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TECHNICAL REPORT – BATS 2023-2024

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SUMMARY

INTRODUCTION

The Hesselø Offshore Wind Farm (OWF) is planned for the Danish part of the Kattegat, about 30 km north of Zealand and 25 km east of Djursland, covering 166 km². In preparation for the environmental impact assessment, a bat monitoring program has been conducted from spring 2023 to autumn 2024, to establish baseline data on bat migration and activity in both offshore and coastal zones.

EXISTING DATA AND KNOWLEDGE

Bats are primarily terrestrial and cannot rest on open water, making sea crossings risky. However, some species migrate seasonally across marine areas or forage over the sea when insect concentrations are high. Long-distance migratory bats, such as Common noctule and Nathusius's pipistrelle, are potentially vulnerable to offshore wind farms. Previous studies in Kattegat are limited, but available data and regional knowledge suggest these two species are the most likely to migrate through the area. Migration typically occurs in spring (April–June) and autumn (August–October).

METHODOLOGY

Bat activity was monitored using detectors mounted on six offshore buoys and at selected coastal sites in Denmark and Sweden. Offshore detectors were placed about 2.5 meters above sea level and recorded bat calls nightly. A vessel-based detector was used in 2023 but yielded little useful data. Coastal detectors were installed to identify migration timing and potential departure points. Data were analysed using automated software and manually reviewed to ensure species-level identification, with some acoustically similar species grouped as "Nyctaloid bats."

DATA AND RESULTS

Offshore bat activity in the Hesselø area was low but showed clear seasonal and spatial patterns. Across two years, 48 offshore detections were recorded 14 in 2023 and 34 in 2024. Most detections were Nyctaloid bats, followed by Nathusius's pipistrelle and Soprano pipistrelle. Offshore activity was highest in the southern part of the area. Nathusius's pipistrelle detections increased substantially in 2024, with the highest single event during spring migration. Nyctaloid bats were present in early August 2024, possibly indicating foraging or early migration. Offshore bat activity was concentrated during the darkest hours of the night and was strongly associated with warm temperatures and low wind speeds. All offshore bat recordings occurred at temperatures above 10°C and wind speeds below 8 m/s, with a clear preference for low wind speeds. Wind direction data suggested that bats may use tailwinds for sea crossings, but the origin of individuals remains speculative.

Data from Hesselø Island, regarded as offshore data due to its distance from the mainland, showed higher bat activity than offshore buoys. The island serves as a stopover and foraging site, especially for Nathusius's pipistrelle and Parti-coloured bats. In 2023, a larger foraging event by Parti-coloured bats was observed in spring, but this did not recur in 2024. Soprano pipistrelle was recorded in low numbers, with some evidence of migratory and foraging activity.

Coastal detectors recorded a mix of local and migratory bat activity, with clear migration peaks for Nathusius's pipistrelle in spring and autumn. Soprano pipistrelle and Nyctaloid bats were also common, but their migratory signals were less distinct due to the presence of resident populations. Coastal activity was highest during migration periods, supporting the interpretation of offshore patterns, but direct comparison is limited due to differences in detection range and behaviour of bats near land.

STATUS AND CONCLUSION

The survey confirms that the Hesselø area is used by both migrating and foraging bats, with seasonal and weather-dependent variations. Larger species are more likely to forage offshore, while smaller species primarily pass-through during migration. Offshore bat activity is influenced by proximity to land, weather conditions, and possibly the availability of insect prey. The findings provide a valuable baseline for assessing potential impacts of offshore wind development on bat populations.

DATA AND KNOWLEDGE GAPS

Challenges in offshore monitoring include equipment malfunctions, limited detection range, and sparse data on flight altitude. Weather data from nearby stations may not fully represent offshore conditions. The origin of bats entering the offshore area is difficult to determine due to multiple potential coastal departure points. These limitations highlight the need for continued research to improve understanding of offshore bat ecology.

INTRODUCTION

In 2018, all parties in the Folketing (Danish parliament) decided to build three new offshore wind farms, including Hesselø Offshore Wind Farm (OWF), which was part of the next steps towards achieving 100% renewable energy in the electricity system in 2020. It was decided in the climate agreement in 2020 that Hesselø OWF should distribute power to the electricity market in 2027. However, the tender process was put on hold in June 2021, after preliminary studies had shown areas of soft seabed in large parts of the area. In the climate agreement from June 2022, it was decided that the area for the Hesselø OWF should be moved to the southwest of the original area. The installed power remains the same, namely 800-1,200 MW, and there have been no changes to the corridor for the export cables to land or to the plan for the associated facilities on land.

In the agreement about tender framework agreed by the Danish Parliament in May 2025, it was decided that the tender for Hesselø OWF will be launched in autumn 2025, with deadline in spring 2026. According to the plan, Hesselø OWF should be established in 2032.

The planning area for the Hesselø OWF is located in the Danish part of the Kattegat, approximately 30 km north of Zealand and approximately 25 km east of Djursland (Figure 1). The area covers approximately 166 km^2. The offshore wind farm is connected to the electricity grid on land via export cables, which are brought ashore at Gilbjerg Hoved, west of Gilleleje on Zealand's north coast.

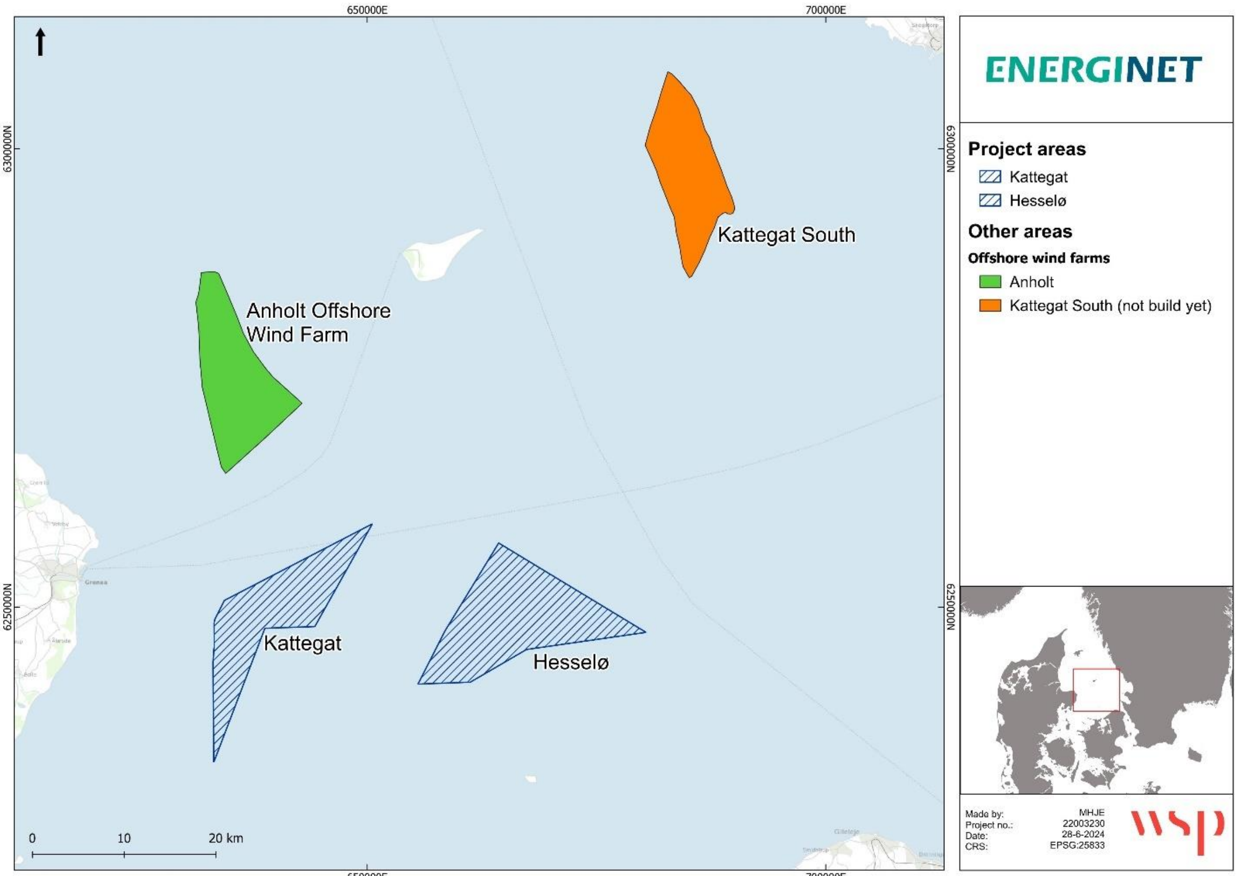

Figure 1 - Overview of existing and planned offshore wind projects in southern Kattegat.

Bat migration across the offshore areas of Denmark remains poorly understood, and to date, no baseline data have been available from the southern part of Kattegat. With several offshore wind farms planned in this region, there is a growing need for information on bat migration patterns and behaviour to support environmental impact assessments.

To contribute to the environmental impact assessment for the planned Hesselø Offshore Wind Farm (OWF), a bat monitoring program was initiated by Energinet in spring 2023 and completed in autumn 2024. This technical report presents the data and findings collected over both survey years.

A similar bat monitoring program has been conducted for the nearby Kattegat OWF area (see (Figure 1). While this report focuses on bat data related to the Hesselø OWF, information from the broader region should also be considered in future impact assessments, to ensure a comprehensive understanding of bat activity across the southern Kattegat.

EXISTING DATA AND KNOWLEDGE

Bats are primarily associated with terrestrial environments, spending most of their lives in forests, open landscapes, or urban areas ((Baagøe, et al., 2007; Elmeros, et al., 2024). Unlike some bird species, bats are unable to rest on the sea surface, making overwater flight inherently riskier than flight over land (Troxell, et al., 2019).
Despite this, there are two main reasons why bats may be observed flying over the sea. First, several bat species undertake seasonal migrations between Northern Europe in summer and Central or Southern Europe in winter (Hutterer, et al., 2005). These migratory routes may partially cross marine areas. Second, bats may fly over the sea to forage. In late summer and early autumn, insect concentrations above the sea can be high, providing a valuable food source that may attract bats (Ahlén, et al., 2009).

BAT MIGRATION

Bat species can be broadly categorized into three groups based on their typical migration distances (Figure 2). The first group consists of long-distance migrants, which may travel several hundred to several thousand kilometers between seasonal habitats. The second group includes short-distance migrants, which typically move up to around 100 kilometers, often between breeding sites and winter roosts. Most bat species in Northern Europe fall into this category. The third group comprises sedentary species, which rarely move more than a few kilometers from their breeding and roosting sites.

Long-distance migratory bats are considered the most vulnerable to offshore wind farms due to their extensive flight paths and potential exposure to offshore infrastructure (Rydell, et al., 2010; Voigt, et al., 2012; Lehnert, et al., 2014; Arnett, et al., 2011; Kruszynski , et al., 2020).

It is generally assumed that most migratory bats avoid long sea crossings when possible. As a result, major migration routes are expected to follow coastlines and land corridors until a sea crossing becomes unavoidable. In Northern Europe, large numbers of bats are known to migrate from Finland, the Baltic States, and Sweden toward the Netherlands, Belgium, northern France, and even southern England.

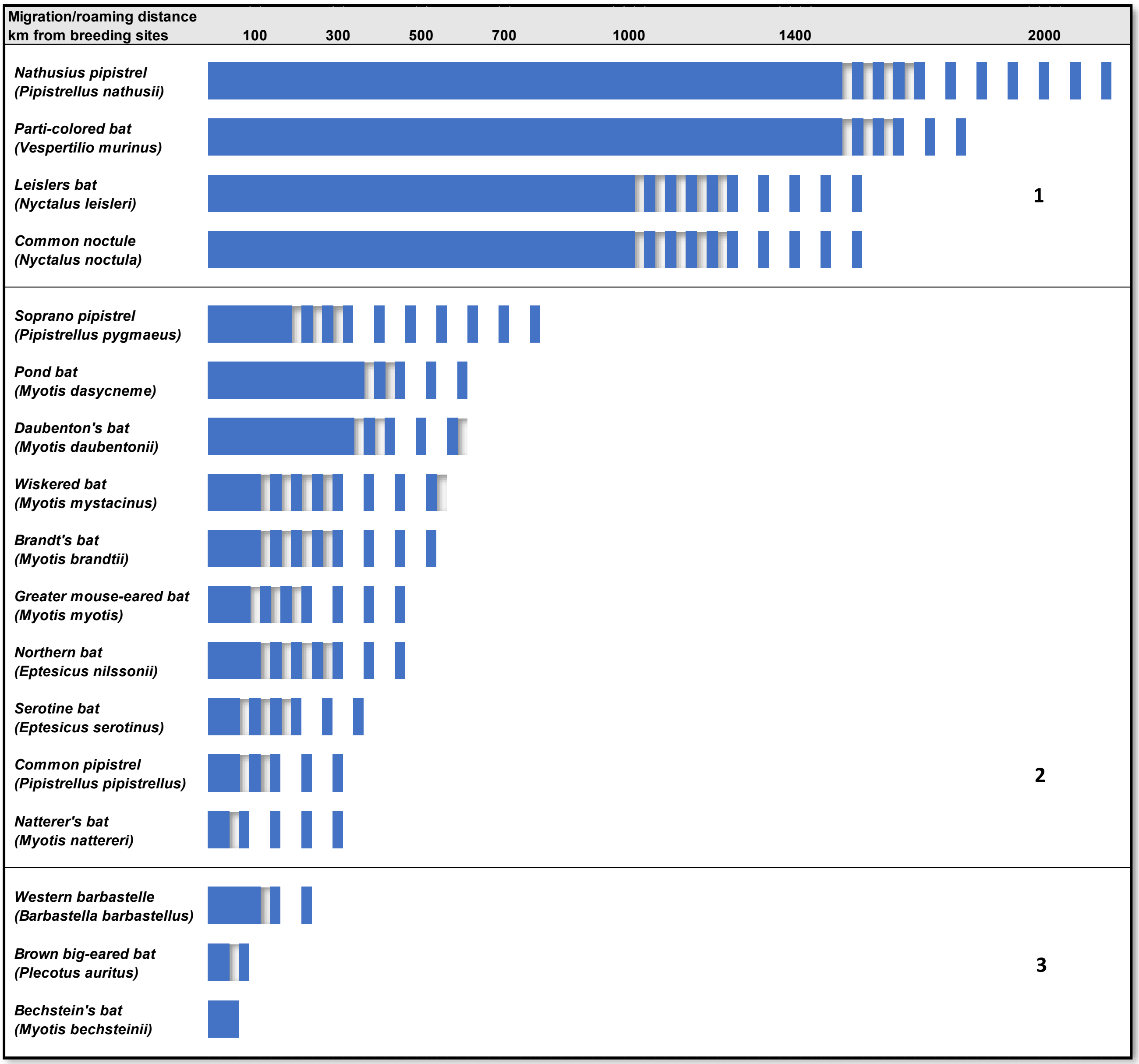

Figure 2 – General distance of migration and roaming for bat species found in Denmark. Figure from (Christensen, et al., 2023) (Translated from Danish). Based on sources: (Baagøe, 2001; Pētersons, 2004; Hutterer, et al., 2005; Dietz, et al., 2011; Baagøe, et al., 2007; Alcalde, et al., 2021) a.o.

BATS FEEDING IN MARINE AREAS

During the summer months, most bats remain at or near their breeding sites, where they forage on the abundant insect populations in the surrounding area. However, under suitable weather conditions, some species are known to forage in marine areas, occasionally at considerable distances from the coast. The extent and frequency of such offshore foraging behaviour remain poorly documented.

It is generally assumed that most of the bat activity over the sea occurs near the coastline, where insect densities are typically higher. Activity is expected to decline with increasing distance from shore, although further research is needed to quantify this pattern.

OFFSHORE BAT SURVEYS IN SOUTHERN KATTEGAT

There are few studies on bat migration over the Kattegat between Denmark and Sweden and Norway and most of them are not public available. This is the case for two projects in the Swedish part of northern Kattegat (Poseidon and Vidar) and Kattegat Syd east of Anholt. Also, no bat survey was carried out prior or post the construction of Anholt Offshore Windfarm, west of Anholt, in the Danish part of Kattegat. The most relevant, and available, information is the survey carried out for Sejerø Nearshore Wind Farm in 2014 (DHI, 2014).

BAT SPECIES MIGRATING THROUGH SOUTHERN KATTEGAT IN LARGER NUMBERS

Two species of bats, Common noctule and Nathusius's pipistrelle, are most likely to migrate through the pre-investigation area in larger numbers, because both species are known to migrate long distance and both species are present in large populations in Sweden (Westling, et al., 2020), Finland (Tidenberg, et al., 2019), and the Baltic countries (EUROBATS, 2015).

COMMON NOCTULE (NYCTALUS NOCTULA)

Common noctule is widespread and common in Denmark (Møller, et al., 2013) and Sweden (De Jong, 2020; Westling, et al., 2020) (Figure 3). The Swedish population is estimated to 130,000 individuals (De Jong, 2020; Westling, et al., 2020).
Common noctule is a typical migratory bat species. Populations from north-eastern Europe are known to migrate southwest in autumn, thus covering distances of several thousands of kilometres. Due to the weather conditions, western populations tend to be more sedentary (Lehnert, et al., 2018).
Common noctule occur in small numbers in coastal bat surveys in the Kattegat ((DHI, 2015) (DHI, 2014))(**Error! Reference source not found.**) and it is expected that the Common noctule migrates t hrough the pre-investigation area.

Figure 3 - Distribution of Common noctule (Source: EUROBAT).).

NATHUSIUS'S PIPISTRELLE (PIPISTRELLUS NATHUSII)

Nathusius pipistrelle is widespread and common in Denmark (Møller, et al., 2013) and Sweden (De Jong, 2020) and the distribution in the region also include southwest Norway, the Baltic countries and southernmost Finland (Figure 4Figure 4). The Nathusius's pipistrelle undertakes a seasonal long-distance migration, usually from northeast to southwest Europe, and it is likely to migrate through the pre-investigation area.

Figure 4 - Distribution of Nathusius's pipistrelle (Source: EUROBAT).).

BAT SPECIES MIGRATING THROUGH SOUTHERN KATTEGAT IN SMALL NUMBERS

PARTI-COLOURED BAT (VESPERTILIO MURINUS)

Parti-coloured bat is common in the northern part of the island Zealand (Denmark) (Møller, et al., 2013). Particoloured bat has a scattered distribution in Sweden (De Jong, 2020) and Kattegat may represent the northernmost part of the species' distribution. Parti-coloured bat is a long-distance migratory species, and even though there are no major population north of Kattegat the species might occur in the marine pre-investigation area in small numbers.

LEISLERS BAT (NYCTALUS LEISLERII)

Leislers bat is only recorded a few times on in Denmark (Møller, et al., 2013) and is very rare in Sweden (De Jong, 2020). Large numbers of Leislers bats are not expected in southern Kattegat.

NORTHERN BAT (EPTESICUS NILSSONII)

Northern bat is common in Sweden (De Jong, 2020; Westling, et al., 2020) but rare in Denmark (Møller, et al., 2013). Although northern bat appears to be a sedentary species, ring recoveries have shown that they occasionally fly longer distances. None of the previous offshore surveys in Kattegat recorded northern bats and it is therefore not expected that the species will occur in in southern Kattegat.

SEROTINE BAT (EPTERSICUS SEROTINUS)

Serotine bat is a common species in most part of Denmark (Møller, et al., 2013). In Sweden the species is rather rare and only found in the southernmost part of the country (De Jong, 2020). Serotine bat is rather sedentary and the distance between summer and winter roosts tends to be small (Baagøe, et al., 2007). It is therefore not expected that the species will occur in significant numbers in the pre-investigation area.

SOPRANO PIPISTRELLE (PIPISTRELLUS PYGMAEUS)

Soprano pipistrelle is widespread and common in Denmark (Møller, et al., 2013) and in southern Sweden (De Jong, 2020). Due to its abundance and occurrence in Denmark and southern Sweden it is likely that a small number of Soprano pipistrelle may migrate through the southern Kattegat and therefore the pre-investigation area.

COMMON PIPISTRELLE (PIPISTRELLUS PIPISTRELLUS)

Common pipistrelle is widespread and common in southern parts of Denmark (Møller, et al., 2013) and found scattered in southern Sweden (De Jong, 2020). Common pipistrelle is a rather sedentary species, with summer and winter roosts often less than 20 km apart (Baagøe, et al., 2007). However, long distance migrations have also been recorded. It is possible that a small number of Common pipistrelle may migrate through the pre-investigation area.

POND BAT (MYOTIS DASYCNEME)

Pond bat is rather common in the northern parts of Jutland (Møller, et al., 2013) but rare in Sweden (De Jong, 2020). Pond bat is often observed along the east coast of Jutland but seem to be limited to a distance of only few kilometres from the coast. Large number of migrating pond bats are not likely to occur in the pre-investigation area.

DAUBENTON'S BAT (MYOTIS DAUBENTONII)

Daubenton's bat is common in Denmark (Møller, et al., 2013) and in Sweden (De Jong, 2020). Daubenton's bat is a migrant species and is known to fly up to 150 km between roosts. The migration seems however, primary to be over land along rivers and lakes. Daubenton’s bat is rarely observed offshore, and large number are not expected in the pre-investigation area.

BRANDT’S BAT (MYOTIS BRANDTII)

Brandt’s bat is widespread and common in Sweden (De Jong, 2020) but rare in Denmark ((Møller, et al., 2013)). Brandt’s bat is an occasional migrant, but the distances covered are usually no more than 40 km. Large numbers of Brandt’s bat migrating through the pre-investigation area are considered unlikely.

WHISKERED BAT (MYOTIS MYSTACINUS)

Whiskered bat is common and widespread in Sweden (De Jong, 2020) but not recorded in Denmark besides from on the island Bornholm in the Baltic Sea (Møller, et al., 2013). Whiskered bat is an occasional migrant, but the distances covered are usually small. Large numbers of whiskered migrating through the pre-investigation area are considered unlikely.

BAT SPECIES UNLIKELY TO MIGRATE IN SOUTHERN KATTEGAT

WESTERN BARBASTELLE (BARBASTELLA BARBASTELLUS)

Western barbastelle is only recorded in the southern part of Zealand and the islands in southern Denmark (Møller, et al., 2013) and is rare in Sweden (De Jong, 2020). Western barbastelle is largely a sedentary species; the distance between summer and winter roosts are usually below 40 km. Occurrences in the offshore parts of Kattegat far away from the coast are therefore considered unlikely.

BROWN BIG-EARED BAT (PLECOTUS AURITUS)

Brown big-eared bat is common and widespread in Denmark (Møller, et al., 2013) and Sweden (De Jong, 2020), but the brown big-eared bat is a very sedentary species (Dietz, et al., 2011). Occurrences over the sea in Kattegat far away from the coast is considered unlikely.

GREATER MOUSE-EARED BAT (MYOTIS MYOTIS)

Greater mouse-eared bat is a regional migrant, whose movements between traditional summer and winter roosts usually range from 50 to 100 km. It is only regularly breeding south of the Baltic Sea (BfN, 2008) and there are only very few records from Sweden (De Jong, 2020). Because Kattegat is situated outside the main distribution area of the species (Dietz, et al., 2011), it seems unlikely that the species will occur in the pre-investigation area.

NATTERER'S BAT (MYOTIS NATTERI)

Natterer's bat is common and widespread in Sweden (De Jong, 2020) and scattered in Denmark (Møller, et al., 2013). Natterer's bat is generally considered a sedentary species; however, some individuals are known to have covered long distances (Dietz, et al., 2011). Due to its sedentary nature and the very few recordings of short- to long distance migrating behaviour, large numbers of Natterer's bat in the pre-investigation area are considered unlikely.

TIMING OF BAT MIGRATION OVER THE SOUTHERN KATTEGAT

Systematic studies of bat migration in the Kattegat region are currently limited. As a result, the expected timing of migration is inferred from general knowledge and observations from Denmark and Sweden. Spring migration is anticipated to begin in April and continue through early June, while autumn migration typically starts in August and may extend into late October.

CLIMATE CHANGE AND THE TIMING OF BAT MIGRATION

The timing of bat migration is closely linked to the availability of specific insect species that serve as primary food sources. Changes in winter temperatures and shifts in the timing of spring and autumn can influence insect abundance and distribution, potentially affecting bat migration patterns. However, the extent to which these environmental changes impact migration timing and how quickly bats can adapt remains uncertain.

An eight-year dataset from Falsterbo in southern Sweden suggests a shift in the timing of autumn migration for Nathusius' pipistrelle, with the median migration date moving from late August in 2012 to late September in 2019 (Bach, 2021). This indicates that autumn migration may be particularly sensitive to temperature changes during August, September, and October. In general, bats are likely to remain longer in their breeding areas if insect availability remains high.

Spring migration is more difficult to predict, as bats cannot assess environmental conditions at their destination in advance. Instead, the timing of departure from wintering areas is believed to be influenced primarily by factors such as day length and internal physiological cues.

METHODOLOGY

The field survey programs for bat detection in offshore and coastal areas are inspired by methods developed by BSH *(Bundesamt für Seeschifffahrt und Hydrographie, October 2013)* in StUK4 *(Standard Investigations of the impacts of Off-shore Wind Turbines in the Marine Environment),* and *technical requirements to the monitoring of bats (TA nr. A04, ver. 3, latest review 30.05.2018, DCE University of Aarhus)*. However, there are no standard survey methods developed for offshore bat surveys and therefore, different methods were applied during this survey programme. The method for the coastal onshore survey was selected mainly to support and supplement the results from the offshore survey. Therefore, the type of detectors and settings onshore are similar to offshore detectors, except for the box design and battery type.

The surveys mainly focused on the most likely migratory seasons; spring (from mid-March to mid-June) and autumn (from August to October), but due to the uncertainty of bat activity offshore and the possibility of foraging bats during the summer season, the offshore monitoring was conducted throughout the entire period from April to October. In both 2023 and 2024, no bats were recorded offshore before mid-April and consequently, all graphs below only show bat activity from 1st of April to 31st of October.

OFFSHORE BUOY BASED SURVEY

Bat detectors were attached to 6 buoys used for the marine mammal Passive Acoustic Monitoring (PAM) survey program conducted by WSP & BioConsult (Figure 5). The initial mountings of the bat detectors to the PAM stations were carried out during a PAM-service expedition in March 2023. The bat detectors were mounted on the buoys by a bat detector technician. The detectors were placed near the top of the PAM-buoys, approximate 2.5 metres above sea level. The mounting position of the detectors ensured that the detectors were protected from direct contact with the saline seawater. However, rough weather conditions could cause the buoys to be more or less submerged, thus exposing the detectors to seawater. In order to protect the microphone from intake of saline seawater, a special Gore-Tex membrane was applied to the detector casings. This membrane was specifically designed to prevent water intake and ensure non impaired sound recordings through the membrane. A preliminary test before the initiation of the project showed, that more than 95 % of all bats were recorded on detectors equipped with the Gore-Tex protected microphones.

The PAM-mounted bat detectors collected recordings of all bats passings at these six positions (Figure 6) in the pre-investigation area during spring, summer, and autumn (1st of April to 31st of October) in 2023 and 2024.

The service of the bat detector was coordinated with the service of the marine mammals PAM- service expeditions. During these expeditions, the crew also replaced all the bat detectors.

Figure 5 - PAM bat detector mounted on a buoy used for the C-POD station in the marine mammal survey.

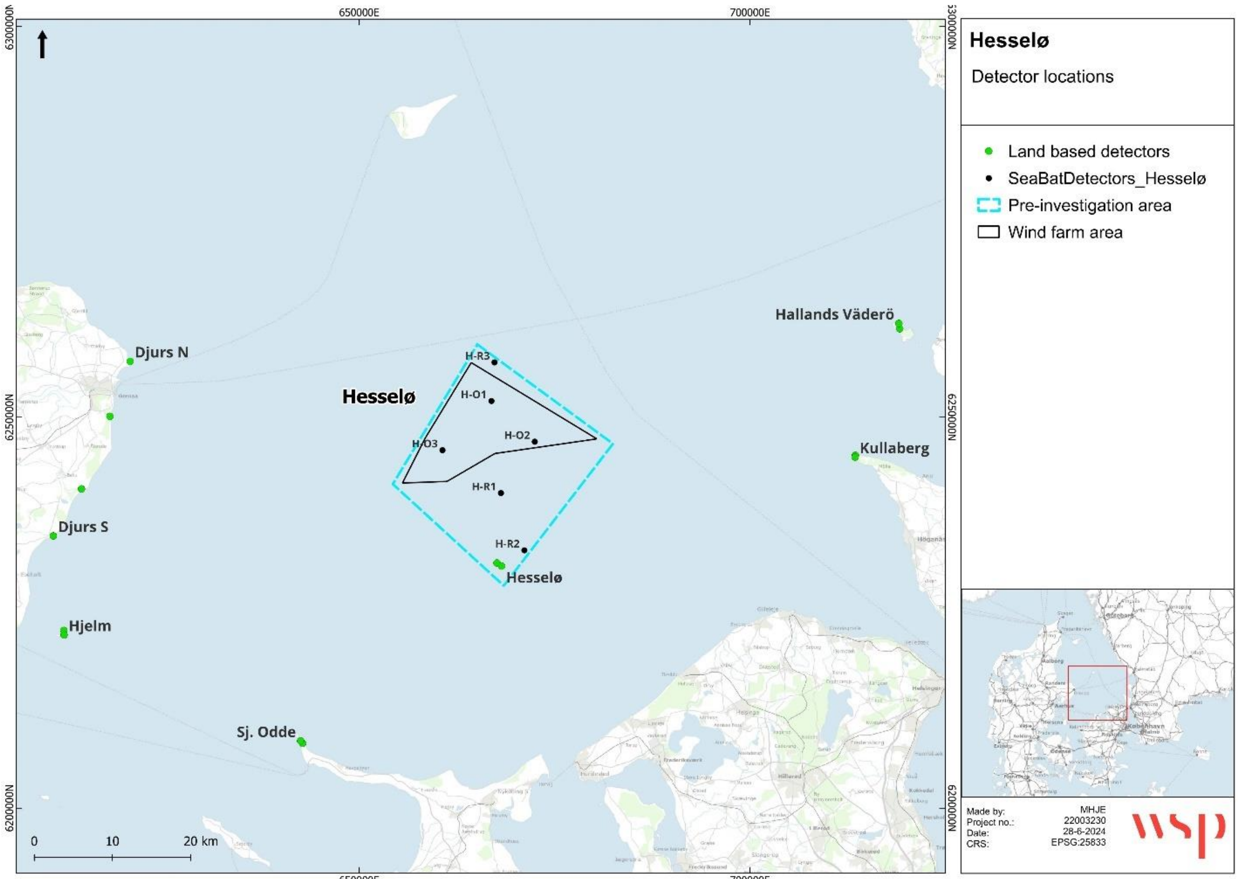

Figure 6 - Map showing the position of the buoys used for the survey. Bat detectors on Djursland, Hjelm, Sjællands Odde, Hesselø, Kullaberg and Hallands Väderö (green dots) and on six buoys within the pre-investigation area for Hesselø Offshore Wind Farm (black dots). All land-based detectors were installed from April to November in 2023 and 2024.

Table 1 gives an overview of stations used in the buoy-based bat survey and which periods the detectors were deployed and recording.

Table 1. Deployment periods for buoy-based bat detectors

	2023		2024	
Stations	**Spring**	**Autumn**	**Spring**	**Autumn**
H-O1	-	16. Aug. – 31. Oct.	1. Apr. – 1. Jul.	2. Jul. – 31. Oct.
H-O2	1. Apr. – 15. Aug.	16. Aug. – 31. Oct.	1. Apr. – 1. Jul.	2. Jul. – 30. Sep.
H-03	1. Apr. – 15. Aug.	16. Aug. – 31. Oct.	1. Apr. – 1. Jul.	8. Sep. – 18. Oct.
H-R1	-	16. Aug. – 31. Oct.	1. Apr. – 24. Aug.	9. Sep. – 2. Oct.
H-R2	-.	16. Aug. – 31. Oct.	1. Apr. – 26. Aug.	7. Sep. – 31. Oct.
H-R3	-	16. Aug. – 31. Oct.	5. May – 23. Aug.	8. Sep. – 31. Oct.

OFFSHORE VESSEL BASED SURVEY

The survey vessel Skoven has been visiting pre-investigation area for different purposes throughout the survey period in 2023. A bat detector has been installed on the vessel (Figure 7). The bat detector was programmed to record completely independently with no assistance from the staff onboard the vessel. The bat detector recorded the ultrasound from bats around the vessel and saved the recording for later analysis. The bat detector also recorded the position of the vessel and the time. Weather conditions (wind direction, wind speed and temperature were taken from the vessels logbook). The vessel-based bat surveys included data collection from March 2023 to October 2023.

Figure 7 - PAM bat detector (box in front) mounted on the survey vessel Skoven.

COASTAL (ONSHORE) SURVEY

Concentration and activity of bats onshore, in the coastal regions, may be a strong indicator for migration trends.

During spring (April-June) and autumn (August-October), the migrating bat species may concentrate along the coast, waiting for the right weather conditions for crossing the sea. Therefore, the level of activity measured along the coast can help to understand when a migration through the pre-investigation area occurs. Hence, a land-based survey was set up, and the survey included data collection from April to October in 2023 and 2024.

The main migration of bats through the pre-investigation area is expected to occur from southwest to northeast in spring and from northeast to southwest in autumn. Therefore, seven sites on the coast of Djursland, Sjællands Odde peninsula, the East Coast of Sweden as well as two small islands in Southern Kattegat were selected because of high probabilities for acting as exit or entry points for migrating bats (Table 2).

Coastal studies provide knowledge of how bats concentrate and most likely start migration from landsites that minimize migration distance over open water, as well as provide knowledge about potential feeding activities offshore during certain weather conditions in the pre-investigation area. Therefore, the survey stations in the survey programme not only include Danish sites, but also sites of adjacent countries.

A total of 15 detectors (Figure 6) in seven different areas along the coast of Djursland, Sjællands Odde peninsula, Hesselø and Hjelm in Denmark, as well as Hallands Väderö and Kullaberga in Sweden, were installed during the survey periods, monitoring bat activity throughout the migration seasons in order to describe and quantify the number of bats waiting near the coast for ideal weather conditions to migrate. Most sites had two detectors with one detector functioning as a backup in case of technical failure (Table 2). At the coast of Djursland four single detectors were places with 10-15 km distance to cover the potential variation along the coast. In the later analysis, the results are grouped for these locations based on similarities in the observed recording patterns.

Table 2. Deployment periods for coastal bat detectors

	2023		2024	
Stations	**Spring**	**Autumn**	**Spring**	**Autumn**
Kullaberg (2 detectors)	1. Apr. – 7. Aug.	8. Aug. – 31. Oct.	-	10. Aug. – 2. Oct.
Hallands Väderö (3 detectors)	1. Apr. – 7. Aug.	8. Aug. – 31. Oct.	1. Apr. – 7. Aug.	8. Aug. – 31. Oct.
Djursland N (2 detectors. 1 on each subsite)	1. Apr. – 7. Aug.	8. Aug. – 31. Oct.	1. Apr. – 7. Aug..	8. Aug. – 22. Sep.
Djursland S (2 detectors. 1 on each subsite)	1. Apr. – 7. Aug.	8. Aug. – 31. Oct.	1. Apr. – 7. Aug..	8. Aug. – 22. Sep.
Sjællands Odde (2 detectors)	1. Apr. – 7. Aug.	8. Aug. – 31. Oct.	1. Apr. – 7. Aug..	8. Aug. – 24. Sep.
Hesselø (2 detectors)	1. Apr. – 7. Aug.	8. Aug. – 31. Oct.	17. Apr. – 7. Aug.	8. Aug. – 11. Oct..
Hjelm (2 detectors)	-	-	17. Apr. – 7. Aug.	8. Aug. – 31. Oct.

All detectors were mounted in trees or other structures in approximate three meters height. The specific mounting locations were selected close to open space, in areas where bat activity was expected (Figure 8).

Figure 8 – *Bat detector mounted on an ash tree on Hesselø island.*

DATA ANALYSIS

MEASUREMENT CONFIGURATIONS

Data collection for both the buoy-based, the vessel-based and the coastal (onshore) bat surveys were conducted using detectors, which all were based on AudioMoth technology but enhanced with an external microphone and a large battery pack (Figure 5 & Figure 8). All detectors were configured to record all bat activity from half an hour before sunset to half an hour after sunrise. Recordings were segmented into 5-second intervals, separated by 10-second pauses. The configurations used on this project are similar to the ones used on bat survey on Energy Island Bornholm (WSP, 2024b), Kattegat OWF (WSP in press) and Kriegers Flak II OWF (WSP in press). The detector configurations are presented in Table 3.

Before deployment all detectors were calibrated to ensure comparability. Detectors with a microphone that performed less than 90 percent of the standard microphone performance were not used.

Table 3 - Configuration of the detectors.

Parameter	Unit	Setting
SD card	GB	256
Sample rate	kHz	192
Gain	-	Medium
Cyclic recording	s	Recording 5 – pause 10
Trigger type		Amplitude
Minimum trigger frequency	kHz	15
Max duration	s	5

Compression	-	WAW

POST PROCESSING

The initial analysis of all bat detection data collected onshore, offshore buoy-based and vessel-based, was performed using Wildlife Acoustics Kaleidoscope Pro software with the automatic identification algorithm enabled. Kaleidoscope analyzes all files for the presence of bat calls based on the signal parameters summarized in Table 4. Files that do not meet these parameters are labeled as noise and deleted by the software. The remaining output files are then analyzed by the Auto-ID function using a classifier library (Bats of Europe 5.4.0) containing calls of relevant bat species. The output files and their contents from Kaleidoscope are summarized in Table 5.

Table 4 - Signal parameters.

Parameter	Unit	Settings
Minimum frequency	kHz	8
Maximum frequency	kHz	120
Minimum pulse length	ms	2
Maximum pulse length	ms	500
Maximum inter-syllable gap	ms	500
Minimum number of pulses	ms	2
CF (cutoff frequency) noise filter maximum frequency	kHz	0
CF (cutoff frequency) noise filter maximum bandwidth	kHz	0

Table 5 - Output files of the Auto-ID process.

Output file	Description
meta.csv	The meta.csv file is a catalog of the input recording files which were processed in the batch.
id.csv	The id.csv file contains a list of all input files and their Auto-ID analysis results. The file also contains extensive statistical information regarding the content of the input files including these main parameters: - AUTO-ID – This field shows the automatic classification result - MATCHING - Number of pulses matching the auto classification result - MATCH RATIO - The ratio of MATCHING over PULSES - MANUEL ID – Manuel identification
idsummary.csv	The idsummary.csv file provides a summary of which species were detected in the Auto-id analysis.
settings.ini	This file is a snapshot of every setting in Kaleidoscope Pro at the time of the Auto-ID for Bats batch process. The settings.ini file is additionally useful because it provides a record of any custom Button Labels in the Viewer
db-batch.wdb	This file contains no actual database records but defines the structure of the database.

MANUAL ANALYSIS

Due to the varying success rates of the Auto-ID function in Kaleidoscope Pro, a manual review of files was conducted by personnel with bat identification expertise. Experience with Kaleidoscope Pro's Auto-ID indicates that the software achieves nearly 100 % accuracy with certain species, such as the Soprano pipistrelle, which performs acoustic output at levels of approximately 50 kHz. However, it has less than 20 % accuracy with other species, such as the Common noctule, which performs acoustics at levels of approximately 20 kHz and are often misclassified due to background noise. Consequently, some Auto-ID suggestions are thoroughly checked, while others are reviewed only if the match ratios are low.

Additionally, random samples were taken throughout the collected data as an additional quality assurance measurement.

All recordings from the buoy-based passive acoustic monitoring (PAM) bat detectors were processed and identified to species level. For the land-based detectors, the identification process focused specifically on migratory bat species. As a result, the species detected on the buoys—confirmed migratory species—were also the primary focus for analysis on land. Recordings of bat species which were not recorded on the buoys and therefore not relevant to this survey were either not identified or excluded from the analysis.

Species-level identification was performed when possible. In cases where confident identification could not be achieved, recordings were classified into species-group. Due to the difficulty in reliably distinguishing between Common noctule, Leisler’s bat, and Parti-coloured bat based on acoustic data, these species were grouped under the category “Nyctaloid bats” for the purposes of analysis.

DATA AND RESULTS

GENERAL COASTAL (ONSHORE) PATTERNS

The coastal detectors recorded a mix of local and migratory bat activity. Coastal forests in both Denmark and Sweden provide rich habitats for bats, offering old-growth trees, moist environments, and abundant insect prey. Despite the overlap between resident and migratory individuals, several locations displayed distinct peaks in activity during known migration periods, particularly for species relevant to offshore environments.

Nathusius' pipistrelle showed the clearest migration pattern, with increased activity along coastal areas during spring (April–May) and autumn (September–October). Elevated activity in August may reflect pre-migratory foraging rather than active migration.

Detailed activity patterns from the coastal detectors are presented in Appendix 2. While local and migratory activity often overlap, some general trends can be identified for individual species:

Nyctaloid bats showed no clear spring migration pattern along the Djursland coast, where most activity occurred in summer and no distinct peaks occur in spring and autumn, suggesting the presence of breeding populations in coastal forests. Very few detections on Hesselø in spring support the impression of limited spring migration. However, increased activity in late summer and early autumn on both Djursland and Hesselø may indicate some level of autumn migration, potentially mixed with local foraging activity from Djursland and possibly northern Zealand.

Nathusius' pipistrelle displayed a well-defined migration pattern. On Djursland, spring migration began in late April and continued through early June. On Hesselø, migration appeared to start earlier, from mid-April to mid-May. This timing suggests that bats detected on Hesselø may originate from northeast Zealand rather than Djursland. The pattern on Hesselø aligns more closely with observations from Hallands Väderö of the Swedish East coast, where bats are expected to arrive from Zealand.

Soprano pipistrelle was commonly recorded across all coastal areas near the pre-investigation area but did not exhibit a clear migratory pattern.

DJURSLAND

Four bat detectors were deployed along the coast of Djursland (Figure 6), and the aggregated data from these monitoring sites are presented in Figure 9. The results indicate that the coastal areas of Djursland constitute a significant habitat for bats. Data from the two survey years reveal broadly consistent patterns, with the most notable variation being a decrease of approximately 10,000 recordings of Soprano pipistrelle in 2024 compared to 2023. Also, Nathisius´s pipistrelle occurs with 25% higher recording in 2023 compared to 2024.
Bat activity was in both survey years particularly high during the summer months, with Soprano pipistrelle and Nyctaloid species dominating the recordings. Among the Nyctaloid bats, the Common noctule was the most frequently detected, accounting for more than 80% of the observations.
Despite the absence of prominent north- or south-facing peninsulas that would typically facilitate migratory pathways, the region appears to play an important role in bat migration. Nathusius's pipistrelle exhibited a clear migratory pattern, with activity peaks in April–May and again in August–September, and minimal presence during the summer breeding period. The Soprano pipistrelle also showed increased activity during spring and late summer to autumn, although its migratory signal was less distinct, likely due to the presence of a substantial number of resident individuals recorded throughout the monitoring period (April–October).

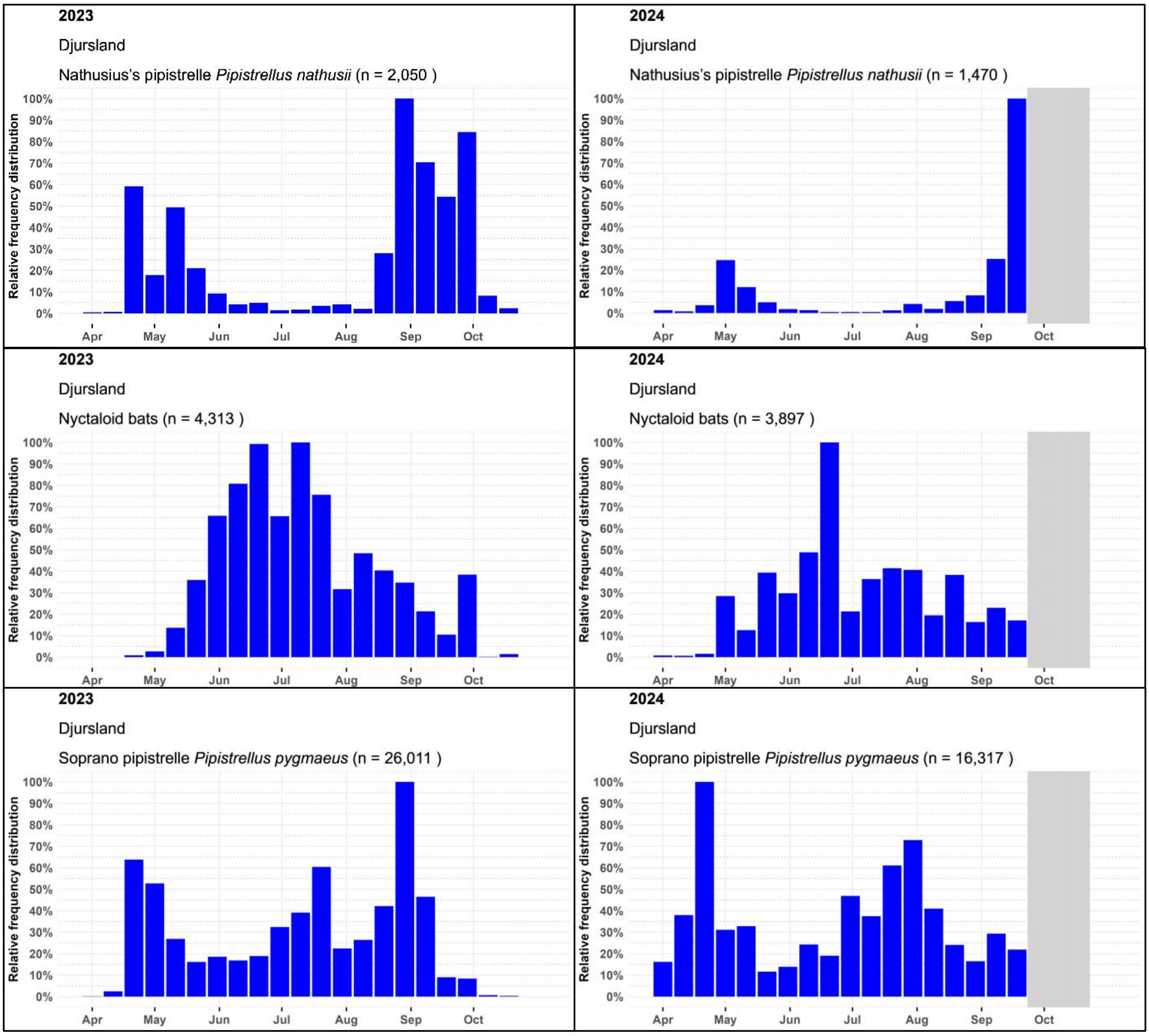

Figure 9 – Relative frequency of bat recordings summarised in 10 days intervals for 2023 and 2024. Grey areas indicate periods without monitoring.

SJÆLLANDS ODDE

The bat survey results from Sjællands Odde show considerable variation between the two monitoring years (Figure 10), both in terms of timing and the number of recorded observations. The data clearly indicate that this narrow peninsula is not a significant breeding site, as bat activity during the peak breeding season is minimal or absent.
Summer activity by Nyctaloid bats is likely attributable to foraging individuals, particularly the Common noctule, which is known to travel long distances in search of food.
While the overall patterns of bat activity are quite dissimilar between the two years, the data still reveals distinct migratory trends. In 2023, Nathusius´s pipistrelle exhibited pronounced peaks during both spring and autumn migration periods. However, in 2024, the autumn peak was nearly absent, and the spring migration occurred earlier in the season (in April). A similar pattern was observed for the Soprano pipistrelle, with the most significant single migratory event in 2024 occurring on the same early April day as for Nathusius' pipistrelle. Observations of Nyctaloid bats at Sjællands Odde varied between years, but the consistently low number of detections suggests that this location does not serve as a major migratory corridor for these species.

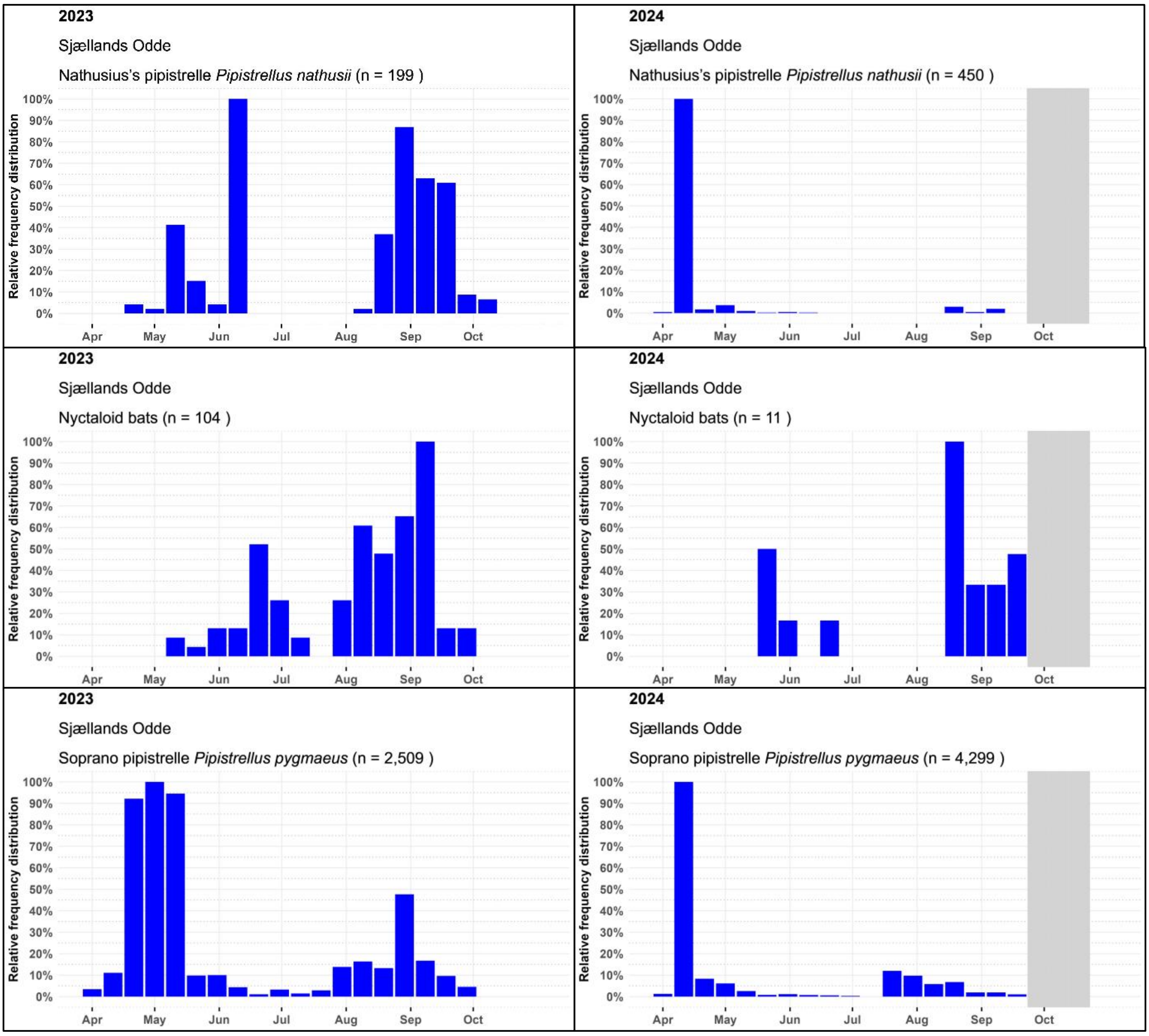

Figure 10 – Relative frequency of bat recordings summarised in 10 days intervals for 2023 and 2024. Grey areas indicate periods without monitoring.

KULLABERG (SWEDEN)

Kullaberg is located at the tip of a large, east-facing peninsula on the west coast of Sweden (Figure 6). Due to equipment failure at the site during spring 2024, no data was collected for the spring and summer periods that year (Figure 11). As a result, only autumn data are available for comparison between the two survey years.

The 2023 data reveals both local breeding activity and clear signs of migration. Nathusius' pipistrelle displayed a distinct migratory pattern, with pronounced peaks in both spring and autumn, and minimal activity during the summer months. Soprano pipistrelle and Nyctaloid bats also showed increased activity in spring (2023) and again in late summer to autumn, although their migratory patterns were less distinct, likely influenced by the presence of resident individuals recorded throughout the monitoring period (April–October).

Overall, the data suggests that Kullaberg is a particularly important site during autumn migration for multiple bat species.

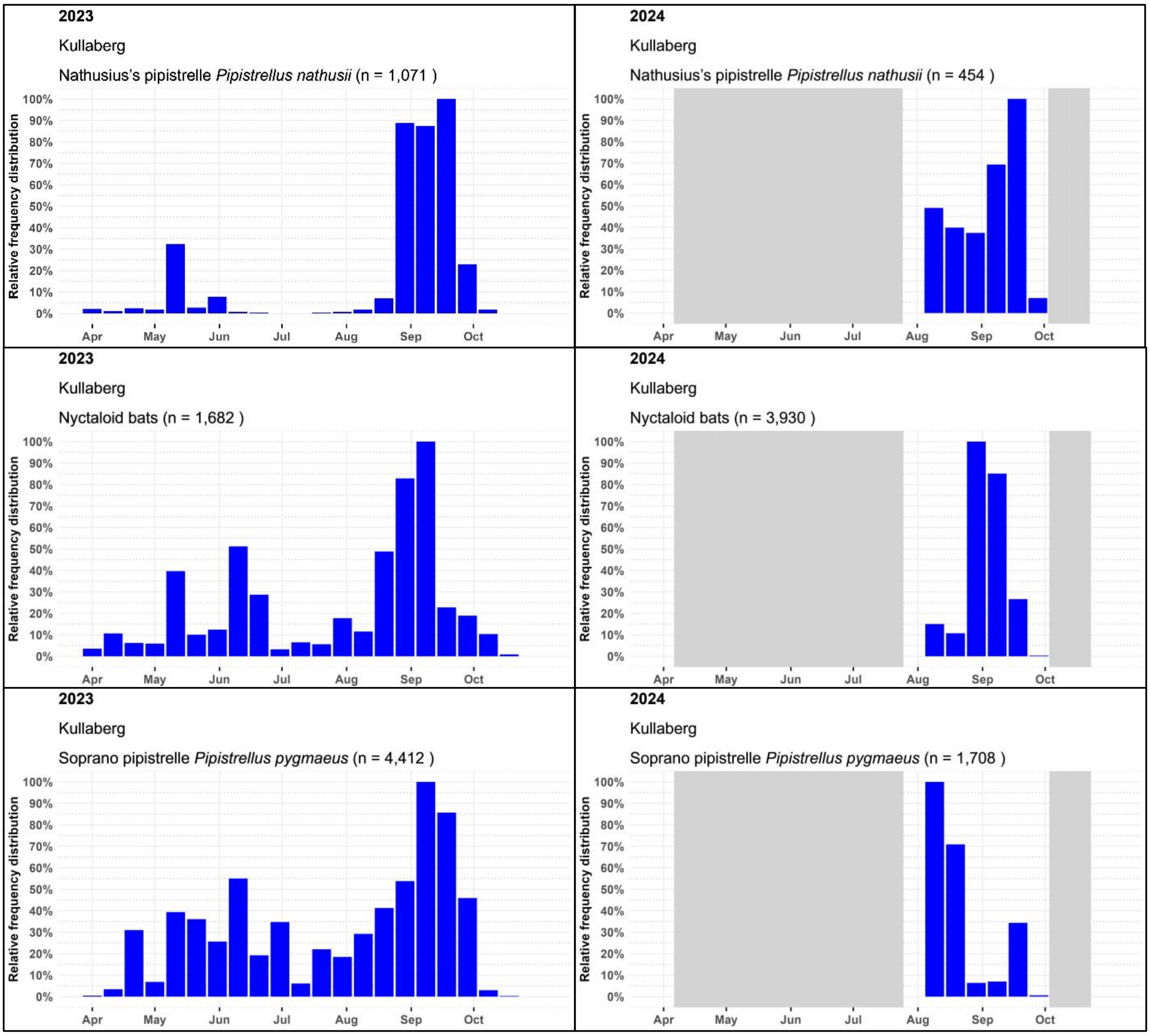

Figure 11 – Relative frequency of bat recordings summarised in 10 days intervals for 2023 and 2024. Grey areas indicate periods without monitoring.

HALLANDS VÄDERÖ (SWEDEN)

Three bat detectors were deployed on Hallands Väderö, an island located off the west coast of Sweden (Figure 6). The island is a designated nature reserve characterized by old deciduous forests and open grasslands.

Observations of migratory bat species on Hallands Väderö suggest the presence of a substantial local population of Soprano pipistrelle. In contrast, Nathusius's pipistrelle and Nyctaloid bats appear to use the island primarily as a stopover during migration (Figure 12). Migration of Nathusius's pipistrelle was recorded in both spring and autumn across both survey years, though the seasonal distribution differed. In 2023, spring migration was more prominent, whereas in 2024, most observations occurred during autumn, with relatively few detections in spring.

Nyctaloid bats were recorded with low activity and almost exclusively during migration periods. Notably, their first appearances in both years occurred relatively late, with initial detections not recorded until May.

As previously mentioned, the Soprano pipistrelle was observed consistently throughout the survey period, supporting the conclusion that a resident population is present. While peaks in activity were observed during migration seasons, it remains unclear whether these reflect actual migratory movements or variations in local foraging behaviour.

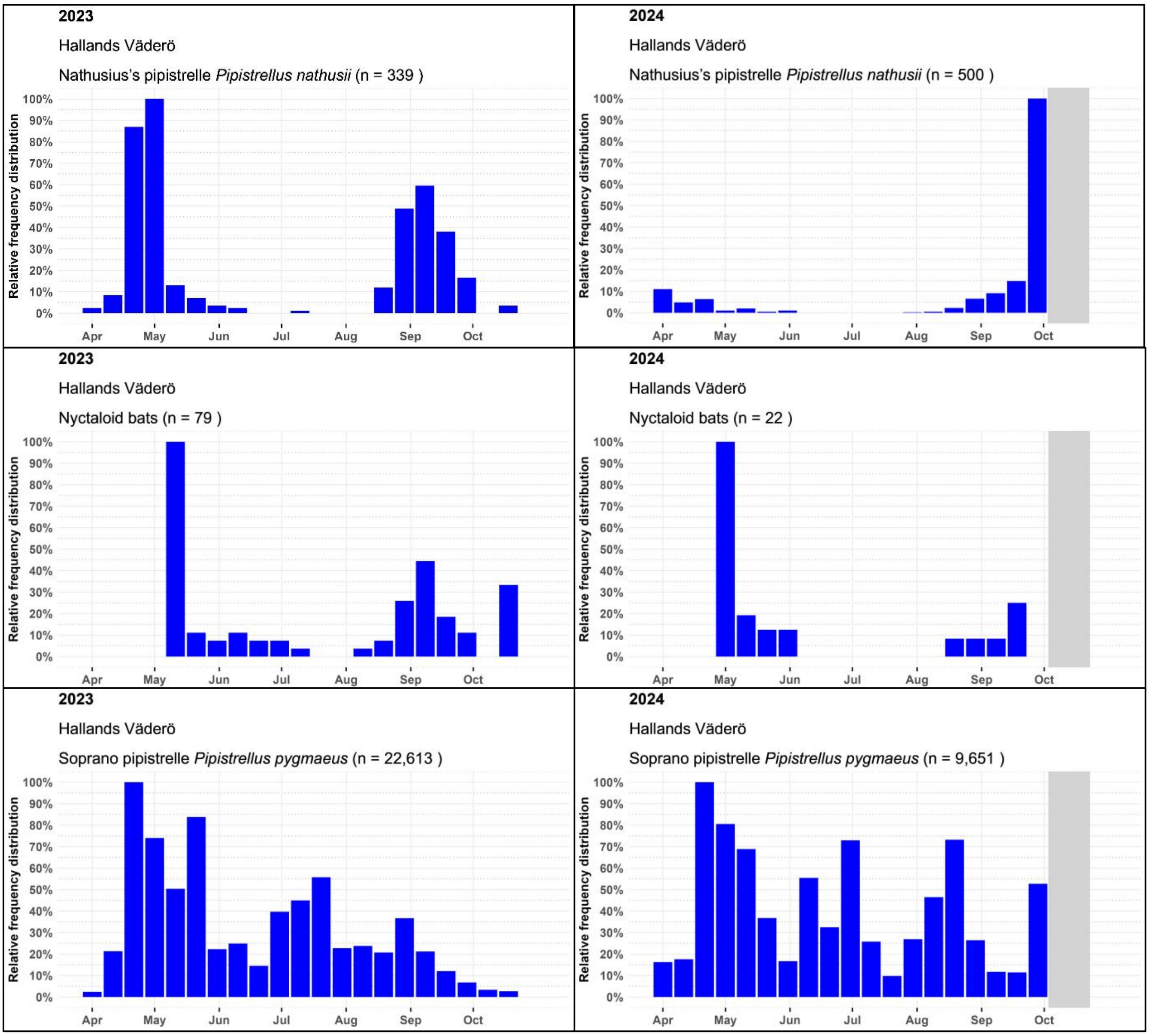

Figure 12 – Relative frequency of bat recordings summarised in 10 days intervals for 2023 and 2024. Grey areas indicate periods without monitoring.

GENERAL OFFSHORE PATTERNS

Foraging and migrating activity of bats in marine areas vary depending on proximity to land and alignment with known migration corridors. Similar to birds, certain marine areas are more significant for migrating bats, as they likely follow preferred routes. Additionally, some marine areas - particularly during late summer - are used by bats for foraging.

Although comprehensive data on bat activity in marine areas is limited, some insights are available from bat monitoring conducted as part of the baseline studies for planned offshore wind farms and on the existing Kriegers Flak OWF. **Error! Reference source not found.** presents the number of bat recordings p er buoy in the Kattegat area, compared with data from the Baltic Sea area where the Kriegers Flak area and Energy Island Bornholm is located. These datasets were collected using consistent methodologies, with detectors mounted on buoys or wind turbines.

Activity is on a similar level as in the pre-investigation area of Energy Island Bornholm (WSP, 2024b)(Table 6) and lower than similar figures from the pre-investigation areas of Kattegat OWF (WSP in press) and Kriegers Flak II OWF (WSP in press). Monitoring on turbines in Kriegers Flak I OWF also show a higher activity (WSP, 2024).

While the Kattegat area shows slightly higher bat activity than the area near Energy Island Bornholm, it still represents a relatively low level of activity compared to regions with consistently higher bat presence.

Table 6 - Average number of recordings per bat detector at Kriegers Flak II, Hesselø, Kattegat , Energy Island Bornholm and on turbines of the existing Kriegers Flak I OWF .

	Kriegers Flak II		Kattegat		Hesselø		Kriegers Flak I OWF			Energy Island Bornholm
Year	2023	2024	2023	2024	2023	2024	2022	2023	2024	2022
Average bat recordings per buoy/WT	63.9	17.2	14.8	5.2	3.9	5.9	26.3	184.3	28.8	5.3

Bat activity recorded by detectors mounted on offshore buoys was generally lower than that recorded by the land-based detector (see Appendix 2).

In the pre-investigation area, the general pattern shows more bat recordings in the southern part of the area (Figure 13).

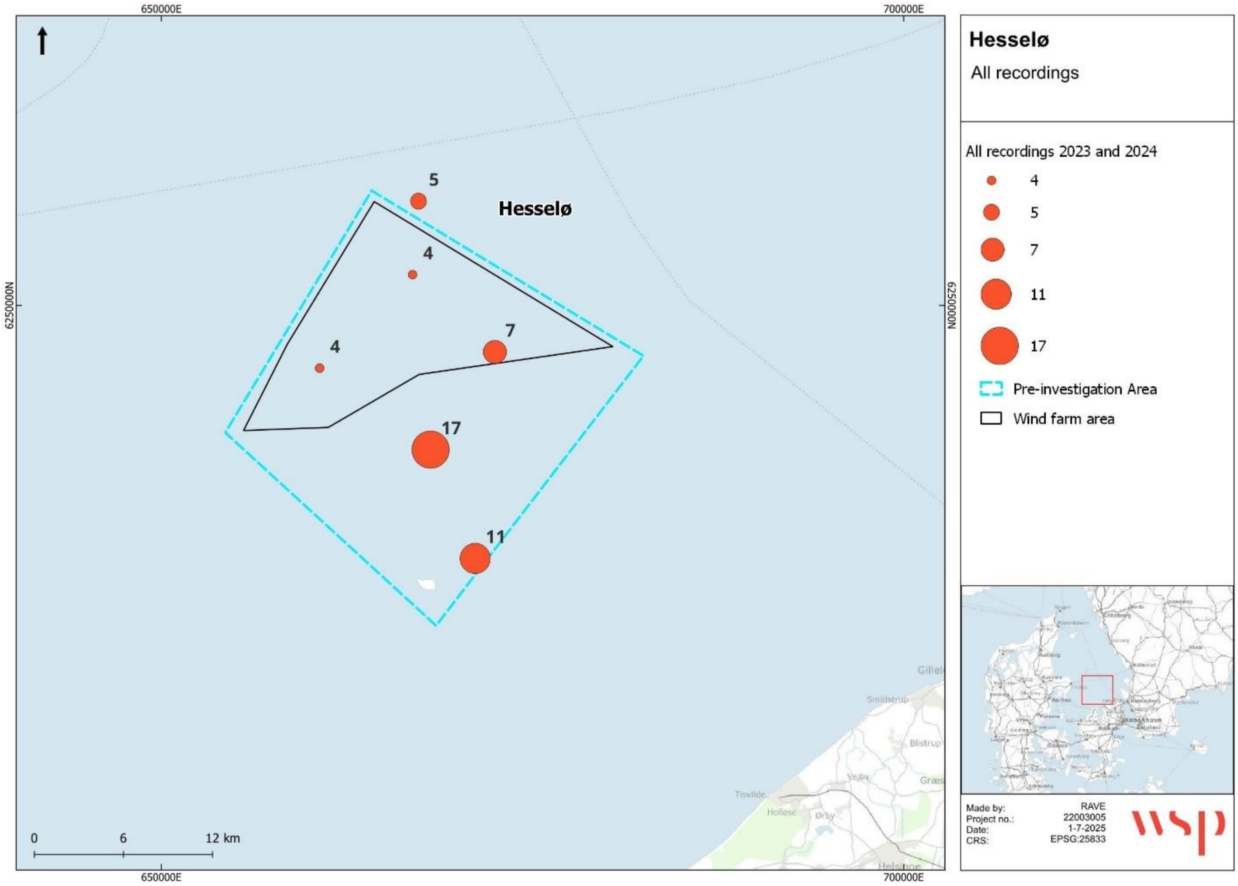

Figure 13 - *Number of bat recordings per buoy in 2023 and 2024.*

SEASONAL VARIATION IN OBSERVATIONS

OFFSHORE OBSERVATIONS

During the two survey years, passive acoustic monitoring (PAM) bat detectors were deployed on six buoys. A total of 48 bat detections were recorded, with 14 observations in 2023 and 34 in 2024 (Figure 14, Figure 15 and Figure 16). Nyctaloid bats accounted for most detections (30), followed by Nathusius' pipistrelle (15) and Soprano pipistrelle (3).

Given the limited number of recordings, year-to-year comparisons should be interpreted with caution. However, one notable difference is the substantial increase in Nathusius' pipistrelle detections in 2024. While only a single observation was recorded in autumn 2023, 2024 saw 14 detections, with the highest single event occurring during the spring migration period. This suggests that bat migration through the pre-investigation area can vary significantly over years, likely influenced by weather conditions preceding and during migration periods.

The presence of Nyctaloid bats in early August 2024 may indicate foraging activity; however, it is also possible that these were male individuals that had completed breeding and had begun their early migration.

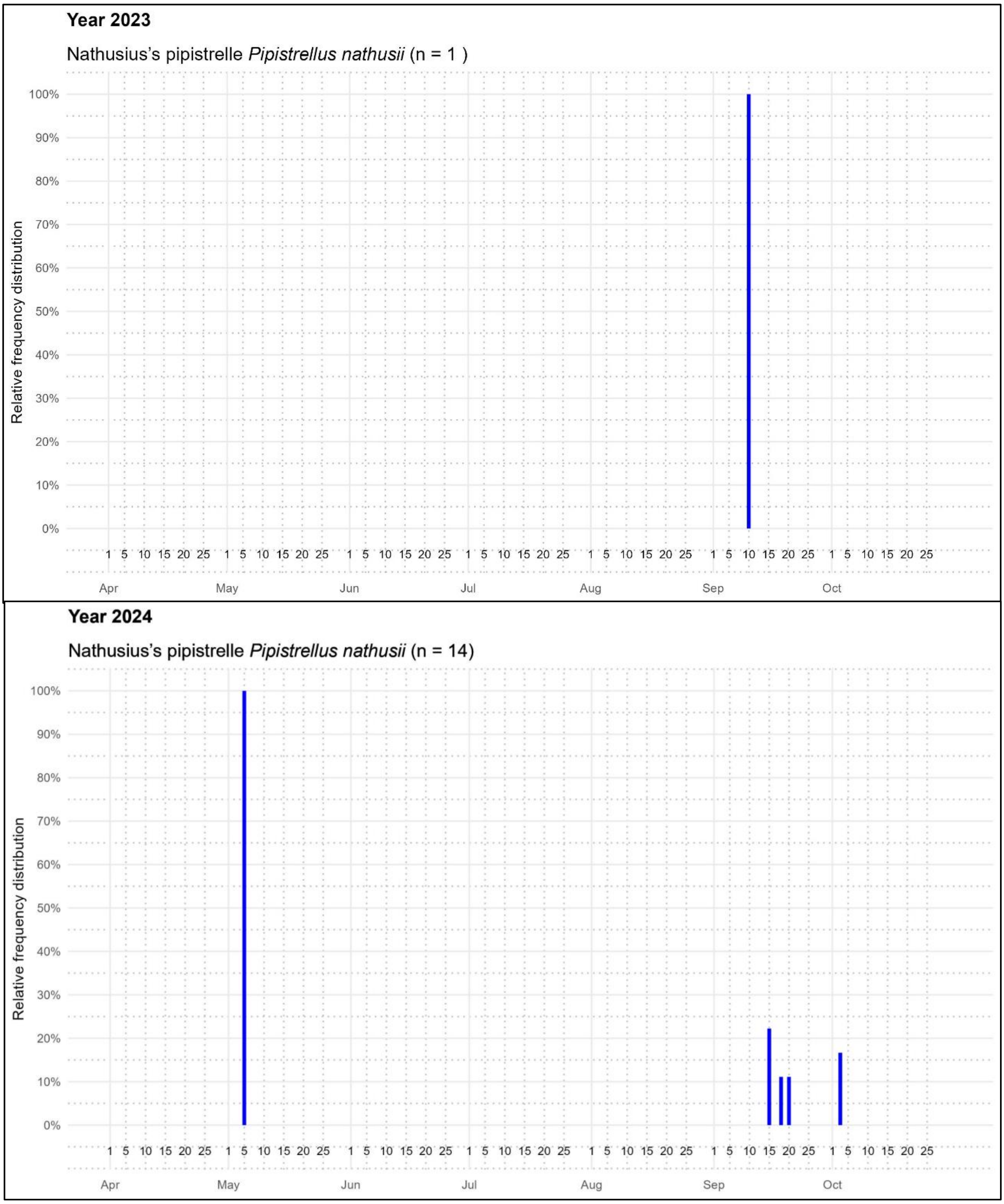

Figure 14 – Offshore observation of Nathusius's pipistrelle based on buoy-based detectors.

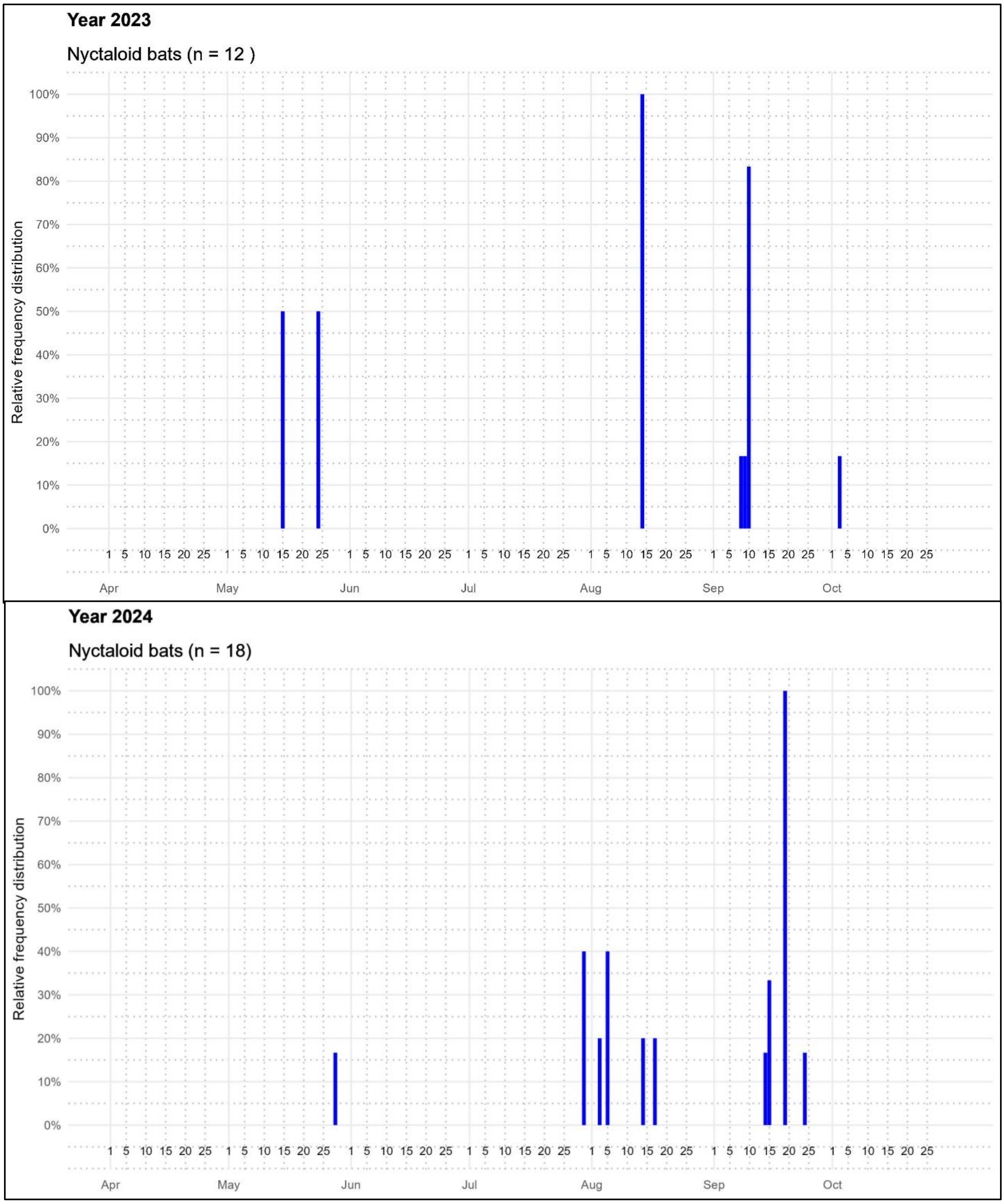

Figure 15– Offshore observation of Nyctaloid bats based on buoy-based detectors

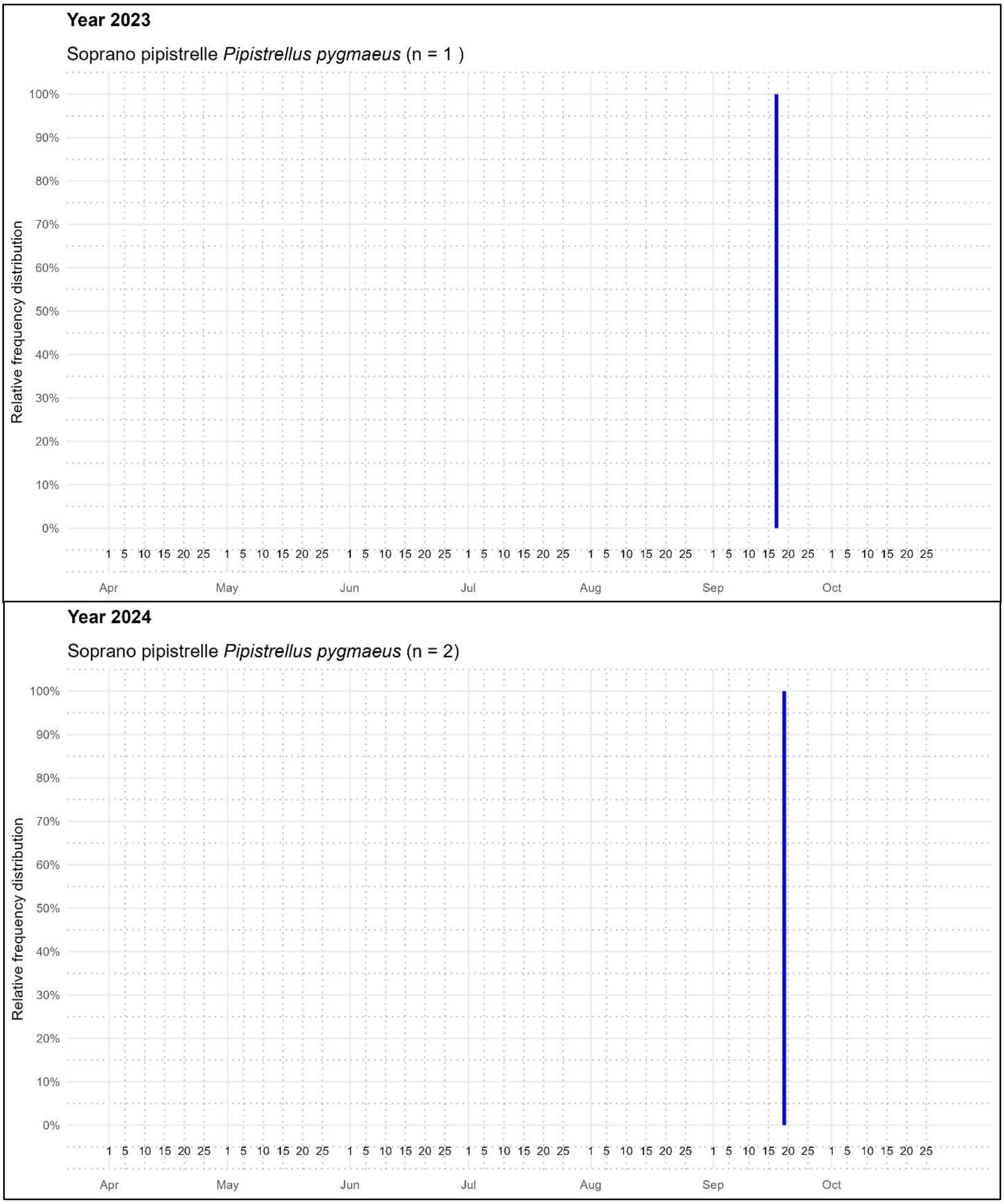

Figure 16– Offshore observation of Soprano pipistrelle based on buoy-based detectors

OBSERVATIONS ON THE ISLAND OF HESSELØ

Data from the island of Hesselø have been included in the offshore results due to the island's distance from the Zealand mainland (Figure 6). Three passive acoustic monitoring (PAM) bat detectors were installed at different locations across the island.

Islands such as Hesselø serve as valuable observation points for studying bird and bat migration. Their isolation, combined with sufficient vegetation and insect availability, makes them attractive stopover sites, offering both food resources and safe resting conditions. Similar patterns have been observed on other islands in the Baltic Sea, including Christiansø and Utklippan (WSP, 2024b). The suitability of Hesselø as a foraging and resting site likely explains the significantly higher number of bat recordings compared to those from detectors mounted on offshore buoys.

In 2023, observations of Nathusius's pipistrelle were considerably higher than in 2024, with most detections occurring during the spring migration period (Figure 17). The timing of both spring and autumn migration was broadly similar between the two years, although some variation was noted, for example, the peak in autumn migration in 2024 occurred later than in 2023.

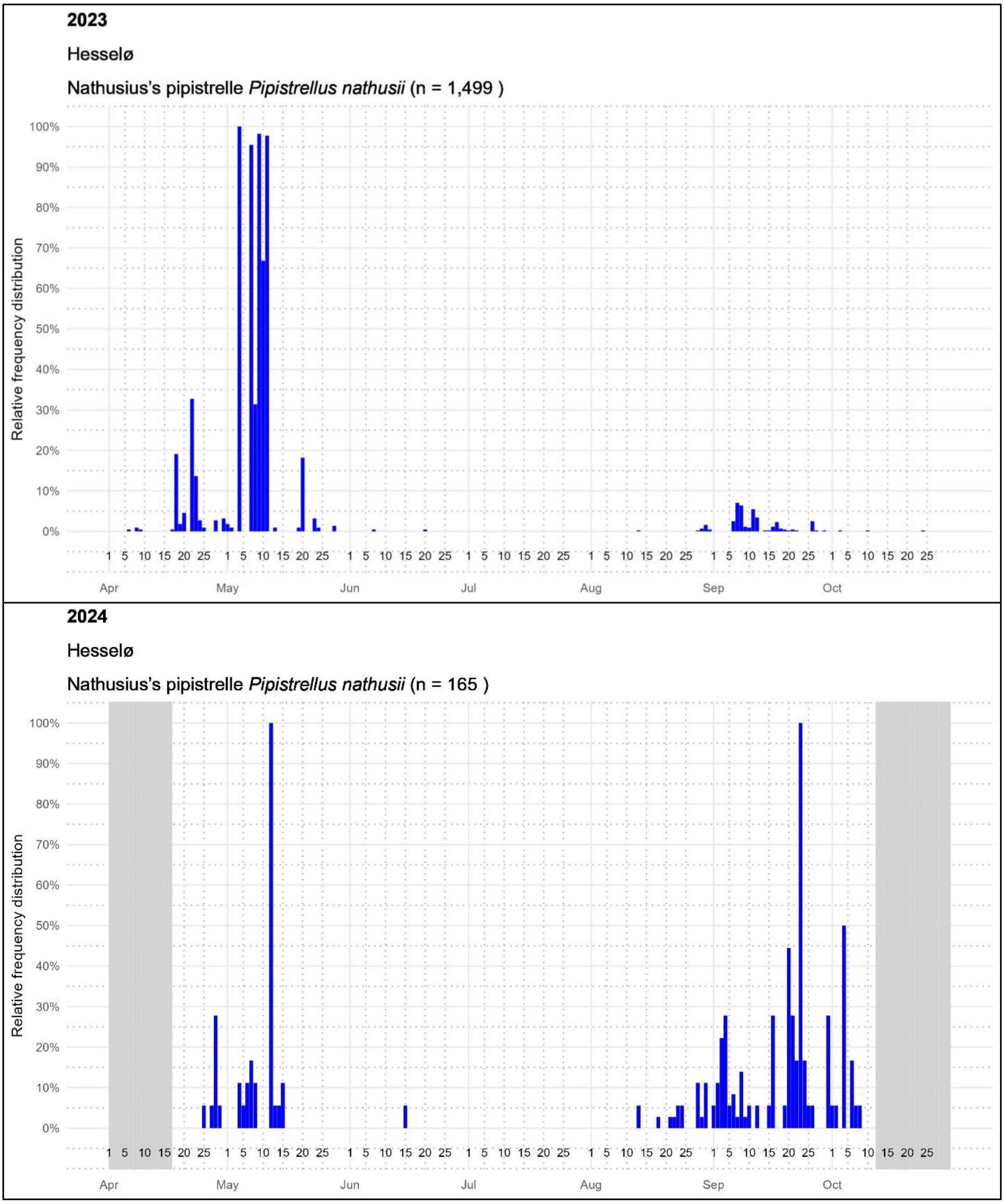

Figure 17 – Relative frequency of bat recordings per night for 2023 and 2024. Grey areas indicate periods without monitoring.

The difference in Nyctaloid bat activity between the two survey years is striking (Figure 18). During the spring migration period in April 2023, an exceptionally high level of Nyctaloid activity was recorded on Hesselø. Nearly all detections during this period were identified as Parti-coloured bats, which appeared on the island over the course of just a few days. Notably, no social calls were recorded, effectively ruling out the possibility of a mating event.

Furthermore, there are no known large colonies of Parti-coloured bats located north of Hesselø, making it unlikely that these individuals were migrating. The most plausible explanation is that this was a large-scale foraging event, with a group of bats originating from Zealand temporarily visiting Hesselø to exploit local food resources.

This pattern did not recur in 2024, when no clear distinguishable recordings of Parti-coloured bats were observed on the island. Nevertheless, Hesselø appears to be an important stopover site for Nyctaloid bats during both spring and autumn migration periods and may occasionally serve as a significant foraging area for Parti-coloured bats in spring. (Troxell, et al., 2019)

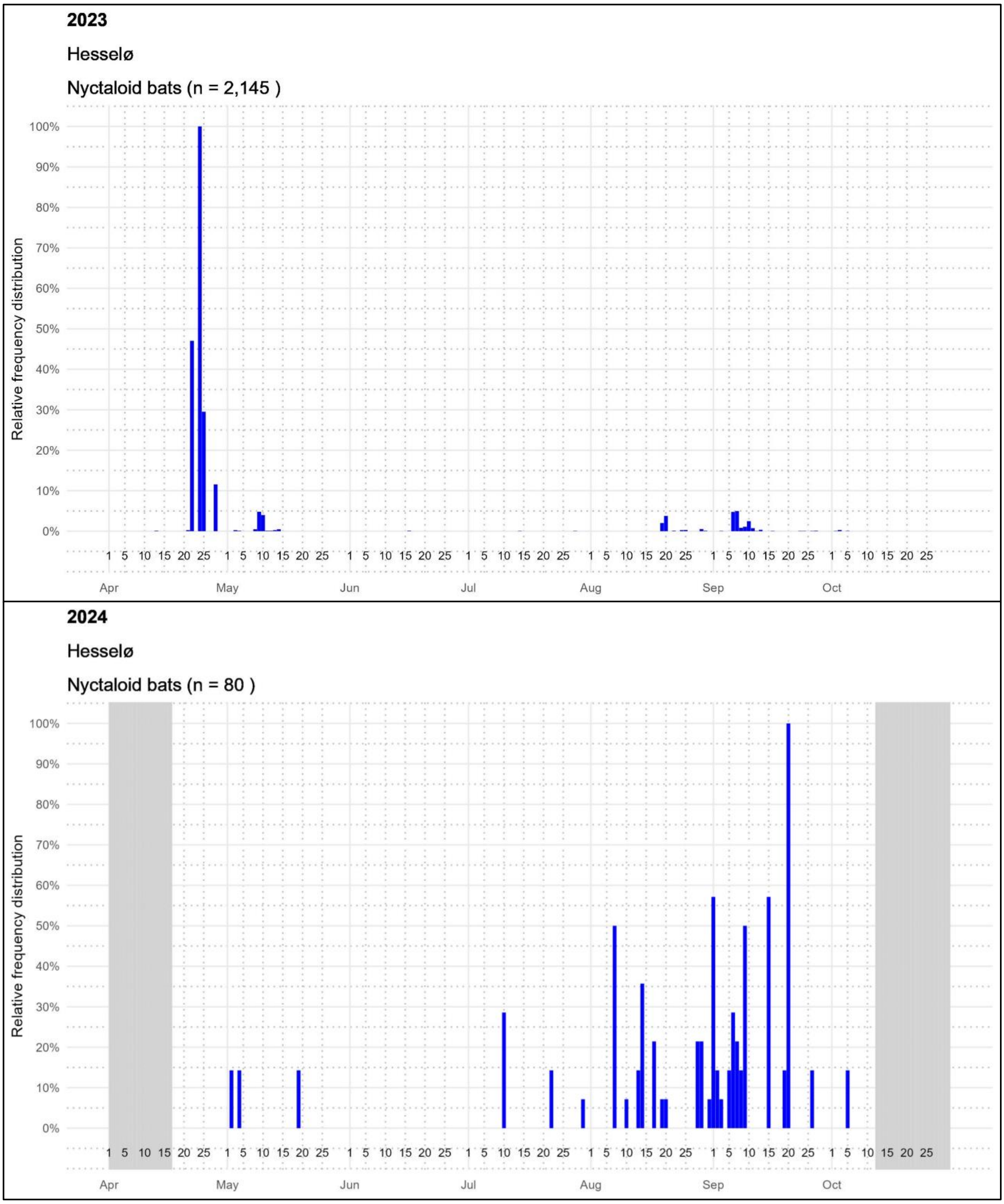

Figure 18 – Relative frequency of bat recordings per night for 2023 and 2024. Grey areas indicate periods without monitoring.

Soprano pipistrelle occurred in relatively low number of recordings on Hesselø. The timing of these observations suggests a modest but discernible migratory pattern. Additionally, detections in June and July indicate that a small number of individuals may visit the island for foraging purposes during the summer months (Figure 19).

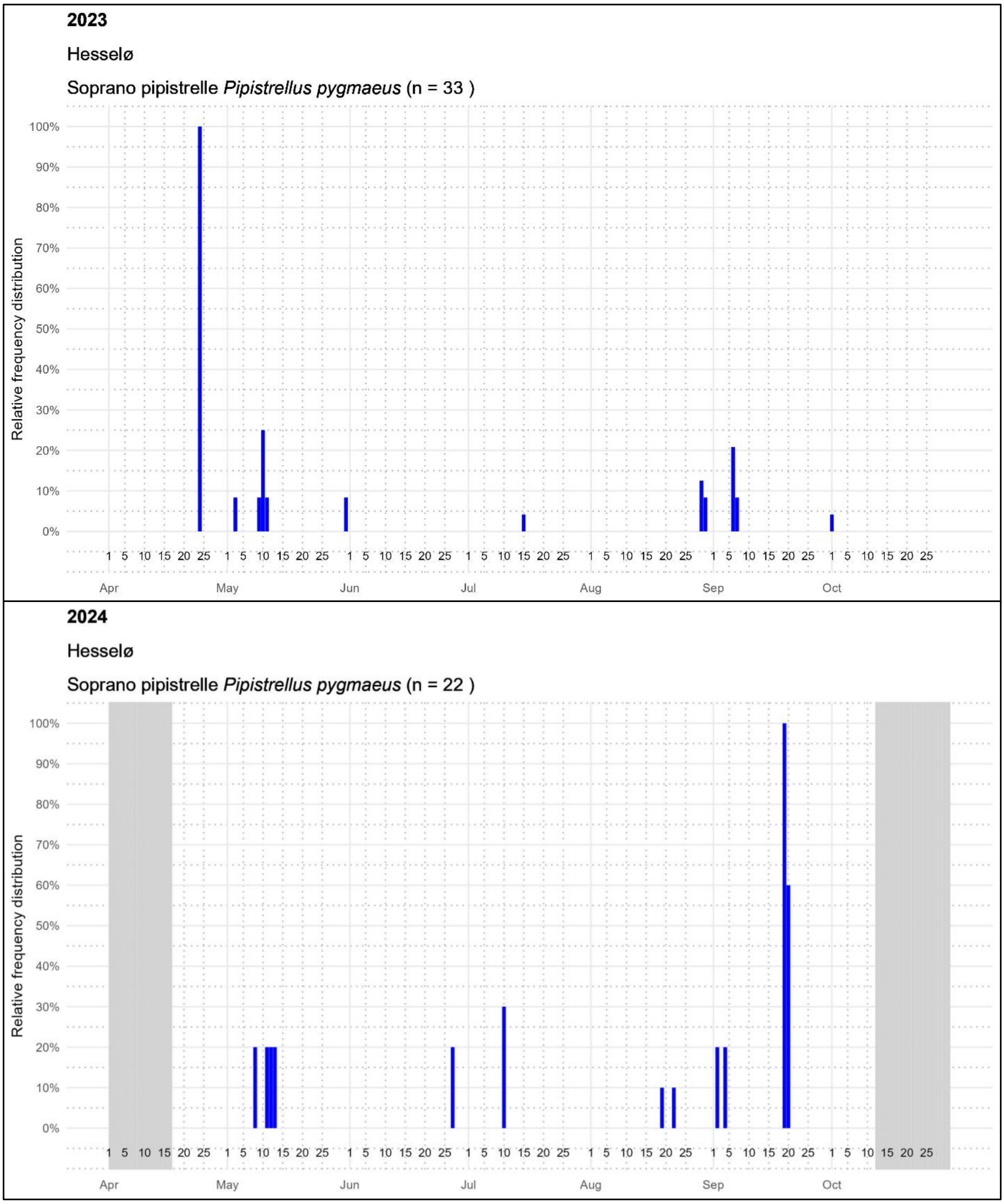

Figure 19 – Relative frequency of bat recordings per night for 2023 and 2024. Grey areas indicate periods without monitoring.

TIME OF OFFSHORE OBSERVATIONS

The timing of bat recordings during the night is a key factor in understanding the sea-crossing strategies of different bat species. Data presented in Figure 20 and Figure 21 clearly show a preference for crossing the open sea during the darkest hours of the night. This pattern suggests that bats may have already travelled a considerable distance before reaching the survey area. Only a limited number of Nyctaloid bats were recorded outside of peak nocturnal hours—specifically before dusk or after dawn. These individuals are likely originating from Hesselø Island, located southeast of the pre-investigation area. It is probable that they forage around the island during the night and use it as a temporary stopover, sheltering in trees or buildings during the day as part of their migratory journey. Crossing the sea during dawn, daylight, or dusk increases the risk of predation, particularly from gulls and other diurnal predators.

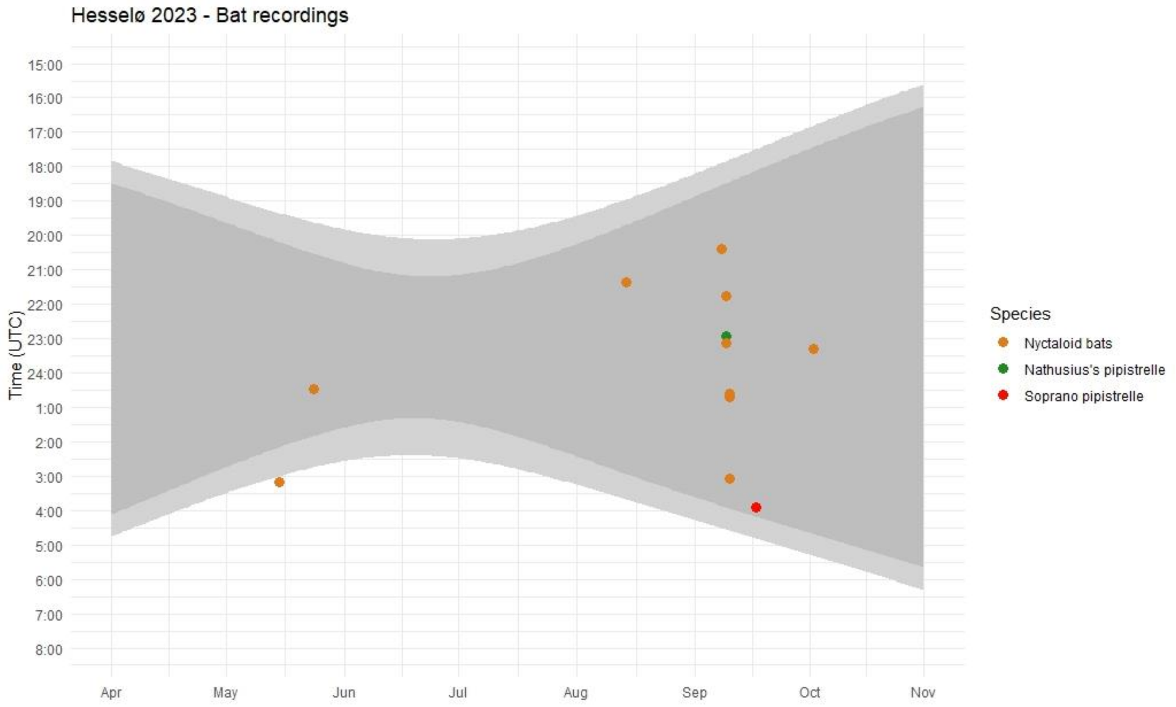

Figure 20 - Time of the bat recordings on the buoy-based detectors in 2023. Shaded areas indicate the nights. Pale shading indicates the dusk from sun set to the sun is more than 6 degrees under the horizon and similar in the morning until sunrise (see suninfo.dk for more information)

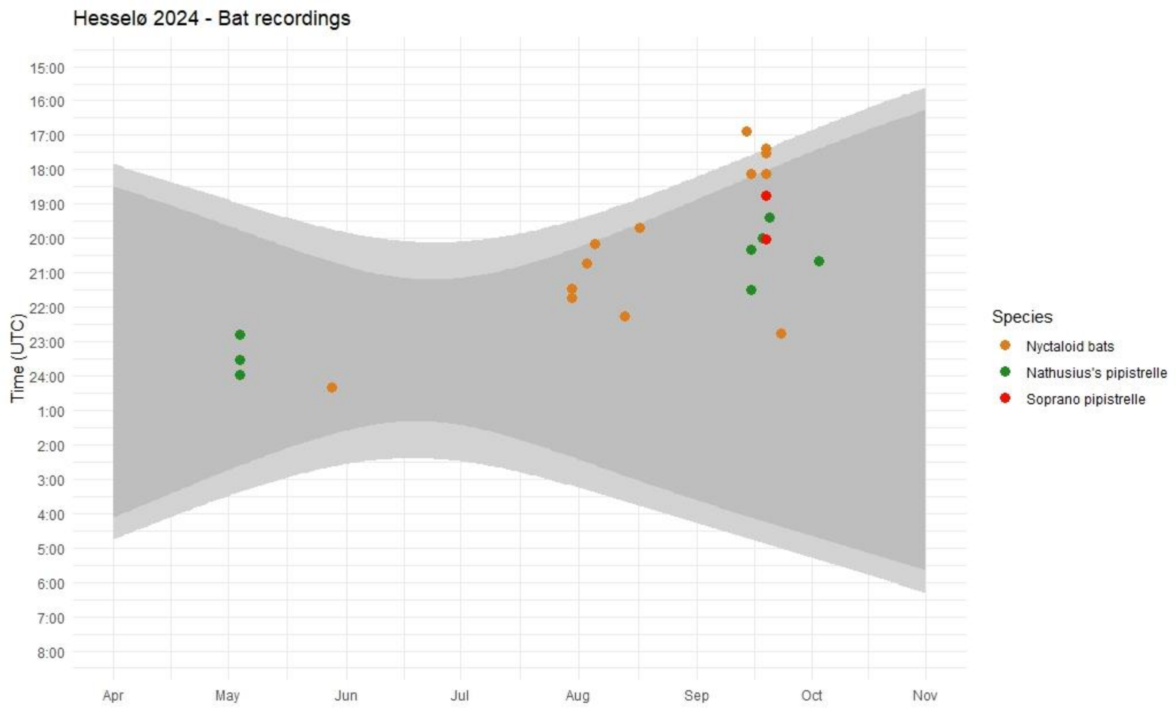

Figure 21 - Time of the bat recordings on the buoy-based detectors in 2024. Shaded areas indicate the nights. Pale shading indicates the dusk from sun set to the sun is more than 6 degrees under the horizon and similar in the morning until sunrise (see suninfo.dk for more information)

OFFSHORE OBSERVATIONS AND WEATHER CONDITIONS

Weather data for the pre-investigation area was initially collected using a MetOcean buoy positioned at the centre of the area. Unfortunately, this method only covered part of the survey period (21st July 2023 to 5th May 2024), resulting in an incomplete dataset that could not be used for comprehensive data presentation.

Subsequently, modelled data from Copernicus was evaluated. Significant discrepancies between the Copernicus data and the collected MetOcean data were identified, particularly with respect to temperature and wind speed measurements, which greatly limited its suitability for the present baseline assessment. These differences appear to originate from the Copernicus model's reliance on land-based condition inputs, which typically result in higher daytime temperatures, lower nighttime temperatures, and lower wind speeds than those observed in marine environments, thereby skewing the results.

For the Hesselø area, the most reliable weather data available was from Anholt Harbour, located approximately 30 km north of the pre-investigation area. Although geographically distant, its near-marine setting makes it more comparable to the MetOcean buoy data. The weather station is operated by the Danish Meteorological Institute (DMI) and data is collected 10 meters above sea level.

As Anholt Harbour is relatively far from the pre-investigation area and the weather is influenced by the land mass of the island, some differences in weather conditions between the two locations are to be expected. However, the correlation between the measured MetOcean data and the data from Anholt Harbour is strong, and it is therefore considered the most reliable source for this data presentation. Nonetheless, the following presentation should be interpreted with an awareness of potential discrepancies between the two locations.

TEMPERATURE

Figure 22 illustrate the relationship between temperature and bat recordings, with data presented by season (spring and autumn).
All bat recordings during both spring and autumn, across both survey years, occurred on nights when temperatures at Anholt Harbour exceeded 10°C. It should be noted that in spring 2023, six of the eight PAM bat detectors experienced equipment failures, resulting in only twelve usable recordings in total for the spring periods. Consequently, the limited data set restricts the ability to identify clear trends. While the graph may suggest that bats showed a preference for lower temperatures while crossing the pre-investigation area during spring, this likely reflects the range of temperatures available during the migration period rather than an actual preference.
In autumn, a larger number of recordings were collected, revealing a more distinct pattern of bats favouring warmer temperatures compared to spring. This difference may be attributable to generally lower sea temperatures in spring. Additionally, the presence of feeding Nyctaloid bats in autumn could influence the overall trend toward warmer nights, which are typically associated with higher insect abundance.

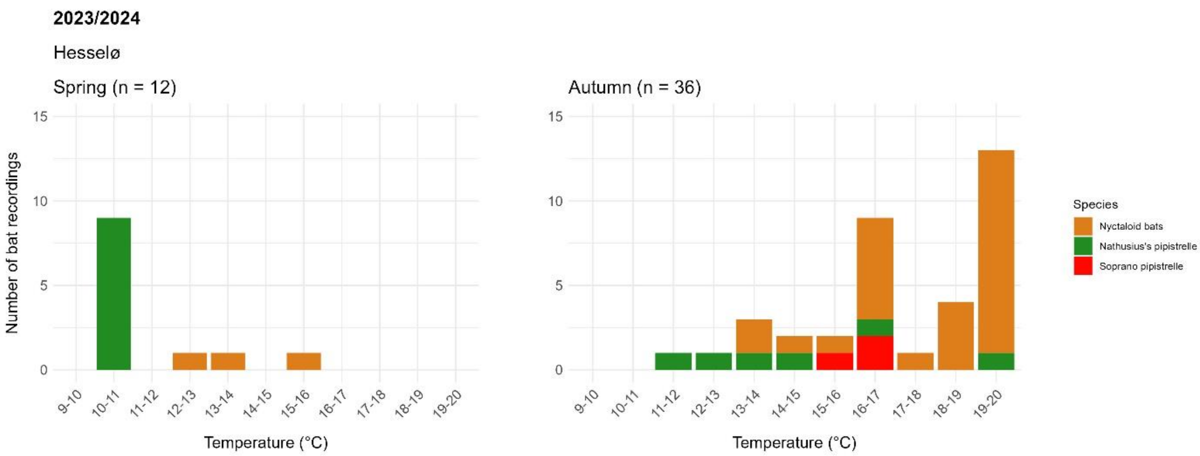

Figure 22 - Relations between temperature and recordings of bats on the buoy-based detectors. Information on temperature are from Anholt Harbour (DMI).

WIND SPEED

Figure 23 demonstrates that bats generally prefer flying over marine areas during low wind conditions, with 90% of all recordings occurring at wind speeds below 5 m/s. All bats are recorded when the wind speed at Anholt harbour were less than 8 m/s.

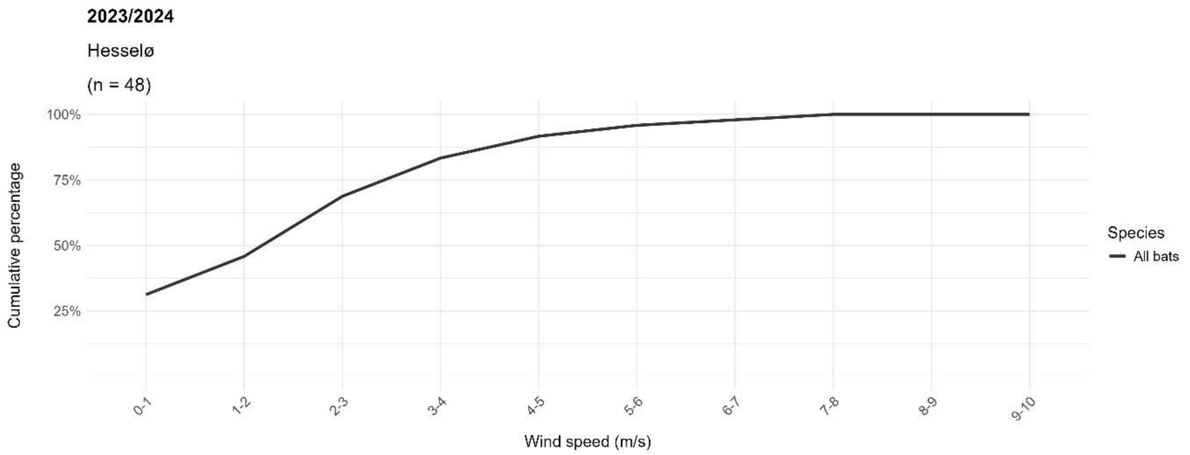

Figure 23 - Cumulative frequency of bat recordings related to wind speed. Information on wind speeds are from Anholt Harbour (DMI).

As outlined above, the sample size during spring was notably limited, which constrains the ability to identify robust patterns or trends. However, it can be stated that all bat recordings in spring occurred during periods of very low wind speeds, with none exceeding 4 m/s. In contrast, during autumn, bats were detected on nights with wind speeds reaching up to 8 m/s, although there remains a clear indication that bats exhibit a preference for flying over marine areas during low wind speeds.

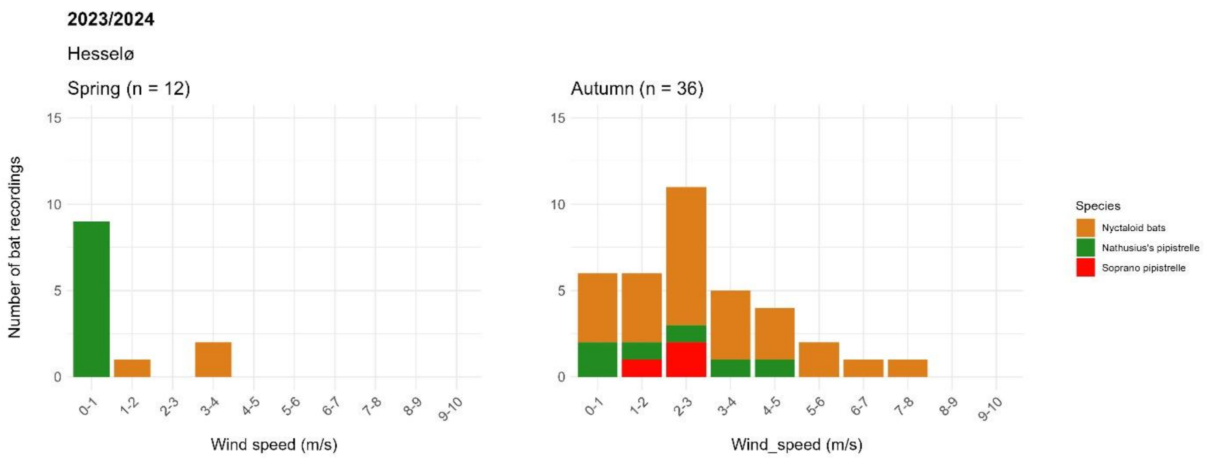

Figure 24 - Relation between windspeed and recordings of bats on the buoy-based detectors. Information on wind speeds are from Anholt Harbour (DMI).

WIND DIRECTION

Of the twelve recordings obtained during spring, nine were made when no wind was measured at Anholt Harbour, rendering wind direction data unavailable for those instances. Consequently, the figure below for spring includes only three valid bat recordings, and meaningful interpretation of wind direction preferences is not feasible. In autumn, five records are similarly excluded due to missing wind speed data. The remaining 31 autumn recordings were collected on nights characterised by northeasterly or south-southeasterly winds. This pattern may suggest that bats from the west coast of Sweden could be crossing the sea with a slight tailwind, and that individuals from the north coast of Zealand are using a tailwind to forage in the pre-investigation area. However, in the absence of data regarding the actual flight direction of the recorded bats, the origin of these individuals remains speculative.

Figure 25 - Relation between wind direction and wind speed and recordings of bats. Information on wind directions and wind speeds are from Anholt Harbour (DMI). The figure is based on 3 recordings in spring and 31 recordings in autumn. Data on wind direction for the remaining record were not available.

STATUS AND CONCLUSION

The present baseline provides extensive information on bat presence in the pre-investigation area and the surrounding coastal areas. However, significant gaps remain in our general understanding of offshore bat activity and migration. At Hesselø pre-investigation area and at the island Hesselø, bat presence comprises mostly of migratory individuals traversing between their wintering sites in central and western Europe and their breeding grounds in Scandinavia, However, there might be also a few bats actively foraging within the area.

In spring, migrating bats appear to dominate, whereas in early autumn both migrating and foraging groups are present simultaneously and may occur in the pre-investigation area during the same nights. Owing to the considerable distance from land, only larger species, such as Common noctule and Parti-coloured bat, are likely to use the area for feeding. In contrast, species such as Nathusius's pipistrelle, Soprano pipistrelle, and members of the genus *Myotis* are expected to occur in the pre-investigation area only during migration periods in spring and autumn.

Weather conditions undoubtedly influence the presence of bats offshore. High wind speeds and low temperatures are generally avoided by most species. However, migrating bats exhibit different preferences for wind speed and temperature compared to bats that forage in offshore areas. Migrating individuals may tolerate lower temperatures and slightly stronger winds, whereas foraging bats are recorded almost exclusively during nights with high temperatures and low wind speeds.

DATA AND KNOWLEDGE GAPS

Monitoring bat activity in the open sea presents considerable challenges, primarily due to adverse weather conditions and the potential for damage arising from fishing and shipping operations. As such, occasional detector malfunctions are to be expected. During the spring and early summer 2023 survey period, several detectors experienced failures, resulting in this phase of the survey relying on data from a reduced number of operational detectors.

When interpreting the results, it is crucial to avoid direct comparison between the number of recordings from offshore buoy-based detectors and those from land-based detectors. The buoys are deployed in the open sea, where bats are generally only passing through. Because of the relatively short detection range for smaller species (approximately 20–50 meters) and the limited number of buoys covering a large area, the probability of registering bats offshore is inherently low.

By contrast, land-based detectors are positioned in locations with expected high bat activity. Consequently, they produce a much larger number of recordings, which may even include repeated detections of the same individuals.

Similarly, our knowledge of the flight height of migrating and foraging bats remains very limited. The present survey only covers altitudes of approximately 20–50 meters above the sea surface, depending on the species. It is therefore likely that some bats, both during migration and while feeding, may fly outside the detection range due to their flight altitude.

Information on offshore meteorological conditions remains limited, and direct measurements at sea are both challenging and costly. Consequently, the relationship between bat activity and weather conditions is primarily inferred from data collected at meteorological stations located outside the pre-investigation area.

It is important to note that the decision of bats to move offshore is, in most cases, made during the evening hours in coastal areas. At Hesselø pre-investigation area, bats may depart from several different coastal regions. The nearest land areas are Djursland, Sjælland and the Swedish west coast all in quite similar distance from the pre-investigation area. For this reason, it is difficult to establish a straightforward analysis of the relationship between onshore and offshore temperatures, as bats may originate from multiple coastal environments with differing local conditions.

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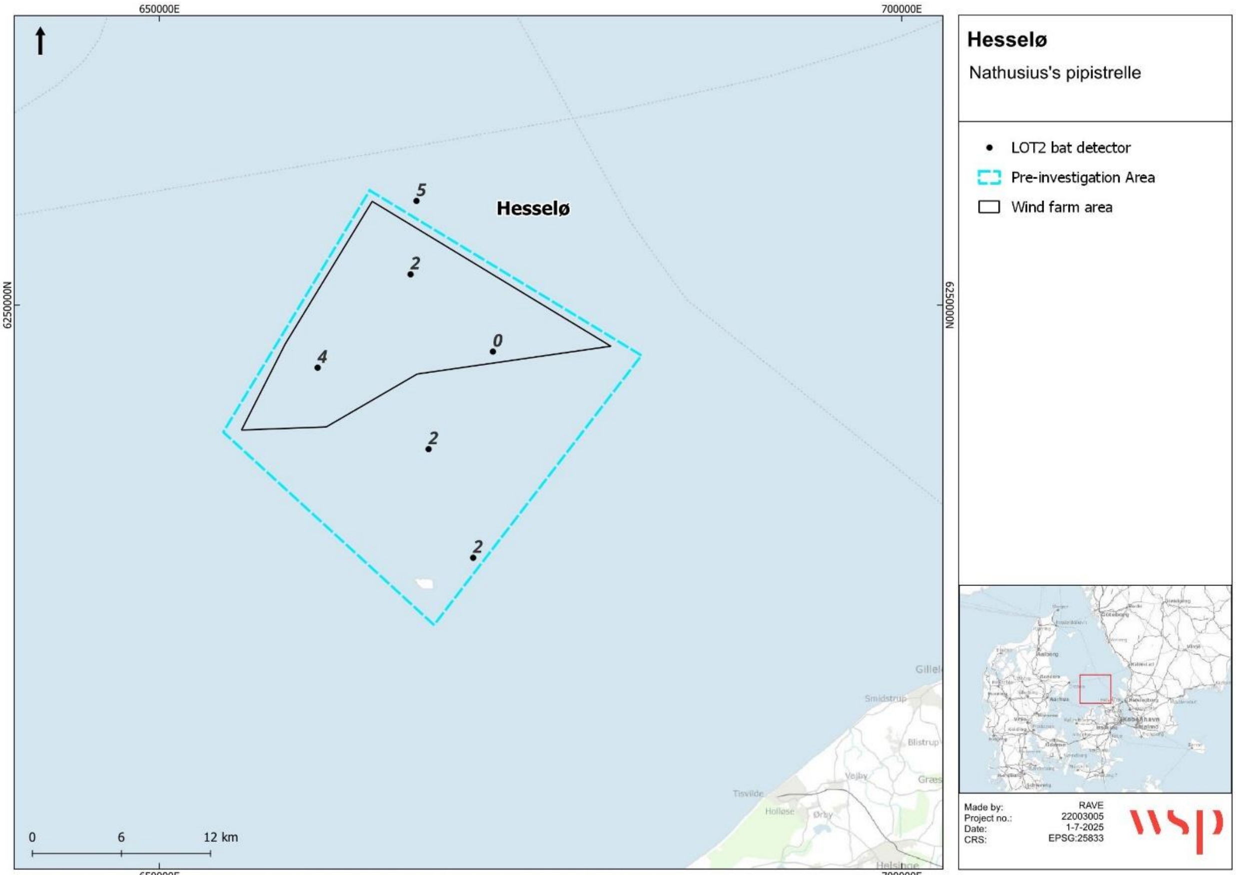
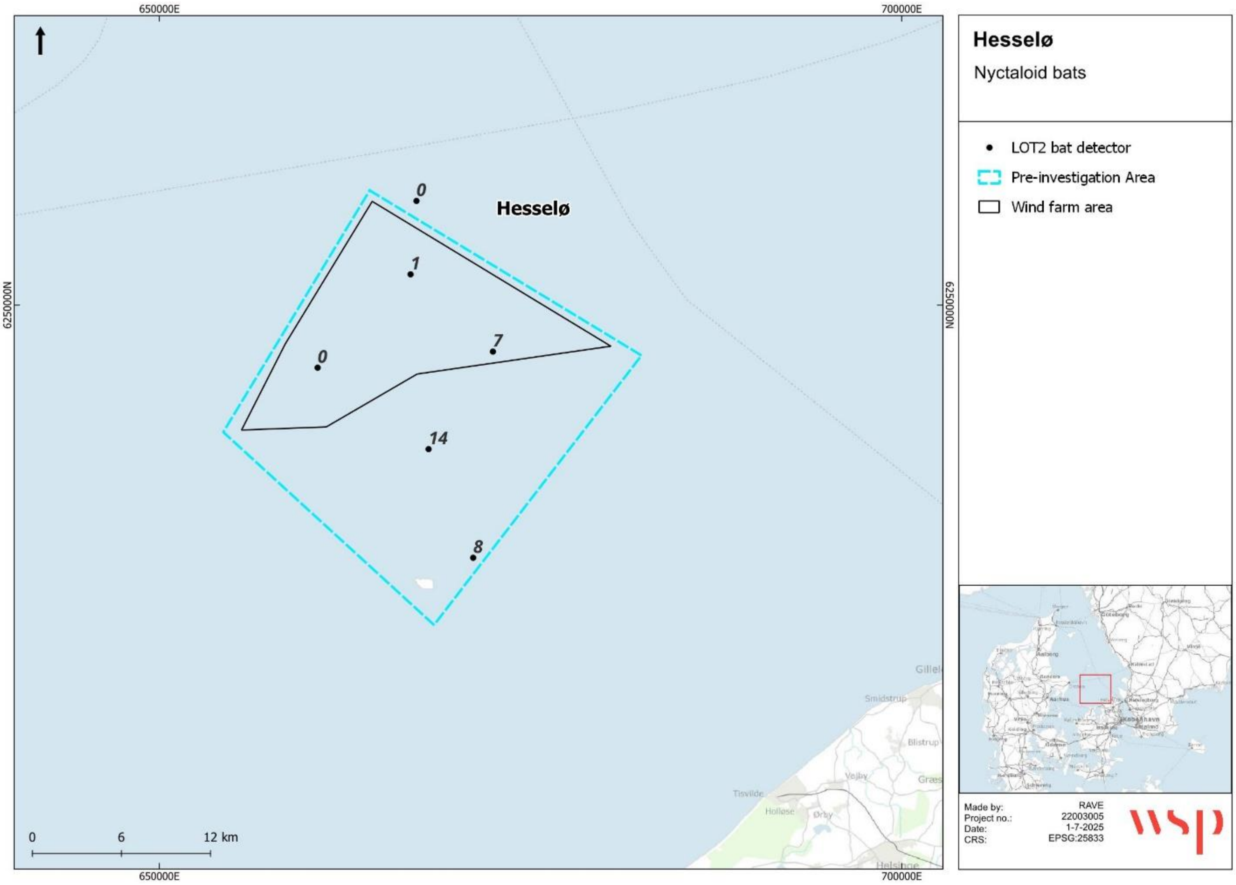
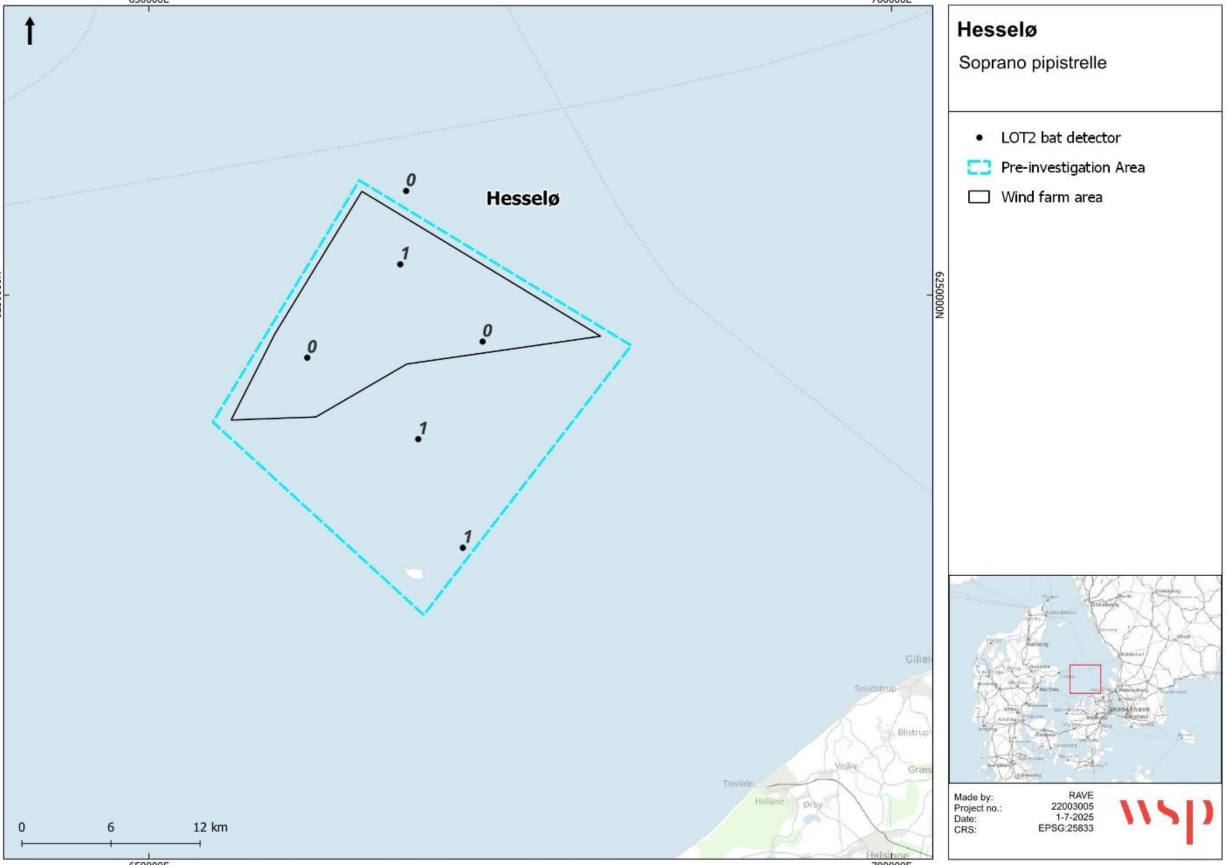
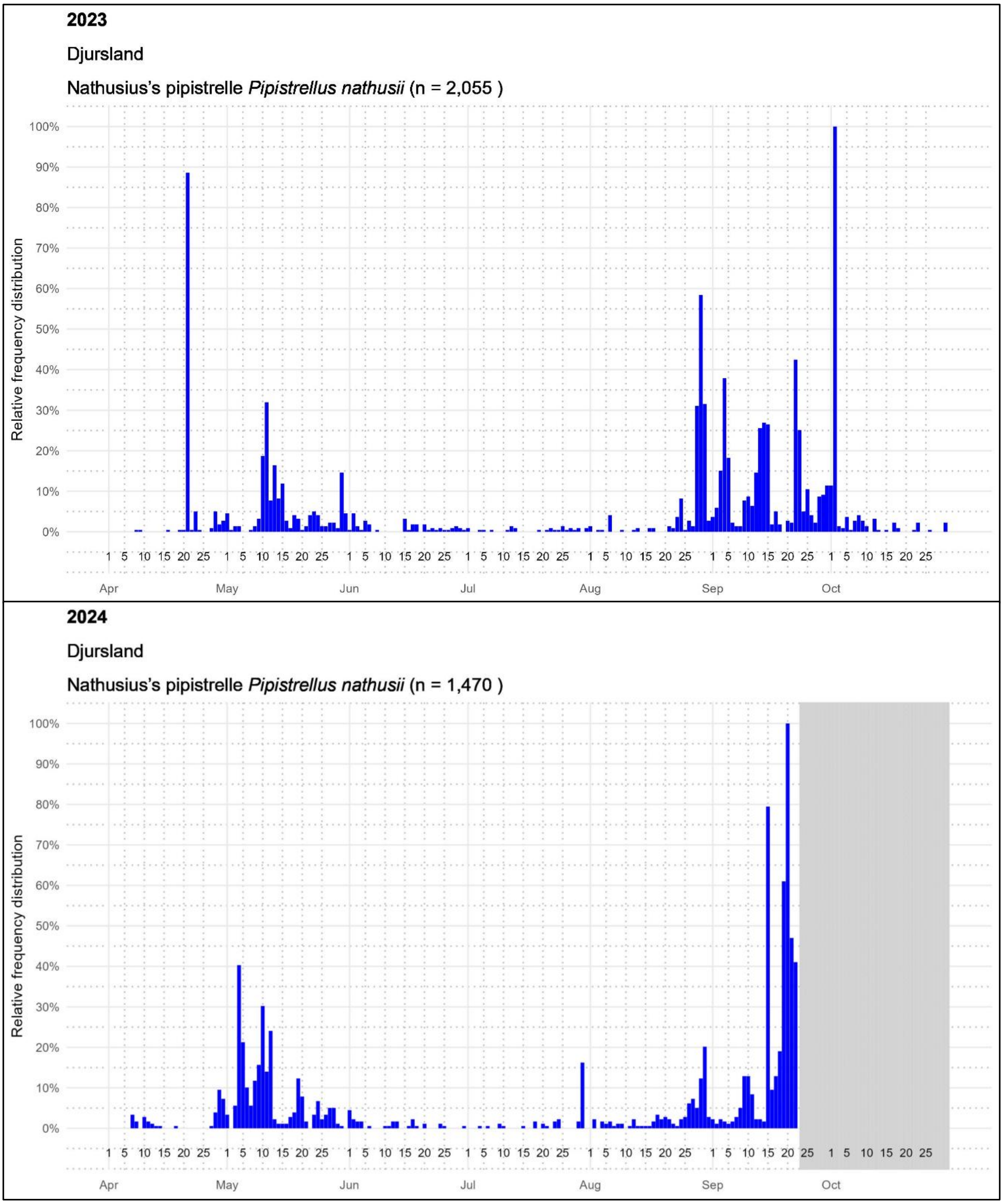
APPENDIX 1 – SPECIES DISTRIBUTION

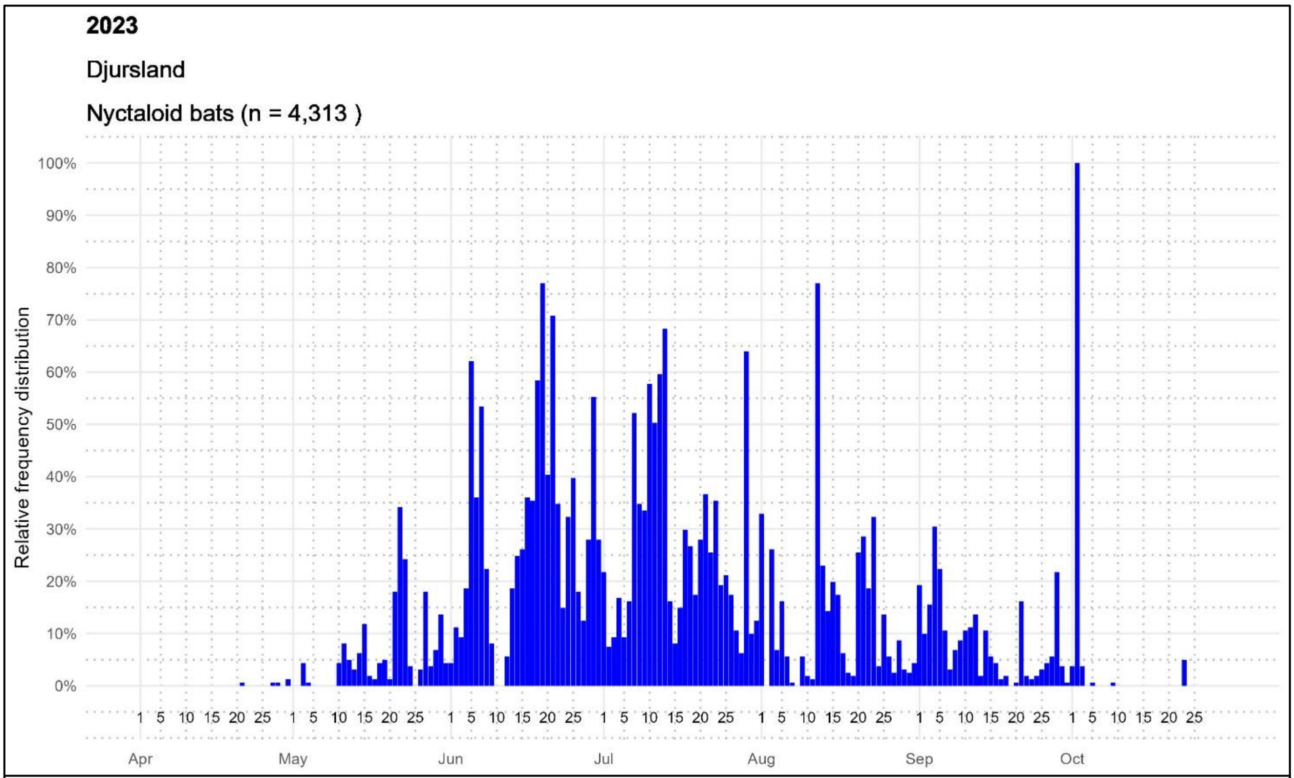


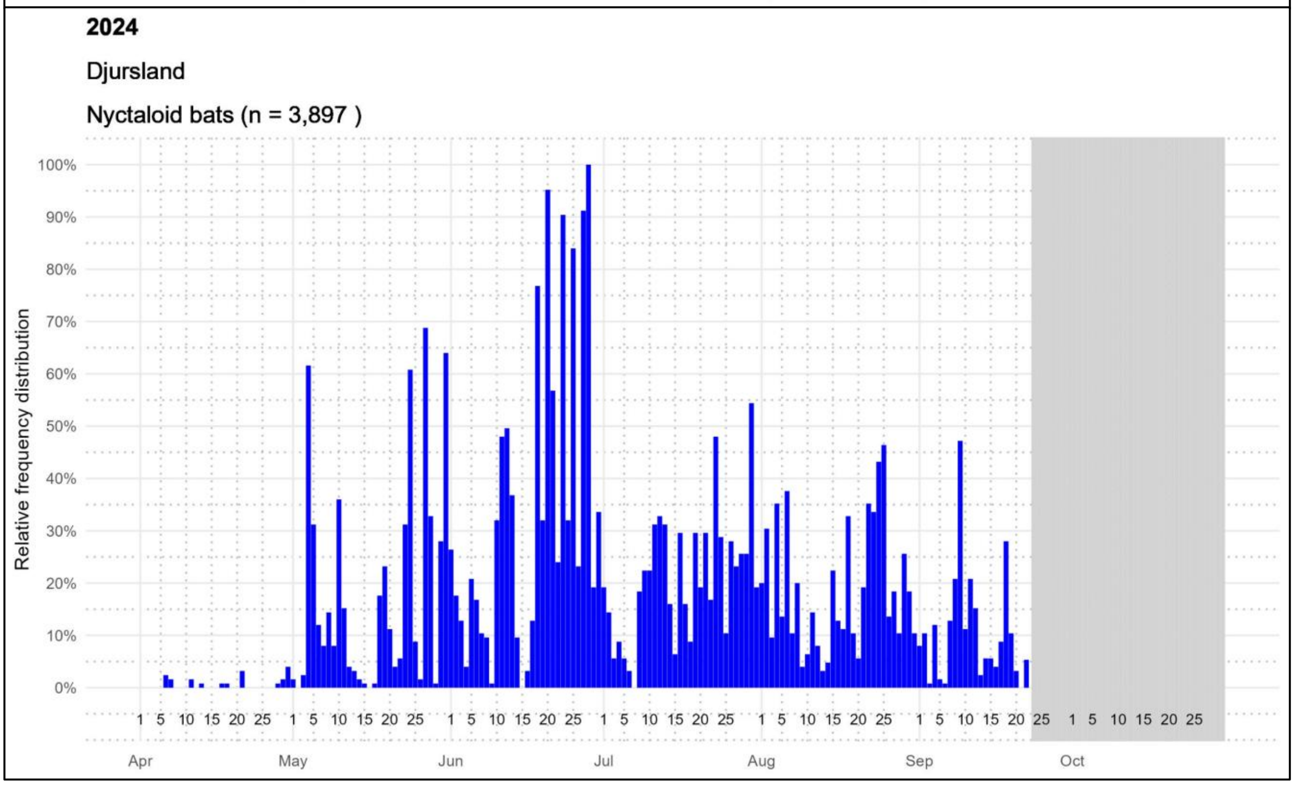



Hesselø
Soprano pipistrelle
LOT2 bat detector
Pre-investigation Area
Wind farm area
Hesselø
650000E
700000E
6250000N
0
1
0
0
1
1
0
6
12 km
Made by: RAVE
Project no.: 22003005
Date: 1-7-2025
CRS: EPSG:25833

APPENDIX 2 – OBSERVATIONS PER NIGHT




2023
Djursland
Nyctaloid bats (n = 4,313)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Apr
May
Jun
Jul
Aug
Sep
Oct


2024
Djursland
Nyctaloid bats (n = 3,897)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Apr
May
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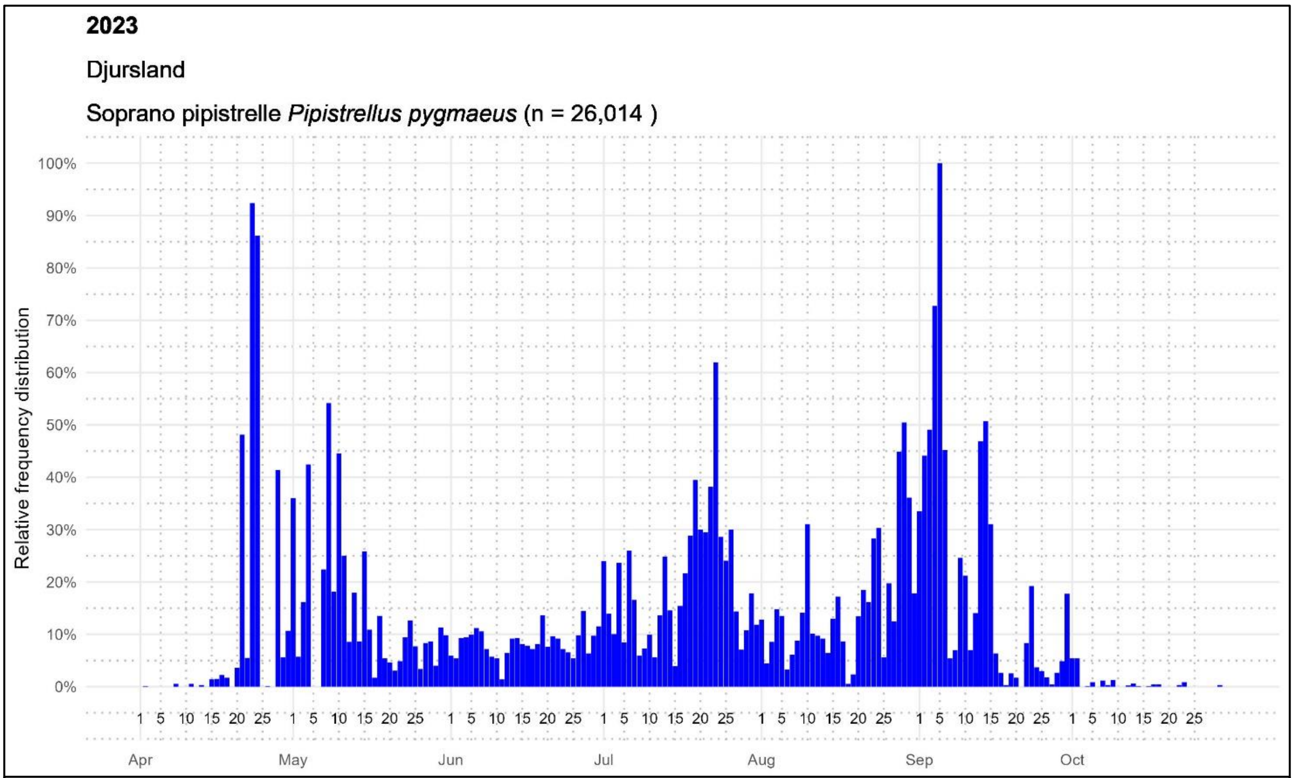
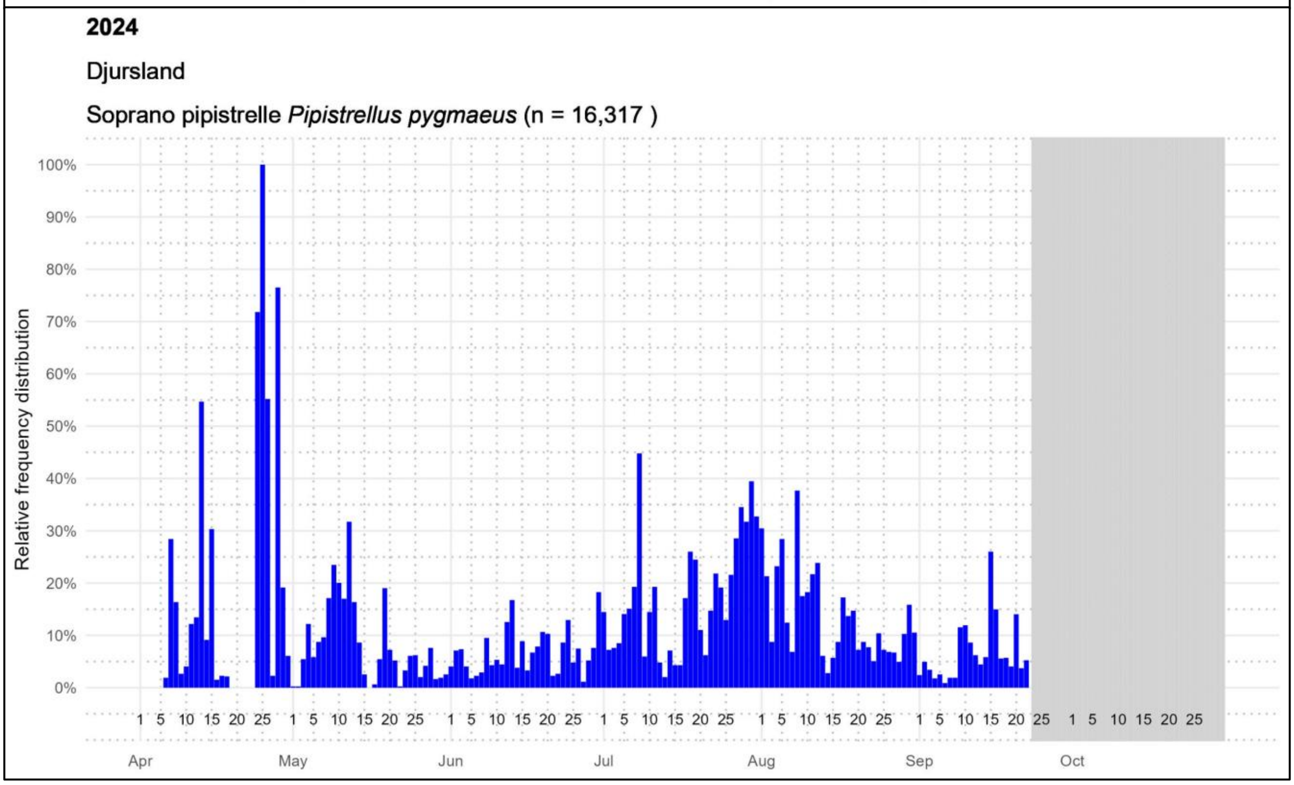
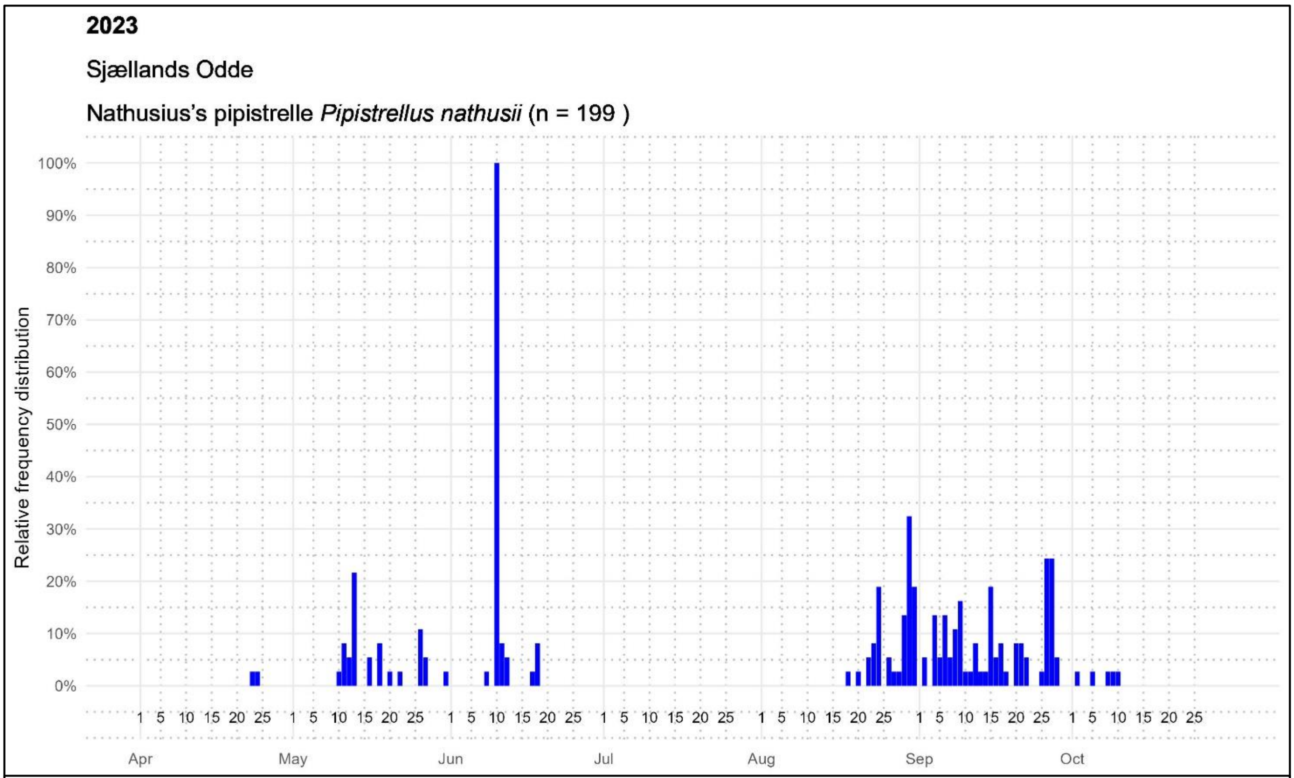
Sep
Oct


2023
Djursland
Soprano pipistrelle *Pipistrellus pygmaeus* (n = 26,014)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25
Apr May Jun Jul Aug Sep Oct


2024
Djursland
Soprano pipistrelle *Pipistrellus pygmaeus* (n = 16,317)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25
Apr May Jun Jul Aug Sep Oct


2023
Sjællands Odde
Nathusius's pipistrelle Pipistrellus nathusii (n = 199)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Apr
May
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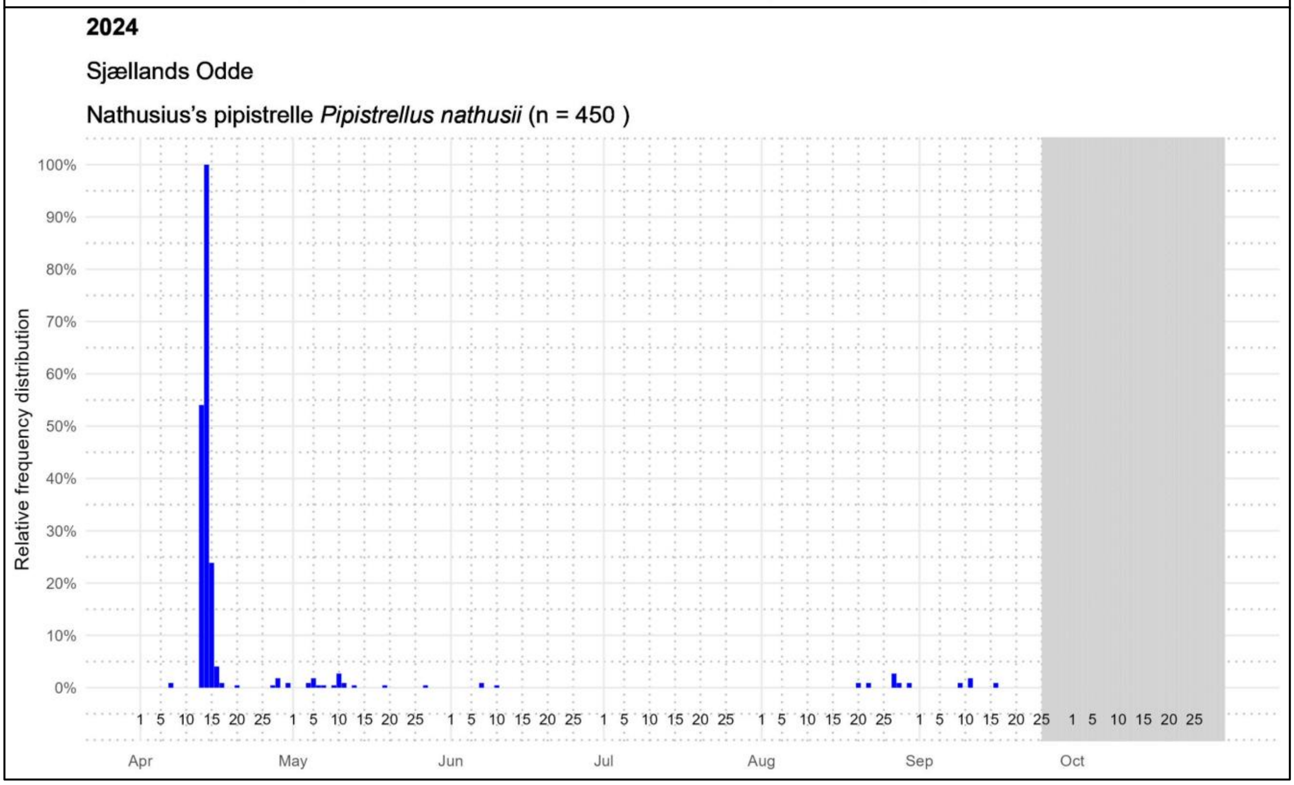
Oct


2024
Sjællands Odde
Nathusius's pipistrelle Pipistrellus nathusii (n = 450)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Apr
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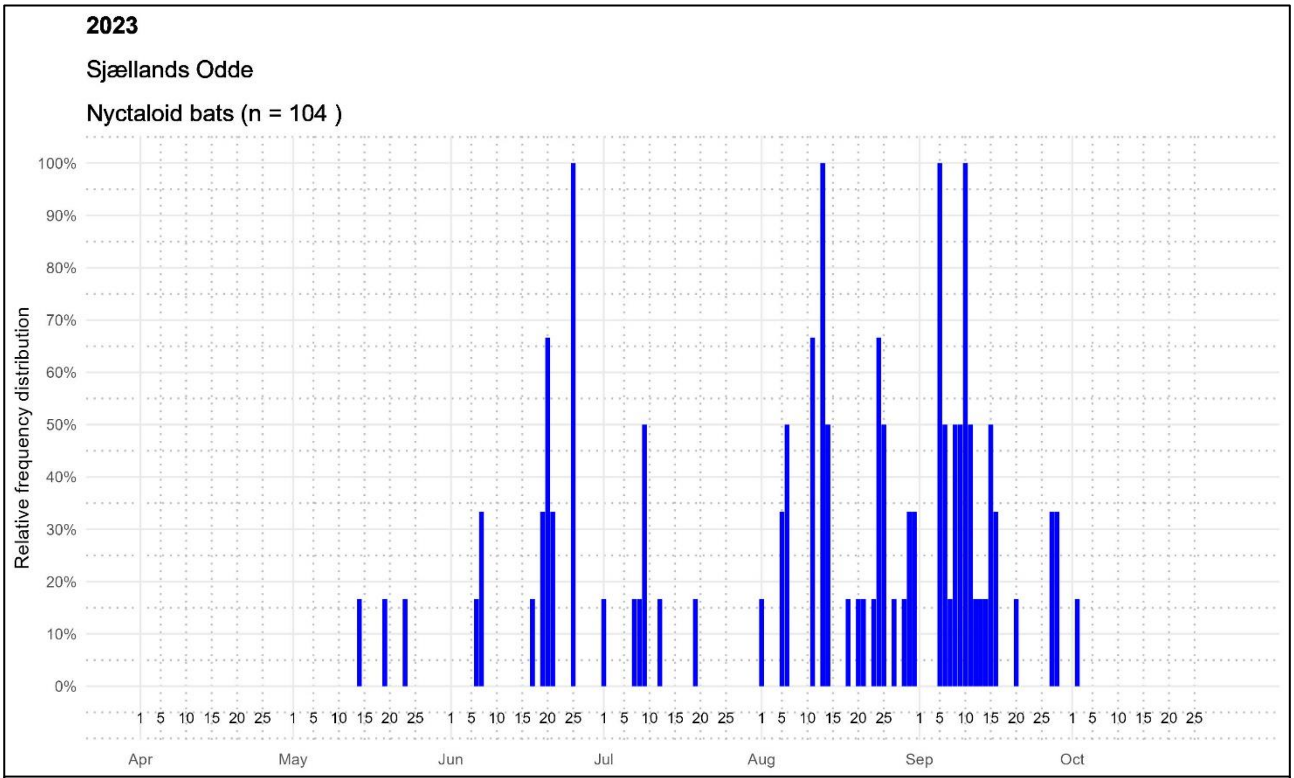
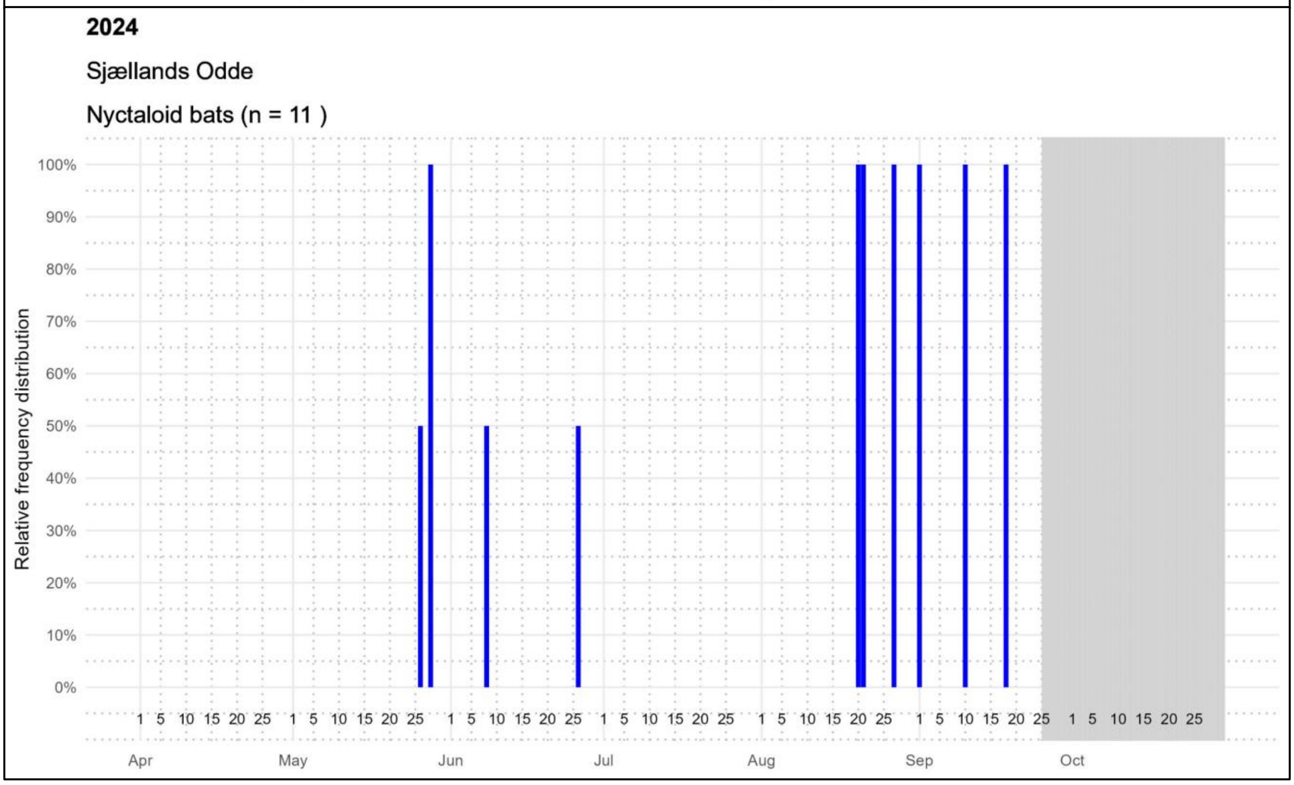
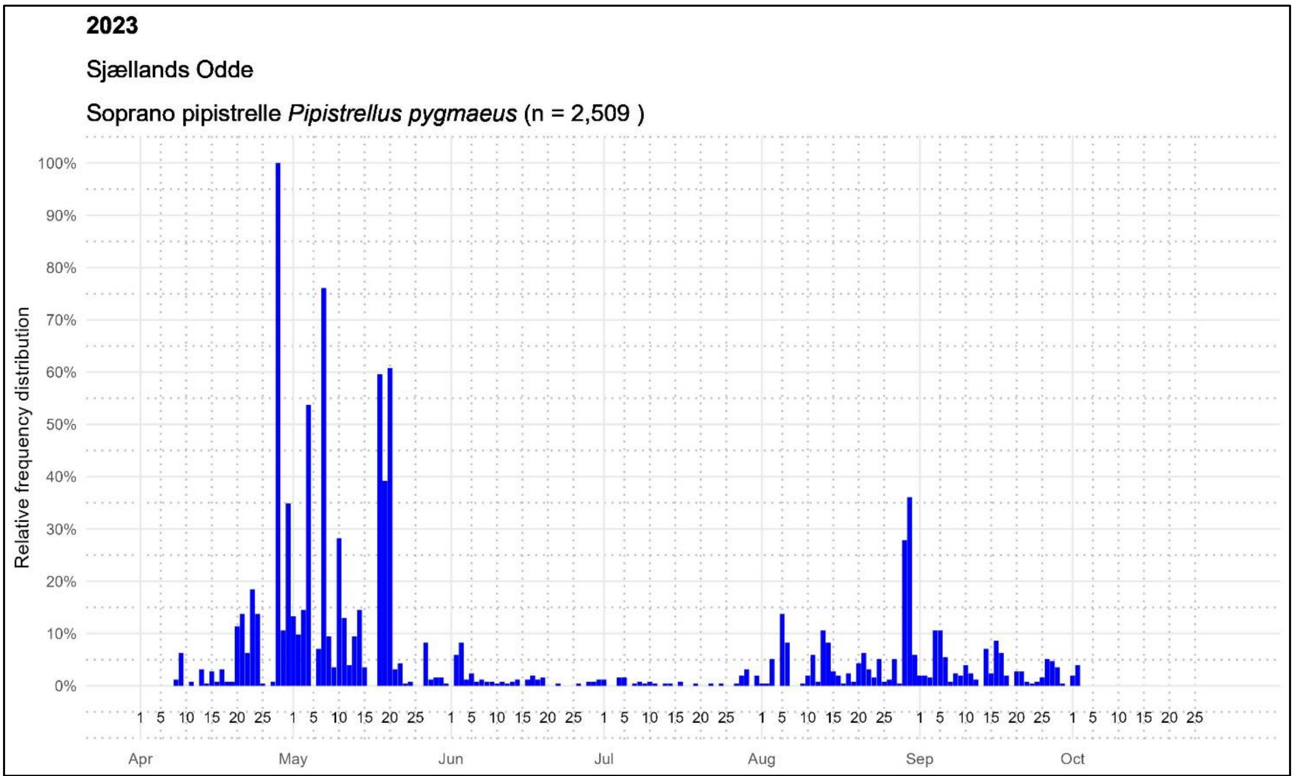

2023
Sjællands Odde
Nyctaloid bats (n = 104)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25
Apr May Jun Jul Aug Sep Oct


2024
Sjællands Odde
Nyctaloid bats (n = 11)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25
Apr May Jun Jul Aug Sep Oct


2023
Sjællands Odde
Soprano pipistrelle *Pipistrellus pygmaeus* (n = 2,509)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Apr
May
Jun
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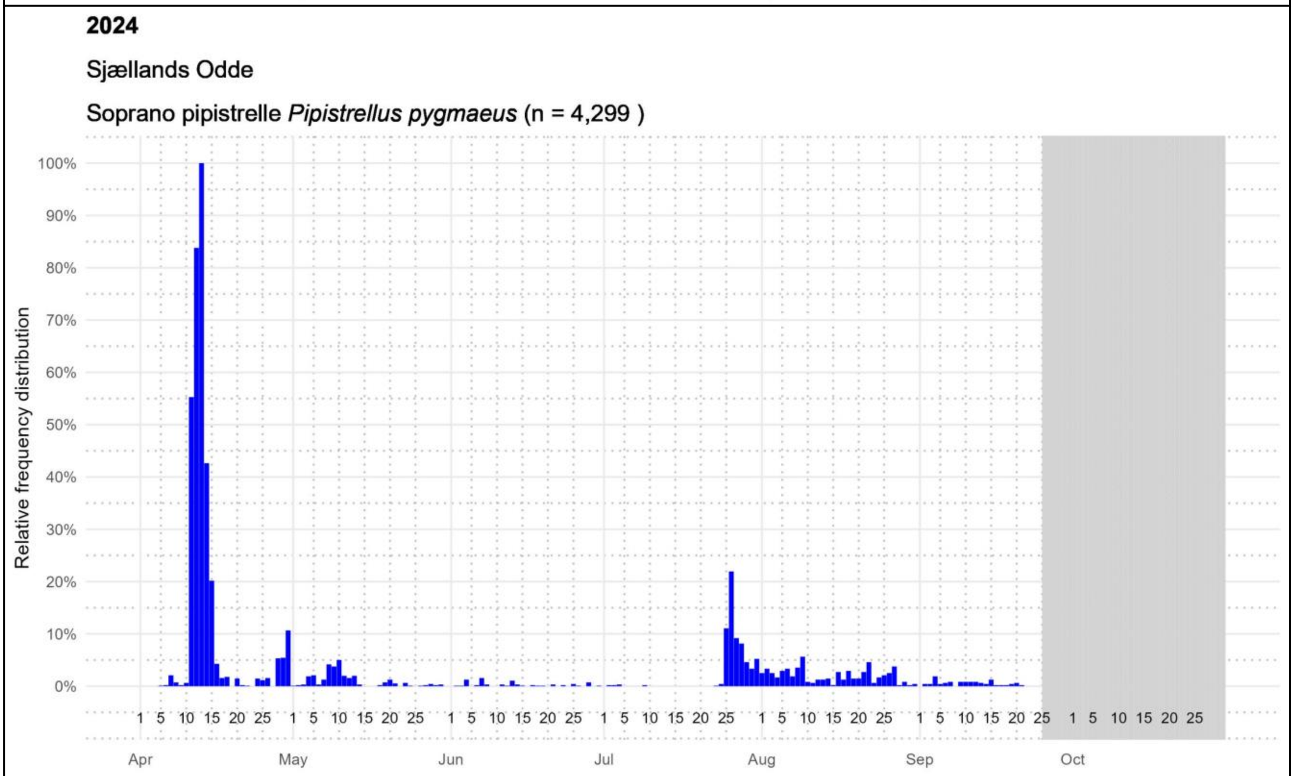
Sep
Oct


2024
Sjællands Odde
Soprano pipistrelle *Pipistrellus pygmaeus* (n = 4,299)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Apr
May
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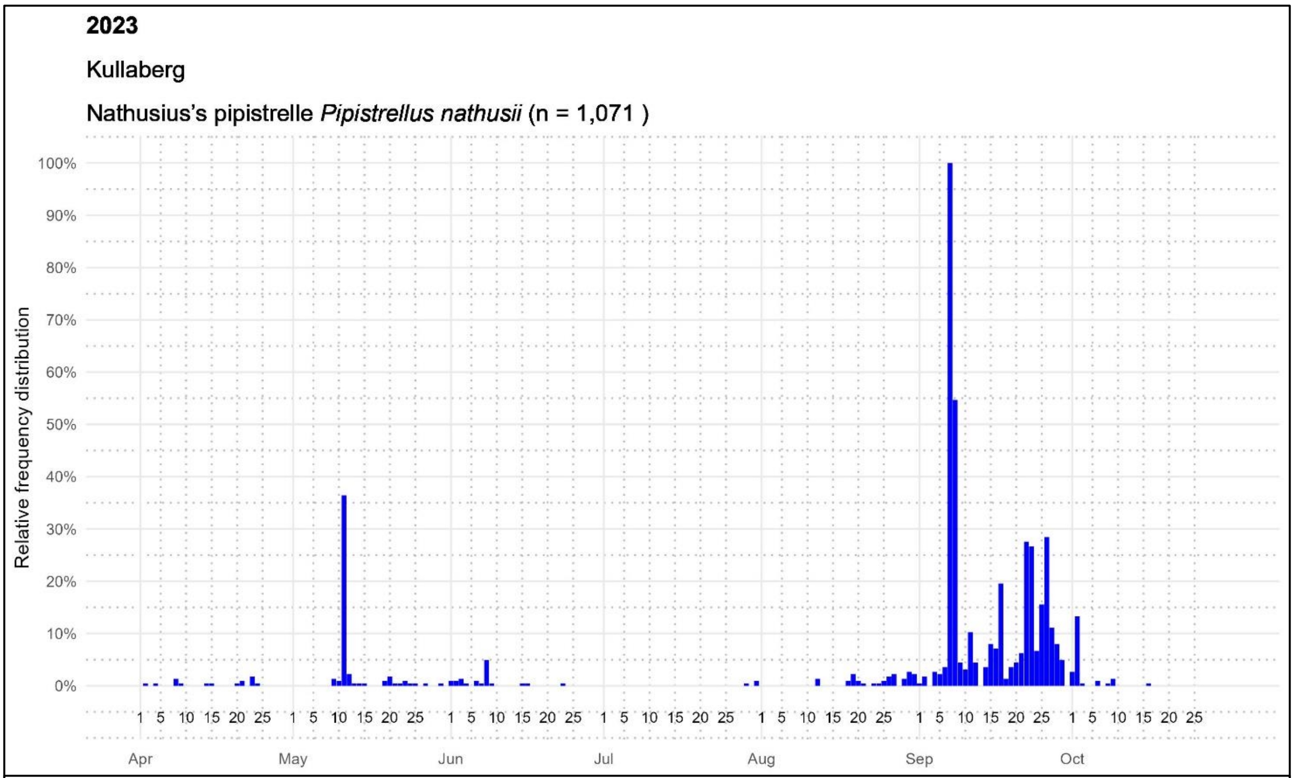
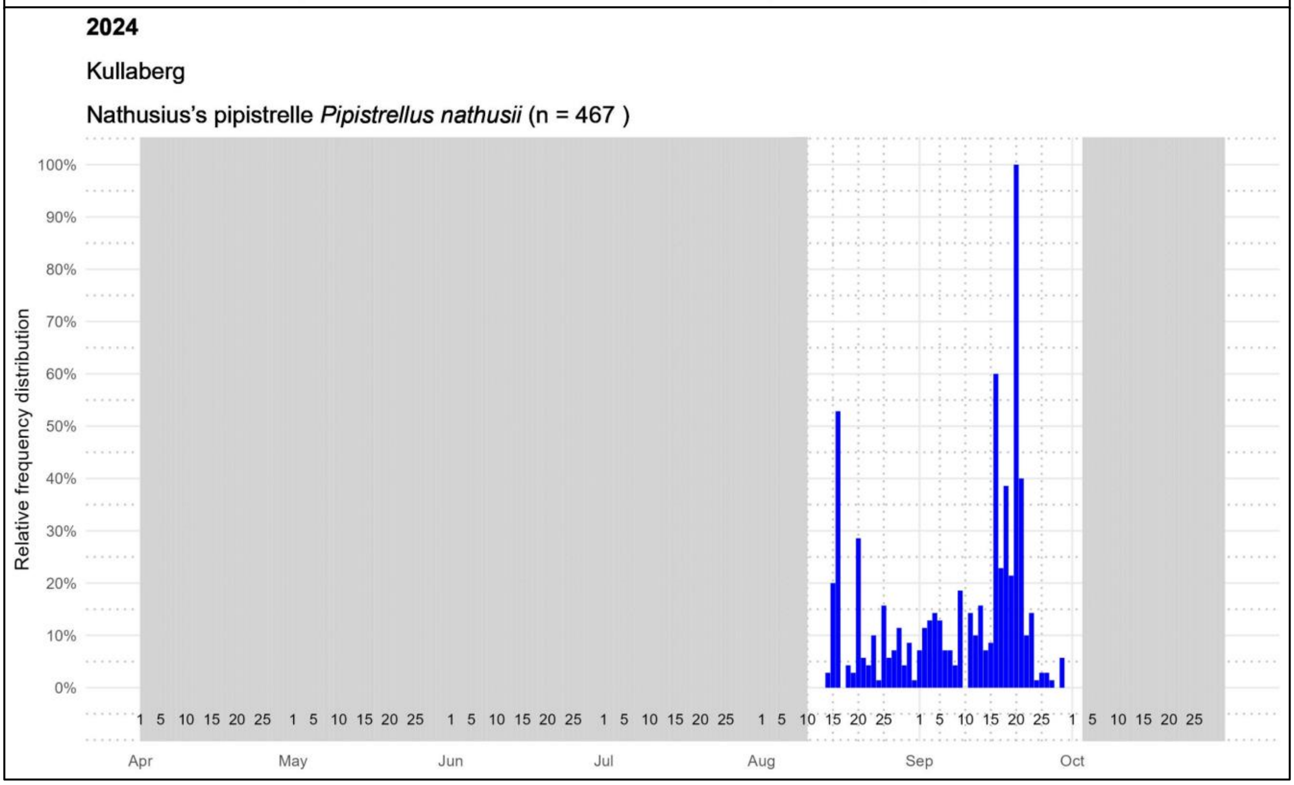
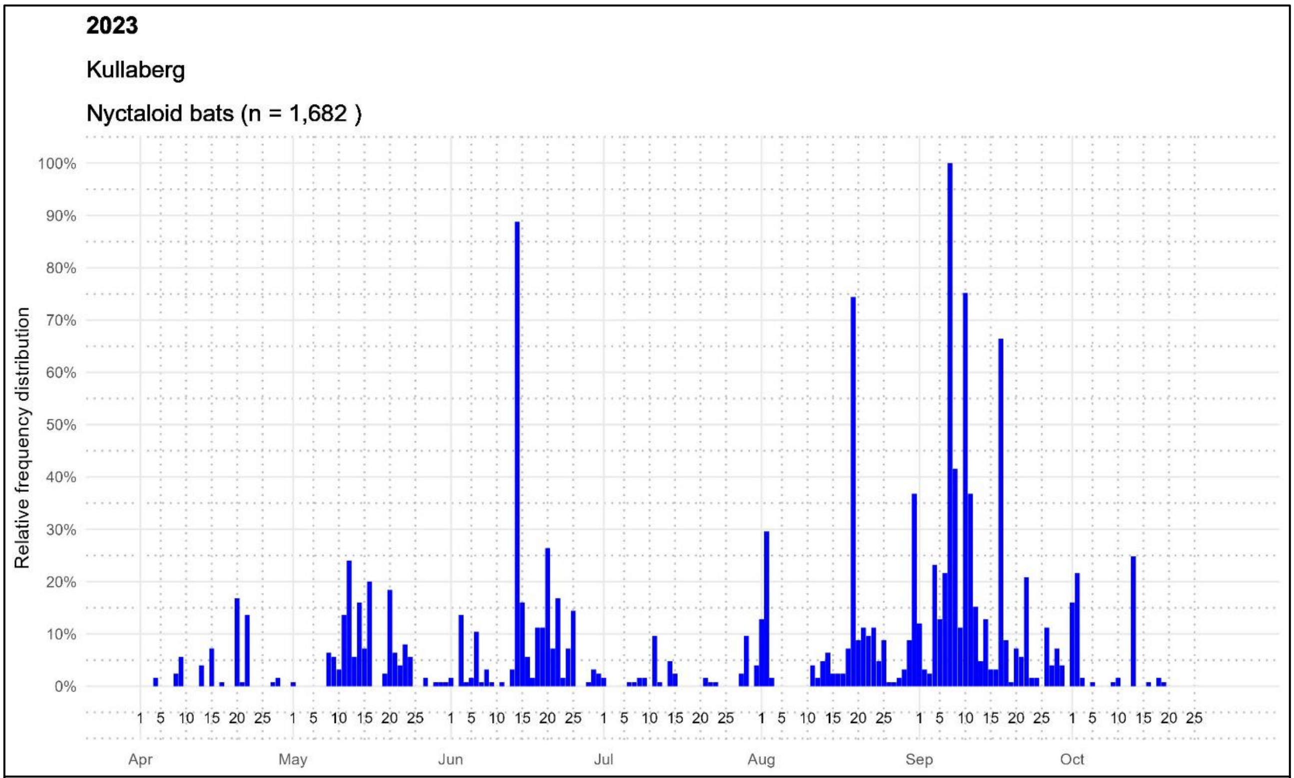

2023
Kullaberg
Nathusius's pipistrelle *Pipistrellus nathusii* (n = 1,071)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25
Apr May Jun Jul Aug Sep Oct


2024
Kullaberg
Nathusius's pipistrelle *Pipistrellus nathusii* (n = 467)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25
Apr May Jun Jul Aug Sep Oct


2023
Kullaberg
Nyctaloid bats (n = 1,682)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
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10%
0%
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May
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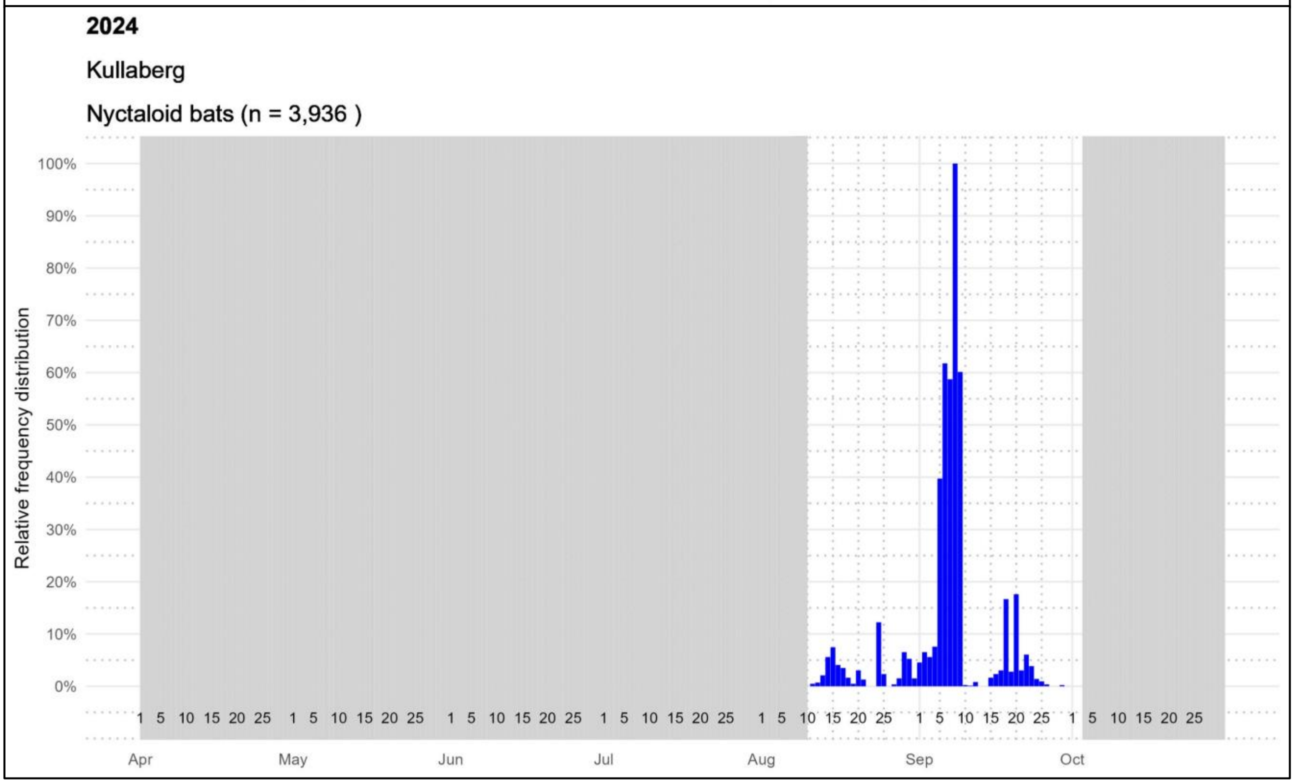
2024
Kullaberg
Nyctaloid bats (n = 3,936)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 5 10 15 20 25
Apr
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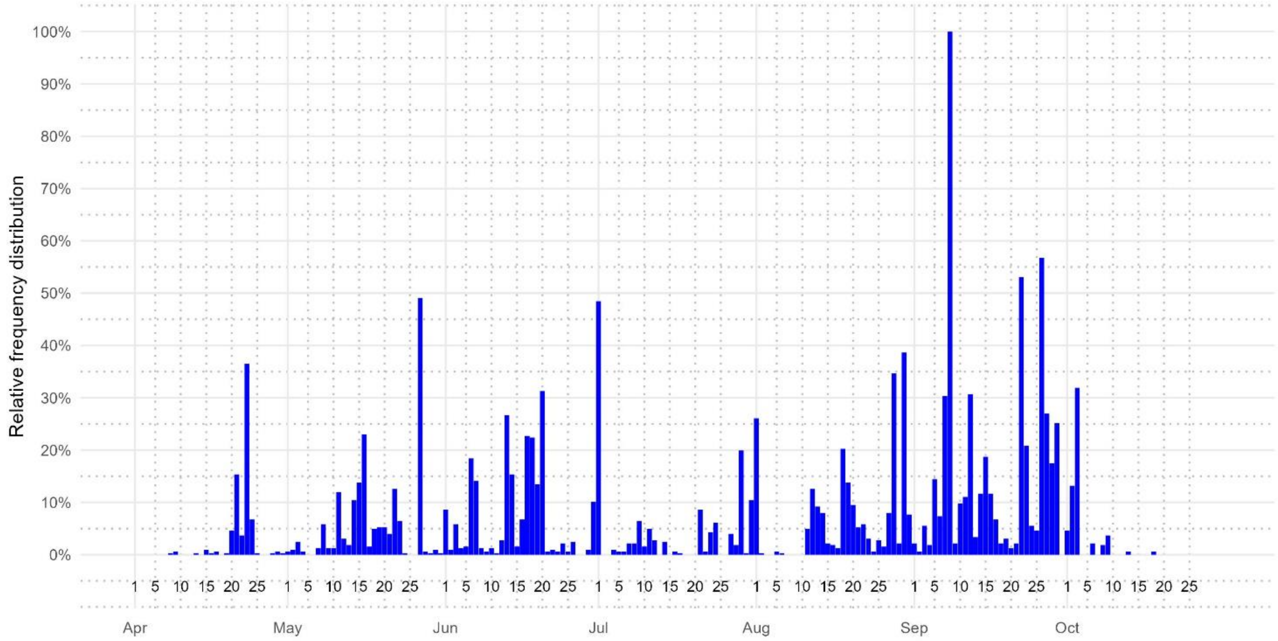
2023

Kullaberg

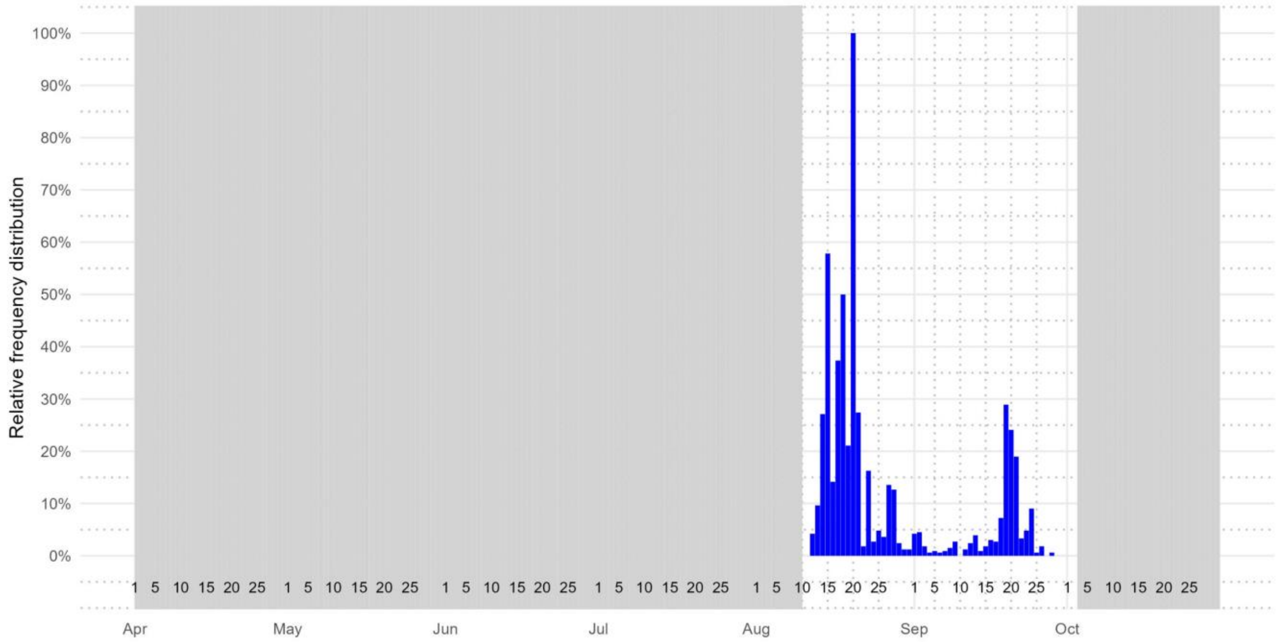
Soprano pipistrelle *Pipistrellus pygmaeus* (n = 4,412)

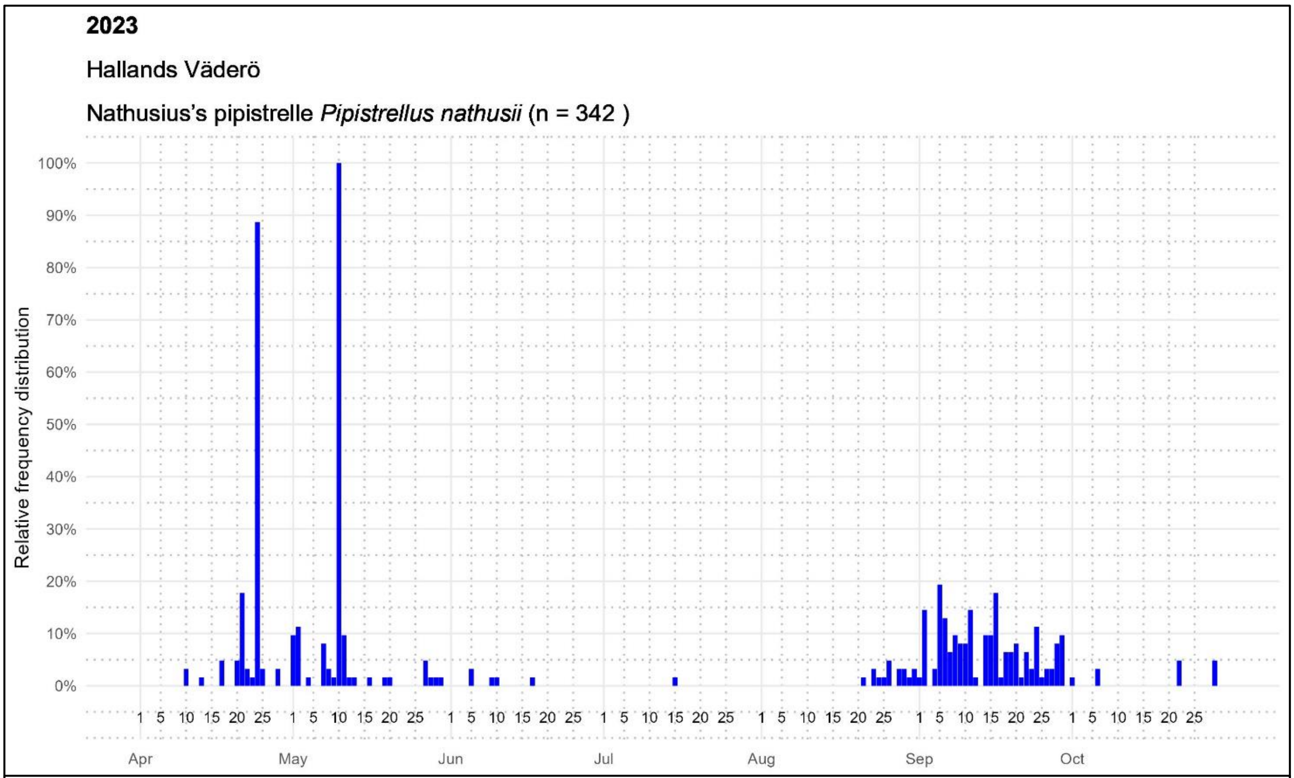


2024

Kullaberg

Soprano pipistrelle *Pipistrellus pygmaeus* (n = 1,822)




2023
Hallands Väderö
Nathusius's pipistrelle *Pipistrellus nathusii* (n = 342)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Apr
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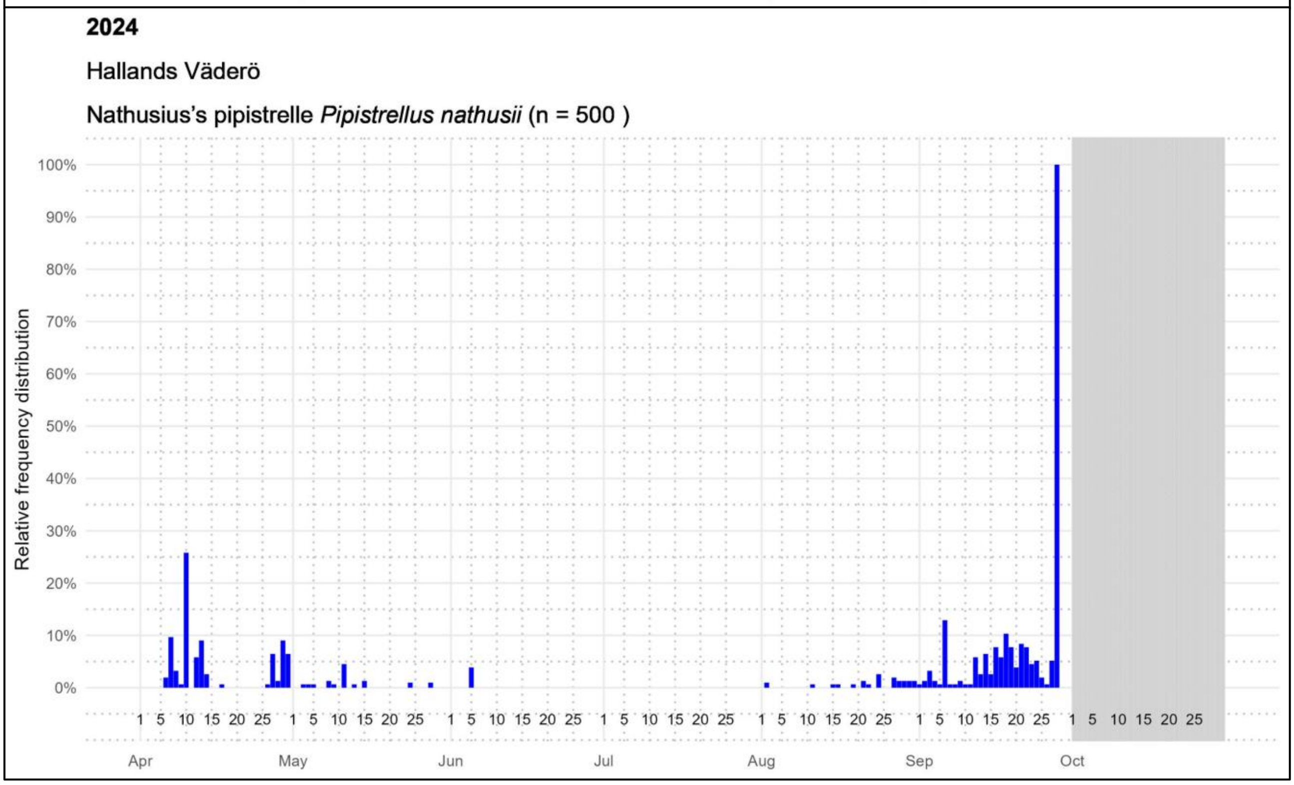
2024
Hallands Väderö
Nathusius's pipistrelle *Pipistrellus nathusii* (n = 500)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Apr
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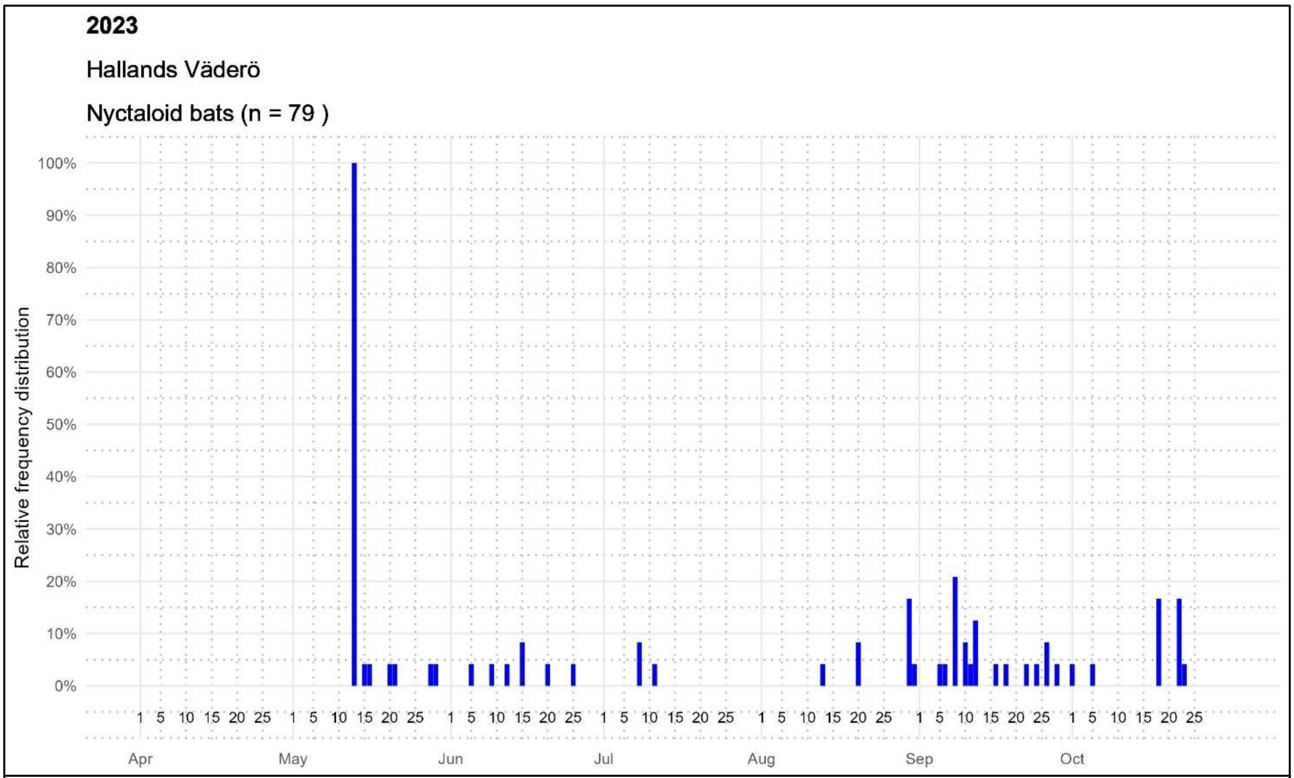
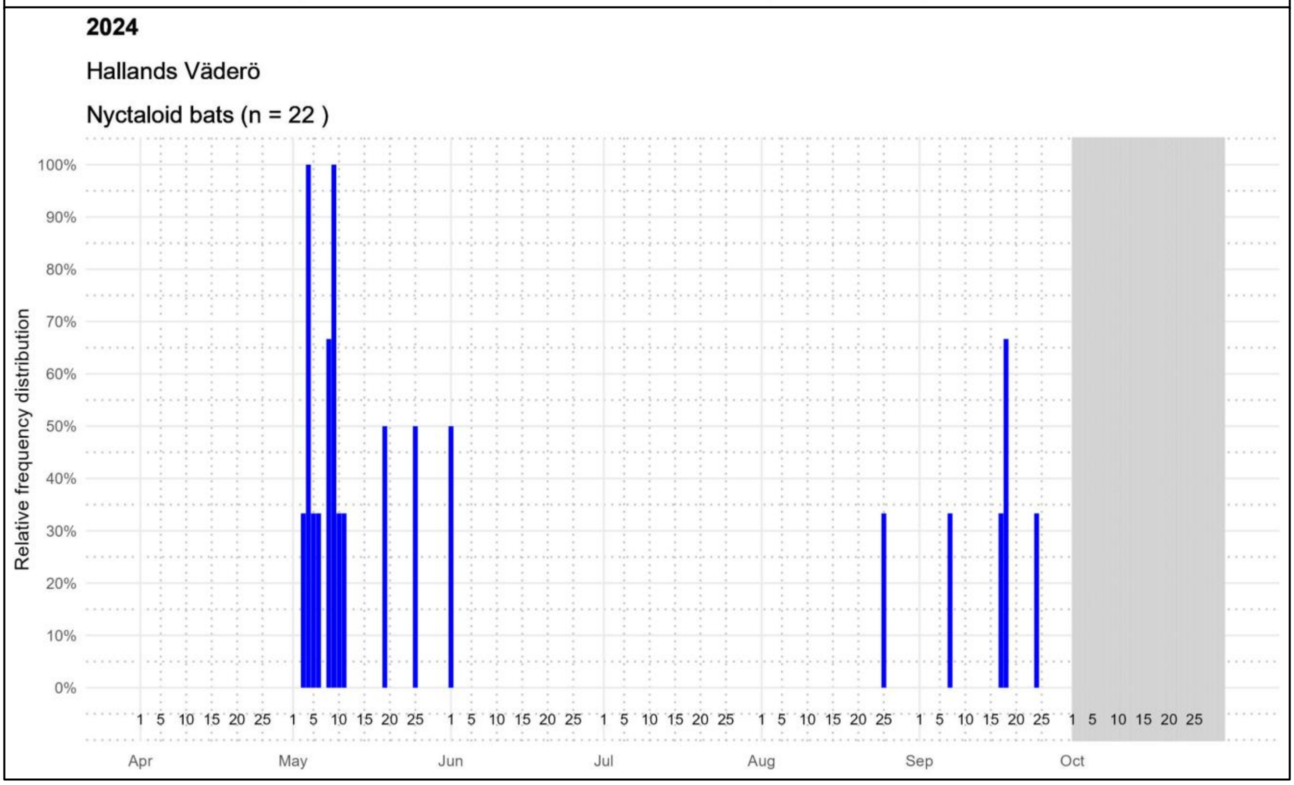
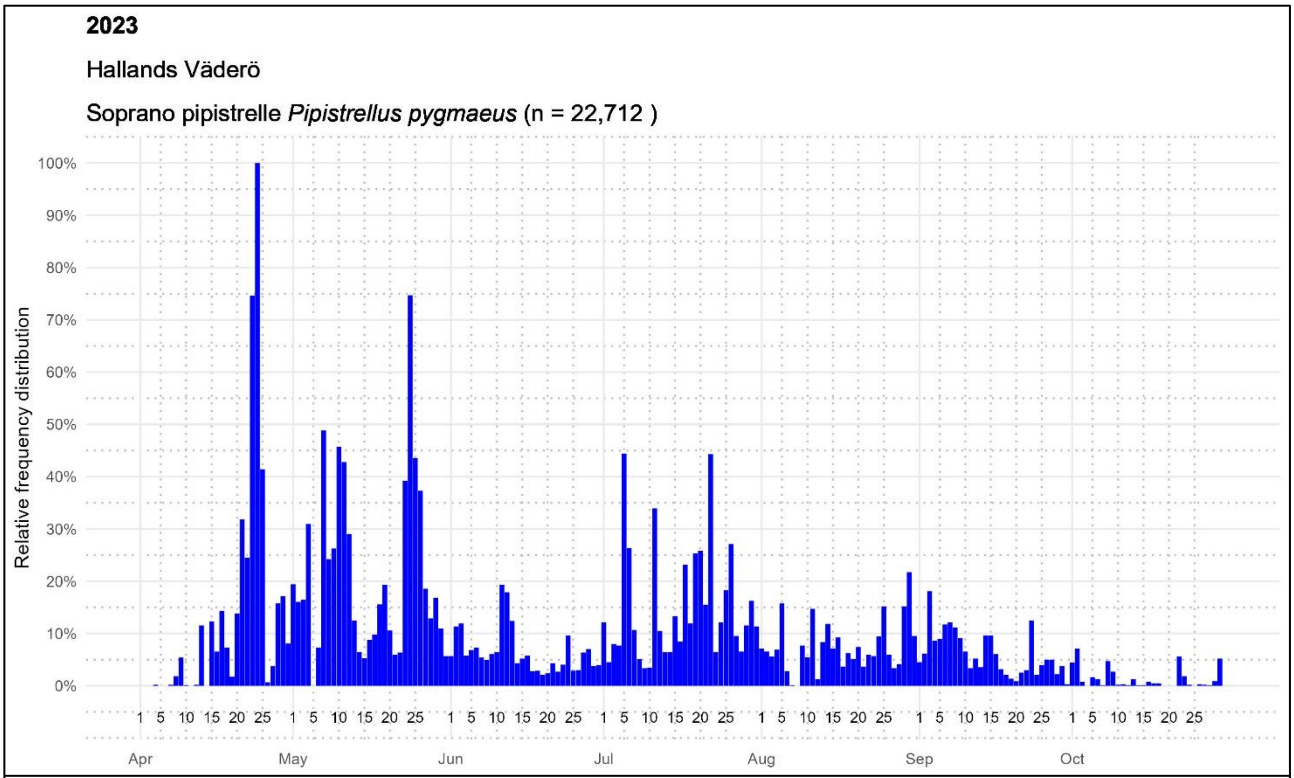

2023
Hallands Väderö
Nyctaloid bats (n = 79)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25
Apr May Jun Jul Aug Sep Oct


2024
Hallands Väderö
Nyctaloid bats (n = 22)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25 1 5 10 15 20 25
Apr May Jun Jul Aug Sep Oct


2023
Hallands Väderö
Soprano pipistrelle *Pipistrellus pygmaeus* (n = 22,712)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Apr
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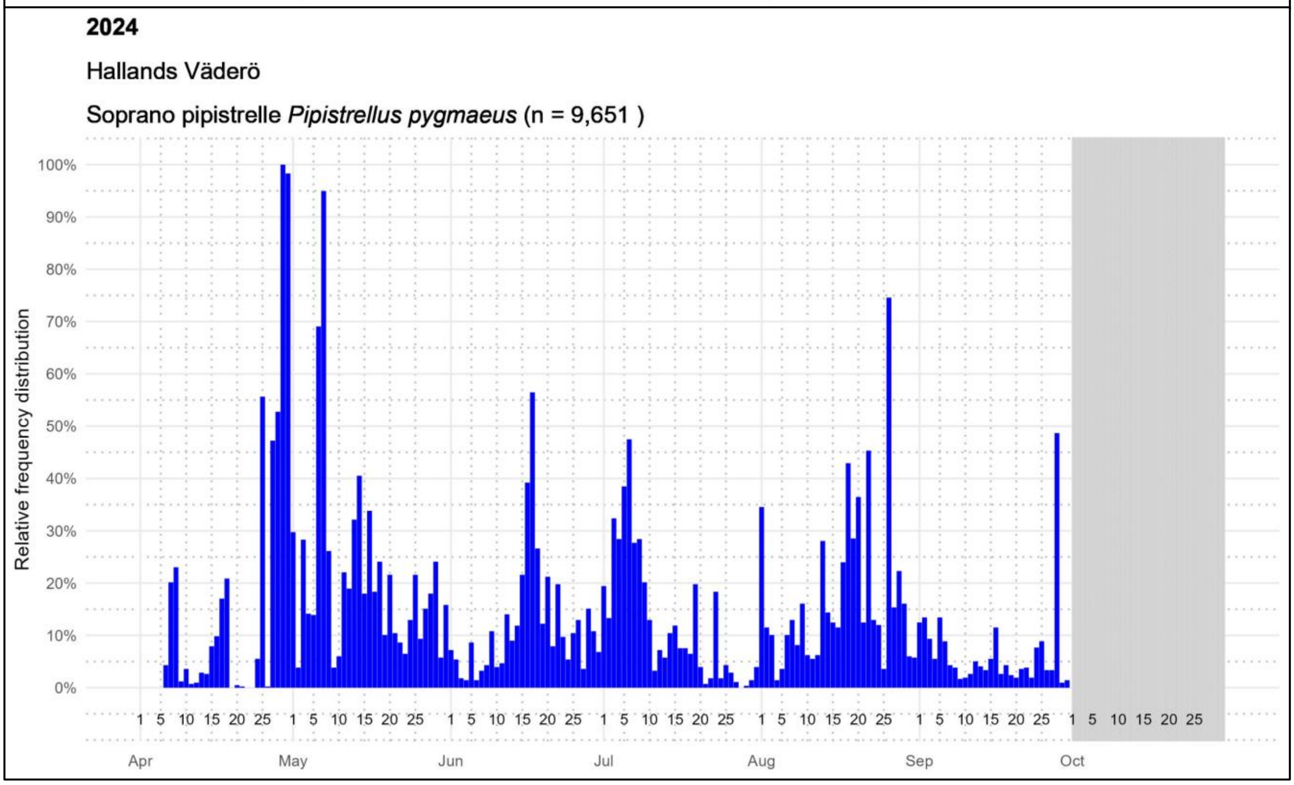
2024
Hallands Väderö
Soprano pipistrelle *Pipistrellus pygmaeus* (n = 9,651)
Relative frequency distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Apr
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