruige dwergvleermuizen van offshore platforms werd een vergelijking gemaakt met soortgenoten die sinds 1991 in vleermuiskasten in de Kop van Noord-Holland werden aangetroffen. De verdeling van de leeftijden en de geslachten bij de ruige dwergvleermuis blijkt te verschillen: van de mannen waren even veel adulte als jonge dieren (5 respectievelijk 5) terwijl bij de vrouwen er meer oudere dieren waren (13 respectievelijk 3). De verdeling van de geslachten over de jaargetijden bij de ruige dwergvleermuis blijkt ook te verschillen: van de mannen werden er 2 in de lente en 8 in de herfst op offshore platforms aangetroffen; bij de vrouwen waren die aantallen respectievelijk 10 en 6. Zowel mannelijke als vrouwelijke dieren afkomstig van offshore platforms hadden een significant lager gewicht. Bij analyse van de weersomstandigheden tot drie dagen voor de vangst op de offshore platforms is het niet aannemelijk gemaakt dat er meer ruige dwergvleermuizen werden gevonden na perioden met wind uit het zuidoosten. Het lijkt niet aannemelijk te zijn dat vleermuizen door voedsel boven zee zijn geraakt. Gezien het nog steeds toenemende scheepvaartverkeer, de intensivering van de winning van olie en gas, en de plaatsing van windturbineparken voor de kust mag verondersteld worden dat er in de nabije toekomst nog veel meer vleermuizen zullen worden aangeleverd. Ook in de andere sectoren van de Noordzee zullen vaker vleermuizen offshore gemeld gaan worden. Het spectrum aan soorten die er boven het Nederlands deel van de Noordzee worden waargenomen zal wellicht nog vergroot worden met bosvleermuis en mogelijk meervleermuis. Het is belangrijk dat de gegevens ter beschikking komen van al diegenen die werken aan het vergroten van de kennis en bescherming van deze diergroep. Zeker voor migrerende vleermuizen is internationale samenwerking noodzakelijk voor deze ook internationaal beschermde diergroep (Convention of Migratory Species of Wild Animals (Bonn 1997); Agreement on the Conservation of Bats in Europe).

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