ENERGINET

ENERGY ISLAND BORNHOLM

TECHNICAL REPORT – BATS

Version 2

28-01-2025

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INDHOLD

1 SUMMARY

The pre-investigation area for Energy Island Bornholm was surveyed for bats offshore by bat detectors mounted on fifteen buoys distributed over the pre-investigation area in 2022 and 2023. The offshore survey was supplemented by surveys of relevant onshore coastal areas in the vicinity of the pre-investigation area.

The following five species of bats were recorded in the offshore pre-investigation area by a total of 97 offshore recordings:

- Common noctule
- Nathusius's pipistrelle
- Parti-coloured bat
- Soprano pipistrelle
- Daubenton's bats.

Common noctule, Nathusius's pipistrelle and Parti-coloured bat were the most frequently recorded species of bats. All these species are known to be long-distance migratory bat species. The results only included a single recording of Soprano pipistrelle, despite a considerable coastal activity. Daubenton's bat is not considered to be migratory and were only recorded a few times on two buoys near the coast of Bornholm.

The present survey shows that most of the recorded bats (90 %) were recorded when the wind speed (measured 4 meter above sea level) was 6 m/s or lower. In summer and autumn, the bats seem to prefer high temperature and rarely fly offshore when the temperature is below 16°C. However, during the spring migration, the bats were recorded offshore at between 6 and 14°C.

2 INTRODUCTION

With the Climate Agreement for Energy and Industry of the 22nd of June 2020, the majority of the Danish Parliament decided that Denmark will become the first country in the world to develop two energy islands. One of these islands will be the island of Bornholm located in the Baltic Sea ("Energiø Bornholm"), with wind farms south-west of Bornholm with an installed capacity of up to 3.8 GW.

Because of these political decisions, a series of biological and scientific investigations have been carried out for a well-defined pre-investigation area, as a part of the baseline mapping of this part of the Baltic Sea. These studies have also included surveys to gain knowledge of occurrence, spatial distribution, and habitat use of bats in this marine area as well as onshore surveys in selected places of importance in bat migration.

The pre-investigation area for Energy Island Bornholm OWF is located south and west of Bornholm (Figure 1) and covers the three areas reserved for potential offshore wind farms (OWF). The suggested wind farm areas consist of Bornholm I South (118 km^2), Bornholm I North (123 km^2) and Bornholm II (410 km^2)) (Figure 1). Bornholm I North and Bornholm II are more than 15 km from the coast of Bornholm, whereas Bornholm I South is more than 30 km from the coast of Bornholm.

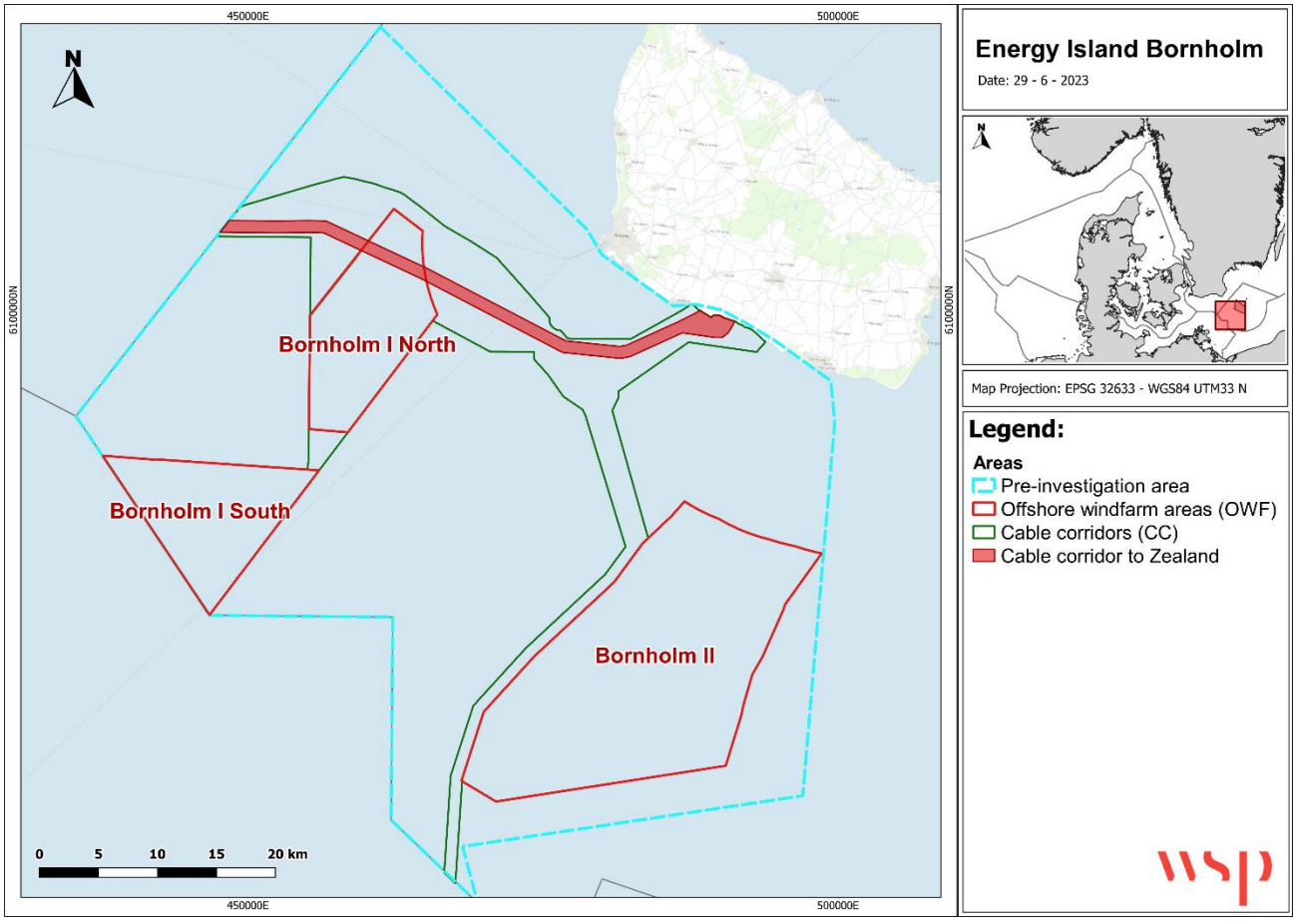

Figure 1 - The pre-investigation area (dotted turquoise polygon) and the suggested areas for wind farms (red polygons) and cables within (green polygons).

3 METHODOLOGY

The field survey programs for bat detection offshore and -coastal 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 and tested during this survey programme. The method for the coastal onshore survey was selected mainly to support and supply the results from the offshore survey. Therefore, the type of detector and settings onshore are similar to offshore detectors, except for the box design and the 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). Due to the uncertainty of bat activity offshore and the risk of foraging bats during the summer season, the offshore monitoring was conducted throughout the entire period from March to October. In both spring seasons of 2022 and 2023, 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.

3.1.1 BUOY BASED SURVEY

Bat detectors were attached to the 15 buoys used for the marine mammal Passive Acoustic Monitoring (PAM) survey program conducted by WSP & BioConsult (Figure 2). The initial mountings of the bat detectors to the PAM stations were carried out during a PAM-service expedition in March 2022. The bat detectors were mounted on the buoys by a dedicated bat detector specialist. 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 Goretex 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 Goretex protected microphones.

The PAM-mounted bat detectors collected recordings of all bats passings at these 15 positions (Figure 3) in the pre-investigation area during spring, summer, and autumn (1st of April to 31st of October) in 2022 and 2023.

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.

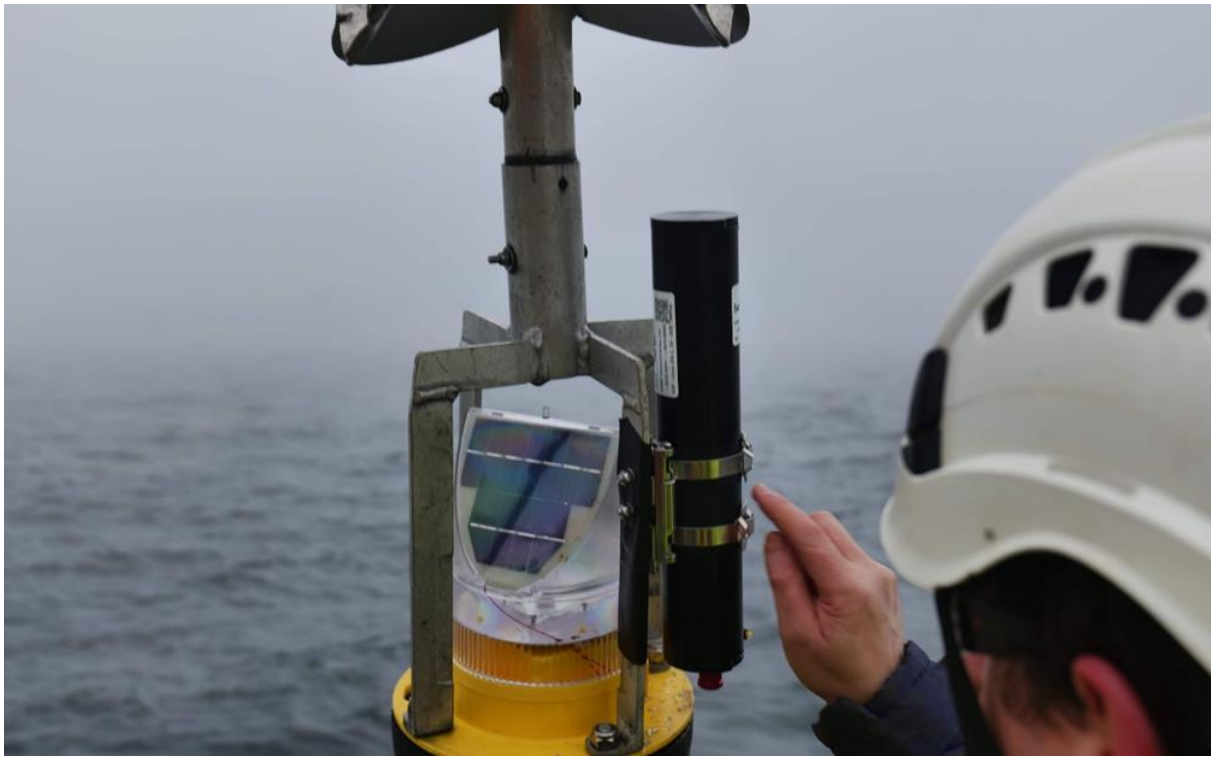

Figure 2 - Automatic bat detector mounted on a PAM-buoy for the marine mammal survey.

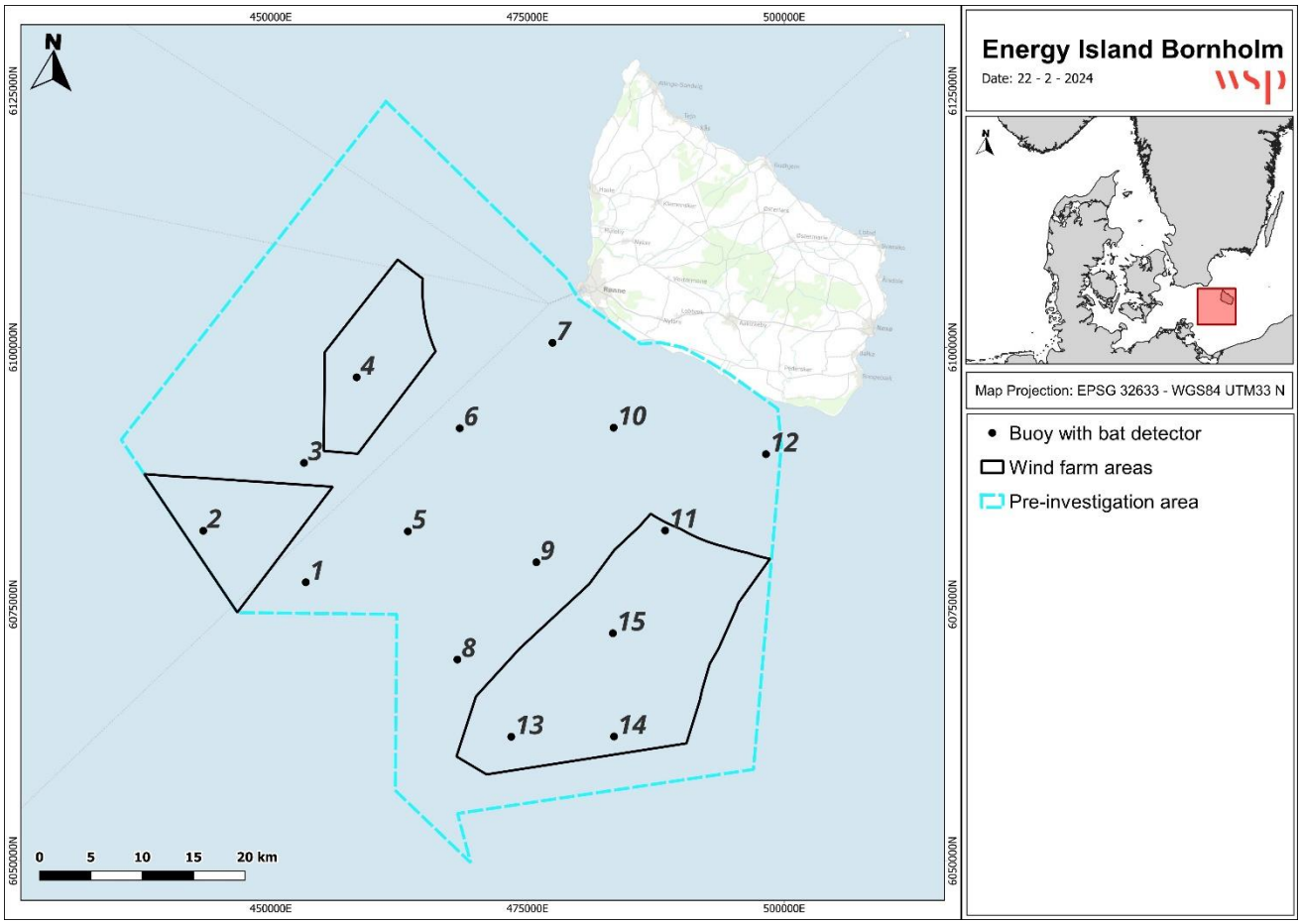

Figure 3 - Map showing the position of the buoys used for the offshore survey. The wind farm areas shown on the map are suggested areas only.

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

	2022		2023	
Stations	**Spring**	**Autumn**	**Spring**	**Autumn**
Bouy 1	15. Mar. – 31. May.	20. Jul. – 29. Aug.	-	
Bouy 2	15. Mar. – 5. Jun.	20. Jul. – 2. Sep.	28. Mar. – 12. Aug.	4. Sep.
Bouy 3	15. Mar. – 9. May + 14. – 31. May.	20. Jul. – 4. Sep.	28. Mar. – 16. Jun.	4. Sep. – 8. Oct.
Bouy 4	15. Mar. – 12. Jun.	20. Jul. – 30. Aug.	-	4. Sep. – 8. Oct.
Bouy 5	15. Mar. – 21. Apr. + 14. May. – 6. Jun.	20. Jul. – 29. Aug.	-	4. Sep. – 8. Oct.
Bouy 6	15. Mar. – 2. Jun.	20. Jul. – 2. Sep.	28. Mar. – 31. Aug.	4. Sep. – 8. Oct.
Bouy 7	15. Mar. – 30. Apr. + 14. May. – 16. Jul.	20. Jul. – 30. Aug.	-	4. – 10. Sep.
Bouy 8	16. Mar. – 16. Apr. + 14. May. – 28. Jun.	20. Jul. – 28. Aug.	28. Mar. – 3. Sep.	4. Sep. – 25. Oct.
Bouy 9	15. Mar. – 25. Jun.	20. Jul. – 2. Sep.	-	4. Sep. – 8. Oct.
Bouy 10	14. May. – 6. Jun.	20. Jul. - 30. Aug.	-	4. Sep. – 8. Oct.
Bouy 11	24. Mar. – 26. Jun.	20. Jul. – 30. Aug.	28. Mar. - 3. Sep.	4. – 26. Sep.
Bouy 12	15. Mar. – 5. Jul..	20. Jul. – 2. Sep.	28. Mar. – 30. Jul.	4. Sep. – 25. Oct.
Bouy 13	15. Mar. – 15. Apr. + 14. – 17. May.	20. Jul. – 25. Aug.	-	4. – 18. Sep.
Bouy 14	16. Mar. – 20. Jun.	20. Jul. – 6. Oct.	28. Mar. – 26. Aug.	7. Sep. – 1. Oct.
Bouy 15	15. Mar. – 1. Apr. + 14. May. – 19. Jul.	20. Jul. – 30. Aug.	-	4. Sep. – 8. Oct.

3.1.2 OFFSHORE VESSEL BASED SURVEY

The survey vessel M/S Skoven has been visiting the survey areas for different purposes throughout the survey period (2022-2023). During this entire survey period, a single bat detector, of the same type as used for the

buoy-based survey, was mounted at the front part of the vessel (Figure 4). This bat detector was programmed to record completely independent, with no assistance from the staff onboard the vessel. The purpose of the bat detector was set to record ultrasound from any possible bats in the vicinity of the vessel and saved the recording for later analysis. The bat detector also logged the position of the vessel at any given time. Weather conditions (wind direction, wind speed and temperature were taken from the vessel logbook). The vessel-based bat surveys included data collection from March 2022 to October 2023. Unfortunately, no bats were registered by the vessel mounted bat detector during this two-year period where surveys were conducted in the pre-investigation area.

Figure 4 - Automatic bat detector (in front) mounted on the survey vessel Skoven.

3.1.3 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 may clearly indicate when a migration through the pre-investigation area occurs. Hence, a land-based survey was set up, and the survey included data collection from September 2021 through to October 2023.

The main migration of bats to and from Bornholm is expected to occur from southwest to northeast in spring and from northeast to southwest in autumn. Therefore, sites on northern and southern Bornholm with high probabilities for acting as exit points for the migrating bats were selected. Unfortunately, the geographical composition of the southwestern or northeastern Bornholm impedes the chances of locating the exact exit points. This is due to the fact, that this area has no obvious spits or peninsulas. The best possible locations were considered to be the southern most extreme; Dueodde, and the northern most extreme; Hammeren.

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, survey stations in the coastal regions of the adjacent countries were also included in the survey programme.

A total of 14 detectors (Figure 5) in seven different areas along the coast at Bornholm, Rügen and Sweden, as well as on the small island of Christiansø between Bornholm and Sweden (Figure 5 & Table 2), were installed during the survey periods monitored for 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. All sites had two detectors with one detector functioning as a backup in case of technical failure. At the south coast of Bornholm, four single detectors were places with 7-10 km distance to cover the potential variation along the coast. In the later analysis, the two detectors towards the eastern part of the coast and the two detectors towards the western part of the coast, respectively, were grouped, based on the similarities in the observed recordings patterns.

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 6).

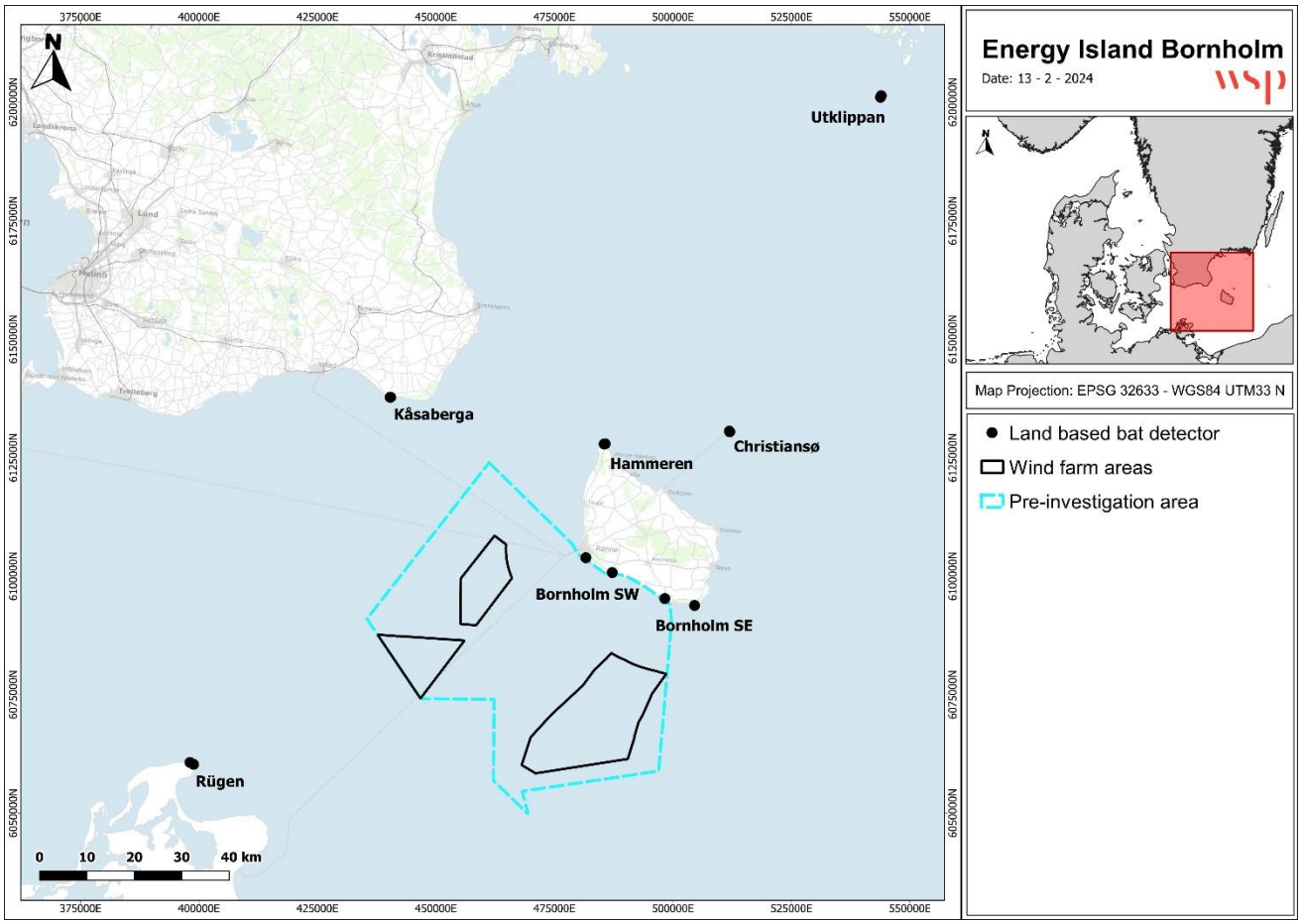

Figure 5 - Map showing the position of the coastal bat detectors. All locations have two detectors. The detectors on the south coast of Bornholm are place with a distance of approximate 7 km. Detector on all other sites are placed less than 1 km apart. The wind farm areas shown on the map are suggested areas only.

Table 2 gives an overview of stations used in the coastal bat survey and which periods the detectors were deployed and recording.

Table 2 – Deployment periods for coastal bat detectors (Two detectors per station).

	2021	2022		2023	
Stations	**Autumn**	**Spring**	**Autumn**	**Spring**	**Autumn**
Bornholm SW	15. Sep – 16. Oct.	17. Mar. – 20. Jun.	9. Aug. – 2. Oct	17. Mar. – 15. Jul.	14. Aug. – 23. Oct.
Bornholm SE	15. Sep – 19. Oct.	17. Mar. – 20. Jun.	9. Aug. – 31. Oct.	17. Mar. – 12. Aug.	14. Aug. – 23. Oct.
Hammeren	-	18. Mar. – 21. Jun.	10. Aug. – 31. Oct.	16. Mar. – 19. Jul.	15. Aug. – 24. Oct.
Christiansø	16. Sep. – 17. Oct.	18. Mar. – 21. Jun.	10. Aug. – 31. Oct.	16. Mar. – 14. Aug	15. Aug. – 24. Oct.
Utklippan	-	-	23. Aug. – 7. Oct.	28. Mar. – 16. Aug.	17. Aug. – 31. Oct..
Kåseberga	-	17. Mar. – 21. Jun.	9. Aug. – 6. Oct.	15. Mar. – 18. Jun.	17. Aug. – 25. Oct.
Rügen	-	19. Mar. – 28. Jun.	11. Aug. – 8. Oct.	16. Mar. – 15. Jun.	22. Aug. – 31. Oct.

Figure 6 - Bat detector on the southeastern coast near Dueodde of Bornholm.

3.1.4 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 2, Figure 4 & Figure 6). 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 detector settings are presented in Table 3.

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 collected onshore, offshore buoy-based and vessel-based bat detection data 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.

4 EXISTING DATA

Existing data for bats within the pre-investigation area for Energy Island Bornholm are very limited. One of the closest relatable studies was carried out in 2014, as part of the environmental impact assessment for the Bornholm Near Shore Windfarm project. Here, a ship-based bat survey was carried out over the duration of six nights in August (28th and 30th) and September (5th, 6th, 19th and 20th) in an area located 5 to 10 km southwest of Bornholm (Amphi Consult , 2015). Only few bats were registered during this survey. During three of the nights, no bats were registered. Daubenton's bat was registered only during two nights, and common noctule and Nathusius's pipistrelle were each registered one night. The areas investigated in the Bornholm Near Shore Windfarm project were situated closer (5-10 km) to the coast of Bornholm than the present project (>15 km from the nearest coast).

Due to the lack of existing data for the pre-investigation area, the existing data included in this report also include data collected from different projects and studies outside the pre-investigation area. The existing and hence comparable data were chosen from projects situated in the same geographical region (southern Baltic Sea). For a comprehensive review of existing data for the Baltic Sea, please see Seebens-Hoyer, et al. (2021).

4.1 BAT MIGRATION

The bat species in Denmark can be divided into three groups, where each group has a unique migration pattern (Figure 7). Some bats are long-distance migrating bats, typically migrating between a few hundred kilometres to several thousand kilometres. Other species are short-distance migrating bats with a migration/ roaming range up to around 100-400 kilometre, typically between a breeding site or a summer roosting site to a winter roosting and hibernation site. The third group consists of sedentary species that only rarely move more than a few kilometres from their breeding and roosting sites. The long-distance migrating bats are considered the species most vulnerable to offshore windfarms (Rydell, et al., 2010; Voigt, Popa-Lisseanu, Niermann, & Kramer-Schadt, 2012; Lehnert, et al., 2014; Arnett, et al., 2016; Kruszynski, C., Bailey, L.D., Courtiol, A.; Bach, l., Bach, P., Göttsche, M., Göttsche, M., Hill, R., Lindecke, O., Matthes, H., Pommeranz, H., Popa-Lisseanu, A.G., Seebens-Hoyer, A., Tichomirowa, M., Voigt, C.C., 2021). The most common migrating trend amongst most bat species of northern Europe is the short-distance migration trend with distance moving ranges of up to few hundred kilometres.

It is generally suggested that most migrating bats avoid crossing long distances over the sea. Therefore, the main migration routes are expected to follow land and coast until sea crossings cannot be avoided. In northern Europe, large numbers of bats are known to migrate from Finland, the Baltic countries and Sweden, to Holland, Belgium, Northern France and even southern UK (Hutterer, Ivanova, Meyer-Cords, & Rodrigues, 2005).

The pre-investigation area is located in an area where especially long-distance migrating bats might be crossing the sea during both spring and autumn migrations (Figure 8).

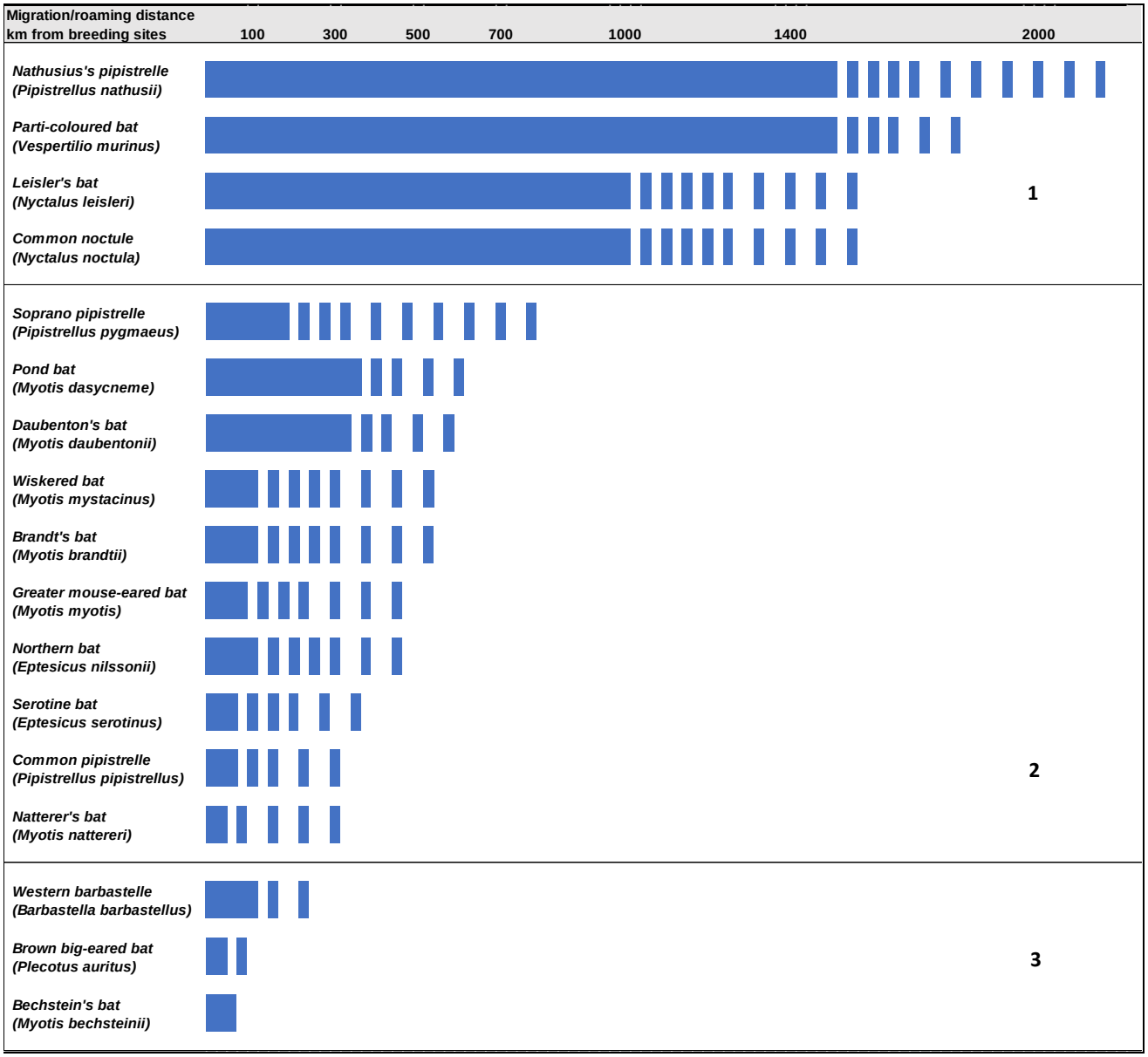

Figure 7 – General distance of migration and roaming for all Danish bat species. Figure from Christensen & Hansen (2023) (Translated from Danish). Solid blue lines indicate typical distances of migration or roaming. Dashed lines indicate more unusual event and maximum distance observed. First group (1) is long-distance migrants, second group (2) is short-distance migrants, and third group (3) is sedentary species. Based on sources: Baagøe (2001), Pētersons (2004), Hutterer et al. (2005), Dietz et al. (2011), Baagøe & Jensen (2007), Alcalde et al. (2021) a.o.

4.1.1 BAT MIGRATION IN SOUTHERN BALTIC SEA

There are rather few scientific studies on bat migration in the pre-investigation area, and in the Baltic Sea in Fennoscandia in general. The available studies show that bats in autumn head south from the southern Swedish coast towards the Baltic Sea, and return to the coast in spring (Figure 8) (Ahlén I. , 1997; Ahlén, I; Baagøe, H; Bach, L, 2009; Bach, L.; Bach, P.; Ehnbom, S. : Karlsson, M., 2015; Ahlén, Bach, & Baagøe, 2007; Hutterer, Ivanova, Meyer-Cords, & Rodrigues, 2005). From the German Baltic coast, studies of bat migration include studies on the island Greifswalder Oie, situated offshore Pomeranian Bay east of Rügen (Seebens, et al., 2013).

Bat migration is also known from Poland, Lithuania, and Estonia in spring and late summer where especially Nathusius's pipistrelle migrate along the coast (Ciechanowski, Jakusz-Gostomska, & Żmihoski, 2016; Masing, 2011; Pētersons, 2004; Šuba, Petersons, & Rydell, 2012).

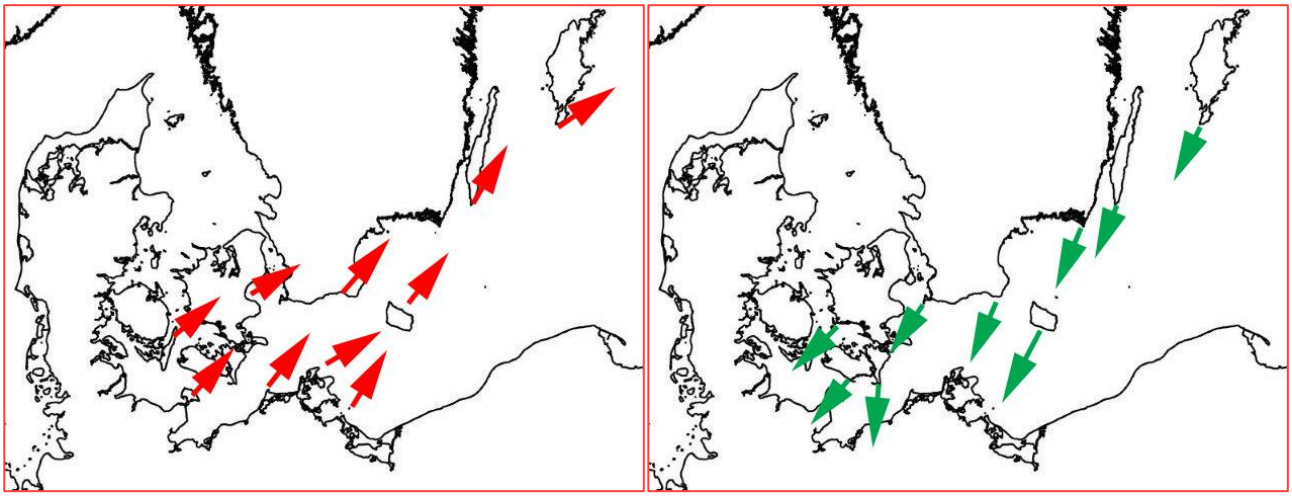

Figure 8 – Suggested patterns of bat spring (left) and autumn (right) migration in southern Baltic Sea (based on (Walter, Matthes, & Joost, 2007; Ahlén, I; Baagøe, H; Bach, L, 2009; Seebens, et al., 2013; Seebens-Hoyer, et al., 2021)).

4.1.2 OFFSHORE AND COASTAL BAT SURVEYS IN SOUTHERN BALTIC SEA

Few offshore studies of bat activity have been carried out in the southern Baltic Sea in the last decade. Figure 9 and Table 6 show a summary of the results of the most relevant studies of bat activity in the southern Baltic Sea with relevance for this project. Most of these studies have been carried out in the German part of the Baltic Sea at two platforms and four marine buoys, as part of environmental impact assessments for various German offshore windfarm, and the Fehmarn connection between Denmark and Germany (Figure 9). Beside these offshore studies of bat activity, a few coastal studies from southern Bornholm (Amphi Consult , 2015), Falsterbo in southern Sweden (Bach L. , Bach, Ehnbom, & Karlsson, 2017), and Gedser (FEBI, 2013) are also relevant. Coastal studies provide knowledge of how bats concentrate and most likely start migration from landsites that minimize migration distance and furthermore provide knowledge regarding the potential feeding activities offshore at certain weather conditions. In combination, the above mentioned coastal and offshore studies from the area around the pre-investigation area, gives a thorough understanding of the bat migration in this area.

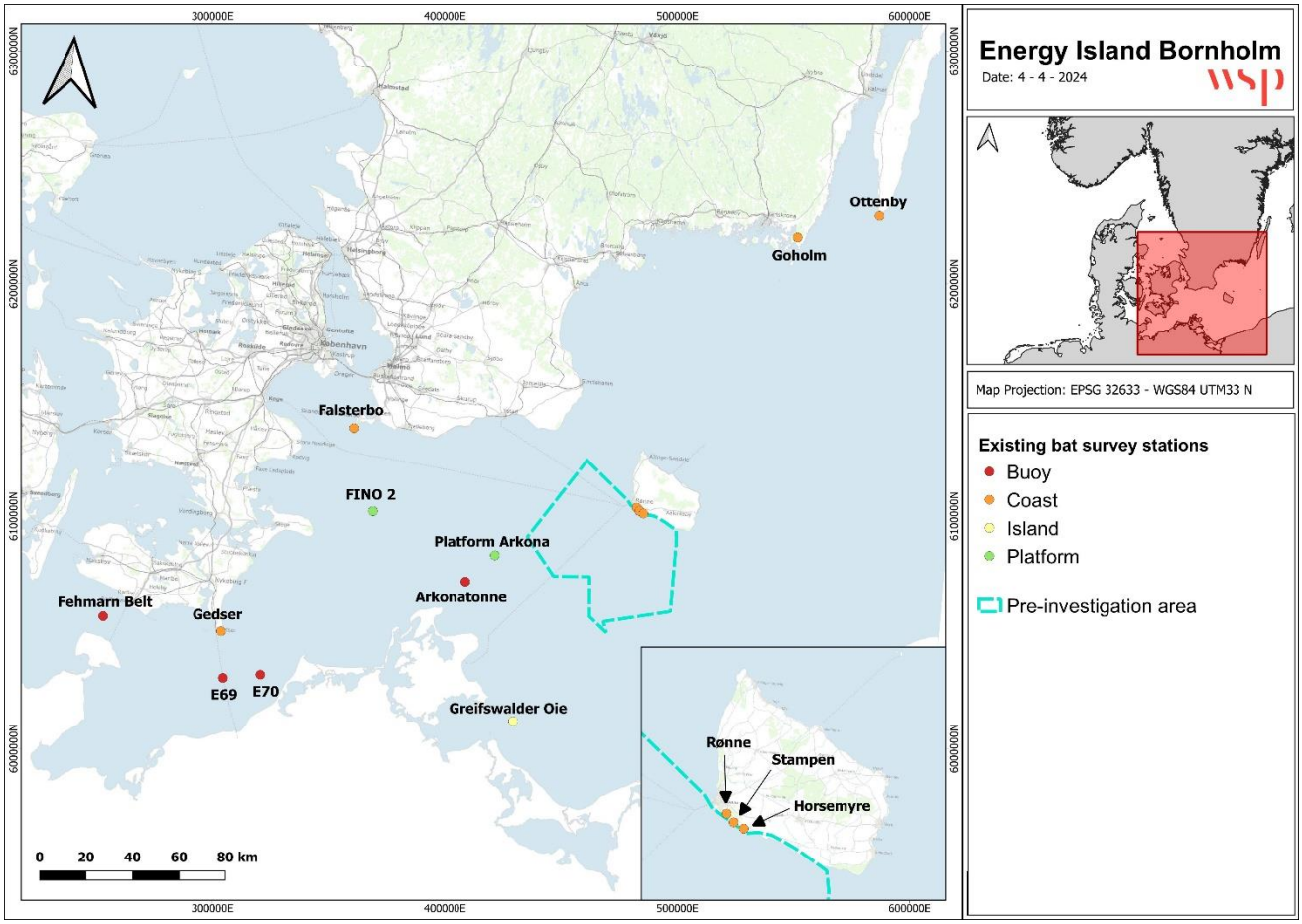

Figure 9 - Bat surveys in the southern Baltic Sea. For offshore references please see Table 6.

The above-mentioned existing studies in the area has resulted in recordings of at least eight species of bats (Table 6). In all the studies, Nathusius's pipistrelle was the most frequent species, with registered detections in 70 to 90 % of the total recordings. Common noctule, Common pipistrelle and Soprano pipistrelle were also recorded in most offshore surveys, but at significantly lower detections.

Table 6 provides an overview of the recording of bat species in the before mentioned seven offshore surveys in the German part of the Baltic Sea.

Table 6 – Bat species recorded on platforms and buoys in the German part of the Baltic Sea (Seebens-Hoyer, et al., 2021). (n=XXX) are the number of bat recordings for each survey.

	Common noctule	Leisler's bat	Noctule or Leisler's bat	Parti-coloured bat	Common serotine	*Myotis* sp.	Common pipistrelle	Soprano pipistrelle	Nathusius' s pipistrelle	*Pipistrellus* sp.
Fehmarn Belt (n=122)*	8 %		6 %		1 %	1 %	1 %	8 %	75 %	
Tonne E69 (2016-18)**** (n=231)	6 %	<1 %	10 %	<1 %	<1 %		1 %	11 %	71 %	
Tonne E70 (2018)**** (n=20)								5 %	95 %	
DS-W (2014)** (n=31)		3 %						6 %	90 %	
FINO 2 (2013)*** (n=289)	4 %		4 %				16 %	<1 %	73 %	3 %
Arkonatonne (2017, 2018)**** (n=78)	5 %	3 %	8 %	4 %			3 %	3 %	76 %	
Plattform Arkona (2017, 2018)**** (n=6)	17 %								83 %	

*) (FEBI, 2013)
**) (Wawra, Wolf, & Russow, 2015; Wawra, 2016)
***) (Skov, Desholm, Heimänen, Johansen, & Therkildsen, 2015)
****) (Seebens-Hoyer, et al., 2021)

4.2 BAT SPECIES LIKELY TO MIGRATE THROUGH THE PRE-INVESTIGATION AREA IN LARGE NUMBERS

Bat migration in the pre-investigation area southwest of Bornholm will most likely be part of a migration route between Northeastern Germany and Sweden (see Figure 8). Others migration routes, between Bornholm and Poland or directly between Zealand or Møn and Bornholm, are considered unlikely due to the long distances the bats would have to migrate over open sea. Therefore, the most likely routes of a bat migration over Bornholm are from Southwest toward Northeast in spring and from Northeast toward Southwest during the autumn migration.

Two species of bats, the Common noctule and the Nathusius's pipistrelle are considered to be the most likely species to migrate through the pre-investigation area in large numbers, since both species are known to migrate long distance and both species are present in large populations in Sweden (Westling, Toräng, Haldin, & Naeslund, 2020), Finland (Tidenberg, Liukko, & Stjernberg, 2019), and in the Baltic countries (Eurobats, 2014). In addition, both species also breed on the island of Bornholm (Møller, Baagøe, & Degn, 2013).

4.2.1 COMMON NOCTULE (NYCTALUS NOCTULA)

Common noctule is a widespread and common bat species on Bornholm (Møller, Baagøe, & Degn, 2013), in northern Germany (BfN, 2008), and Sweden, with a population size of approximately 130,000 individuals (De Jong, 2020; Westling, Toräng, Haldin, & Naeslund, 2020). The distribution also includes the Baltic countries and southernmost Finland (Tidenberg, Liukko, & Stjernberg, 2019) (Figure 10).

Common noctule is a typical migratory bat species. Populations from northeastern Europe are known to migrate southwest in autumn, thus covering distances of up to 1,000 km. Due to the weather conditions, western populations tend to be more sedentary (Lehnert et, al., 2018). The Common noctule is recorded in most offshore bat survey in the southern Baltic Sea (Table 6). The Common noctule is therefore expected to be very likely to migrate through the pre-investigation area.

Figure 10 - Distribution of Common noctule (Eurobats, 2014).

4.2.2 NATHUSIUS'S PIPISTRELLE (PIPISTRELLUS NATHUSII)

Nathusius's pipistrelle breeds regularly on Bornholm but in relatively low numbers (Møller, Baagøe, & Degn, 2013; Baagøe H. , Personal communication). The species is very common on Bornholm during migration - both in spring and in autumn (see present study, chapter 5.2.2). Nathusius's pipistrelle is also widespread and common in Germany (BfN, 2008) and Sweden (De Jong, 2020), and the distribution in the region also includes the Baltic countries and southernmost Finland (Figure 11).

The Nathusius's pipistrelle undertakes a seasonal long-distance migration, usually between the northeast to southwest regions of Europe. All existing offshore surveys in the Baltic Sea show Nathusius's pipistrelle to be the most abundant species (Seebens-Hoyer, et al., 2021). The Nathusius's pipistrelle is therefore expected to be very likely to migrate through the pre-investigation area.

Figure 11 - Distribution of Nathusius's pipistrelle (Eurobats, 2014).

4.3 BAT SPECIES LIKELY TO MIGRATE THROUGH THE PRE-INVESTIGATION AREA IN SMALL NUMBERS

Ten species of bats could potentially migrate or feed in the pre-investigation area south of island of Bornholm. However, due to the distribution patterns and the general migration behaviour of these ten species, they are deemed somewhat unlikely to occur in significant numbers within and around the pre-investigation area. As it cannot be completely ruled out that these ten species might migrate through the pre-investigation area, each species are described below.

4.3.1 PARTI-COLOURED BAT (VESPERTILIO MURINUS)

The Parti-coloured bat has been observed a few times on the island of Bornholm, but indication of breeding animals (Møller, Baagøe, & Degn, 2013) has so far not been verified (Baagøe H. , Personal communication). The distrubution of the population of Parti-coloured bat is scattered in the northern parts of Germany (BfN, 2008) and Sweden (De Jong, 2020). The Parti-coloured bat is a migratory species, and due to its occurrence in the northern parts of Germany and in Sweden, the species might occur in, and around the pre-investigation area in small numbers during migrations between Sweden and Germany, although it seems rather unlikely.

4.3.2 LEISLER'S BAT (NYCTALUS LEISLERII)

The Leisler's bat has only been recorded a few times on the island of Bornholm (Baagøe H. , Personal communication) and Leisler's bat is considered rare in the northern parts of Germany (BfN, 2008) and very rare in Sweden (De Jong, 2020). In the southern Baltic Sea, the Leisler's bat has been recorded a few times in previous conducted offshore surveys. However, large numbers are not expected in the pre-investigation area since it is on the margin of this species' distribution.

4.3.3 NORTHERN BAT (EPTESICUS NILSSONII)

The Northern bat has been recorded on the island of Bornholm several times, and recent findings indicate that this species may breed in small numbers on the island (Baagøe H. , Personal communication). The Northern bat is very rare in the northern parts of Germany (BfN, 2008). Although the Northern bat appears to be a sedentary species, ring recoveries have shown that the species occasionally migrate over longer distances. None of the offshore studies in the Baltic (Seebens-Hoyer, et al., 2021) has recorded Northern bats during their surveys and hence, it seems rather unlikely that the species will occur in significant numbers in and around the pre-investigation area.

4.3.4 SEROTINE BAT (EPTERSICUS SEROTINUS)

The Serotine bat is a common species on the island of Bornholm (Møller, Baagøe, & Degn, 2013) and in Germany (BfN, 2008). In Sweden, the species is rather rare and only found in the southernmost part of the country (De Jong, 2020). The Serotine bat is a rather sedentary species, and the distance between summer and winter roosts tends to be short (Møller, Baagøe, & Degn, 2013). The species is only recorded very few times in the offshore surveys in the southern Baltic Sea (Seebens-Hoyer, et al., 2021). It is therefore not expected that the species will occur in significant numbers in the pre-investigation area.

4.3.5 SOPRANO PIPISTRELLE (PIPISTRELLUS PYGMAEUS)

The Soprano pipistrelle has only been observed on the island of Bornholm in small numbers, but their occurrence may be increasing (Baagøe H. , Personal communication). The Soprano pipistrelle is widespread and quite common in the north-eastern parts of Germany (BfN, 2008) as well as in the southern parts of Sweden (De Jong, 2020). Due to its abundance and occurrence in the before mentioned neighbouring countries, it is considered likely that the Soprano pipistrelle may migrate sporadically through the pre-investigation area.

4.3.6 COMMON PIPISTRELLE (PIPISTRELLUS PIPISTRELLUS)

The Common pipistrelle regularly breeds on island of Bornholm, especially along the south coast between Rønne and Dueodde (Baagøe H. , Personal communication). The Common pipistrelle is one of the most common bats in the northern parts of Germany (BfN, 2008). The Common pipistrelle is a rather sedentary species, with summer and winter roosts often less than 20 km apart. However, long distance migrations have also been recorded. Hence, it cannot be ruled out, that a small number of the Common pipistrelle may migrate through the pre-investigation area.

4.3.7 POND BAT (MYOTIS DASYCNEME)

The Pond bat has only been recorded a few times on island of Bornholm (Møller, Baagøe, & Degn, 2013; Baagøe H. , Personal communication) and no indication of breeding colonies on the island exists. Nearest breeding site is in the northern parts of Germany (BfN, 2008). Due to this, it is rather unlikely that large numbers of migrating Pond bats will cross the pre-investigation area.

4.3.8 DAUBENTON'S BAT (MYOTIS DAUBENTONII)

The Daubenton's bat is a common bat on the island of Bornholm, both in regards to breeding and migration (Møller, Baagøe, & Degn, 2013). This species is also common in both Germany (BfN, 2008) and Sweden (De Jong, 2020). The Daubenton's bat is a short migrating species as it is known to fly up to 150 km between roosts. There are only few records of the Daubenton’s bat in the previous mentioned offshore studies in the Baltic Sea (Seebens-Hoyer, et al., 2021). However, the species was recorded during two nights on a ship-based survey south of Bornholm in 2014 (Amphi Consult , 2015). Therefore, it cannot be completely ruled out,

that low numbers of the Daubenton's bat might cross the pre-investigation area close to the coast of Bornholm.

4.3.9 BRANDT'S BAT (MYOTIS BRANDTII)

The Brandt's bat is a widespread and common bat species on the island of Bornholm (Møller, Baagøe, & Degn, 2013) and in Sweden (De Jong, 2020), and somewhat common in the northeastern parts of Germany (BfN, 2008). The Brandt's bat is an occasional migrant, but the distances covered are usually no more than 40 km. Hence, it is rather unlikely that large numbers of the Brandt's bat will cross the pre-investigation area.

4.3.10 WHISKERED BAT (MYOTIS MYSTACINUS)

The Whiskered bat is a common and widespread bat species on island of Bornholm (Møller, Baagøe, & Degn, 2013) and in Sweden (De Jong, 2020), but is considered as rare and scattered distributed through the northern parts of Germany (BfN, 2008). The Whiskered bat is an occasional migrant, but the distances covered are usually small, why it is deemed rather unlikely that large numbers of Whiskered bats will cross the pre-investigation area.

4.4 SPECIES UNLIKELY TO MIGRATE THROUGH THE PRE-INVESTIGATION AREA

Five species of bats are considered to be unlikely to occur within and around the pre-investigation area, mainly due to their sedentary nature and thus, limited migration distances. Although it seems very unlikely that these five species might migrate through the pre-investigation area, it cannot be completely ruled out. Thus each of the five species are described below.

4.4.1 WESTERN BARBASTELLE (BARBASTELLA BARBASTELLUS)

The Western barbastelle has never been recorded on the island of Bornholm (Møller, Baagøe, & Degn, 2013) and only very rarely on the German peninsula of Rügen (BfN, 2008) as well as and in Sweden (De Jong, 2020). The Western barbastelle is a largely sedentary species; the distance between summer and winter roosts are usually below 40 km (Dietz, von Helversen, & Nill, 2011). Occurrences over the Baltic Sea far away from the coast are therefore deemed very unlikely.

4.4.2 BROWN BIG-EARED BAT (PLECOTUS AURITUS)

The Brown big-eared bat is common and widespread on the island of Bornholm (Møller, Baagøe, & Degn, 2013) and Rügen (BfN, 2008), but the brown big-eared bat is a very sedentary species (Dietz, von Helversen, & Nill, 2011). Occurrences over the Baltic Sea, including the pre-investigation area, far away from the coast seems unlikely.

4.4.3 GREATER MOUSE-EARED BAT (MYOTIS MYOTIS)

The Greater mouse-eared bat is a short distance migrant, whose movements between traditional summer and winter roosts usually range from 50 to 100 km (Dietz, von Helversen, & Nill, 2011). It is only regularly breeding south of the Baltic Sea (BfN, 2008) and have never been recorded on island of Bornholm, and there are only very few records from Sweden. Because the pre-investigation area is situated outside the main distribution area of this species (Dietz, von Helversen, & Nill, 2011), it seems very unlikely that the species will occur in or around the pre-investigation area, except for very few sporadic individuals.

4.4.4 NATTERER'S BAT (MYOTIS NATTERI)

The Natterer's bat is a common and widespread bat species on the island of Bornholm (Møller, Baagøe, & Degn, 2013) and rather common in the northeastern parts of Germany (BfN, 2008). The Natterer's bat is generally considered a sedentary species; however, some individuals are known to have covered long distances (Dietz, von Helversen, & Nill, 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 is considered unlikely.

4.4.5 BECHSTEIN'S BAT (MYOTIS BECHSTEINII)

The Bechstein's bat is a rare and very local distributed species on central Bornholm (Møller, Baagøe, & Degn, 2013), and is found scattered in forest areas in the northeastern parts of Germany (BfN, 2008). Bechstein's bat is a very sedentary species connected to forest (Dietz, von Helversen, & Nill, 2011). Due to its sedentary nature, occurrence of the Bechstein's bat in the pre-investigation area is considered very unlikely.

4.5 TIMING OF BAT MIGRATION OVER THE SOUTHERN BALTIC SEA

Unfortunately, only a few systematic studies of migrating bats have been carried out at the island of Bornholm (Rydell, et al., 2014). Most relevant is the study from 2014 as part of the environmental impact assessment for Bornholm Havmøllepark (Amphi Consult , 2015) (Figure 9). This study showed a peak in activity on the southern coast of Bornholm for the migration of Nathusius's pipistrelle from late April to early May in spring, and in September in autumn (Figure 12). A peak in activity for the Common noctule in early May and from mid-August to mid-September (Figure 13) may as well be due to migration, but can also potentially be a mixture of migrating bats and feeding activity by local breeders.

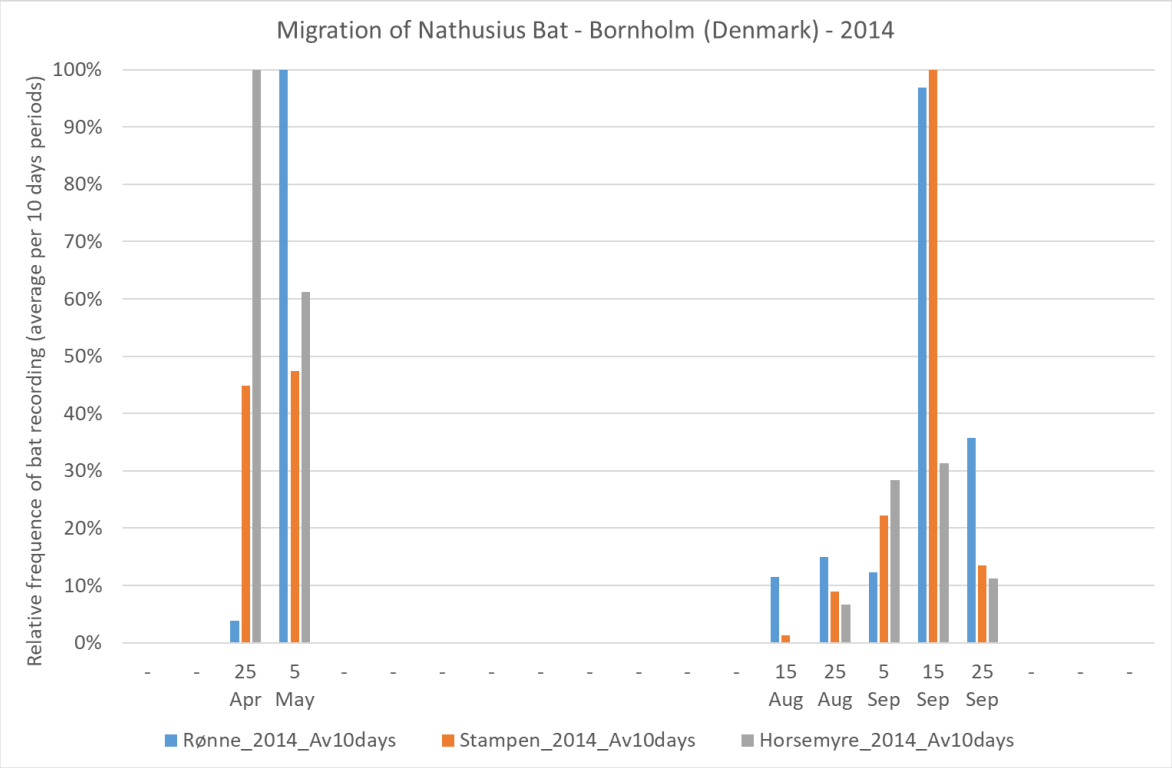

Figure 12 - Activity of Nathusius's bats at the southern coast of Bornholm (figure based on data from (Amphi Consult , 2015)). Remark: The survey only includes data collection from 22 April to 7 May and from 13 August to 25 September 2014.

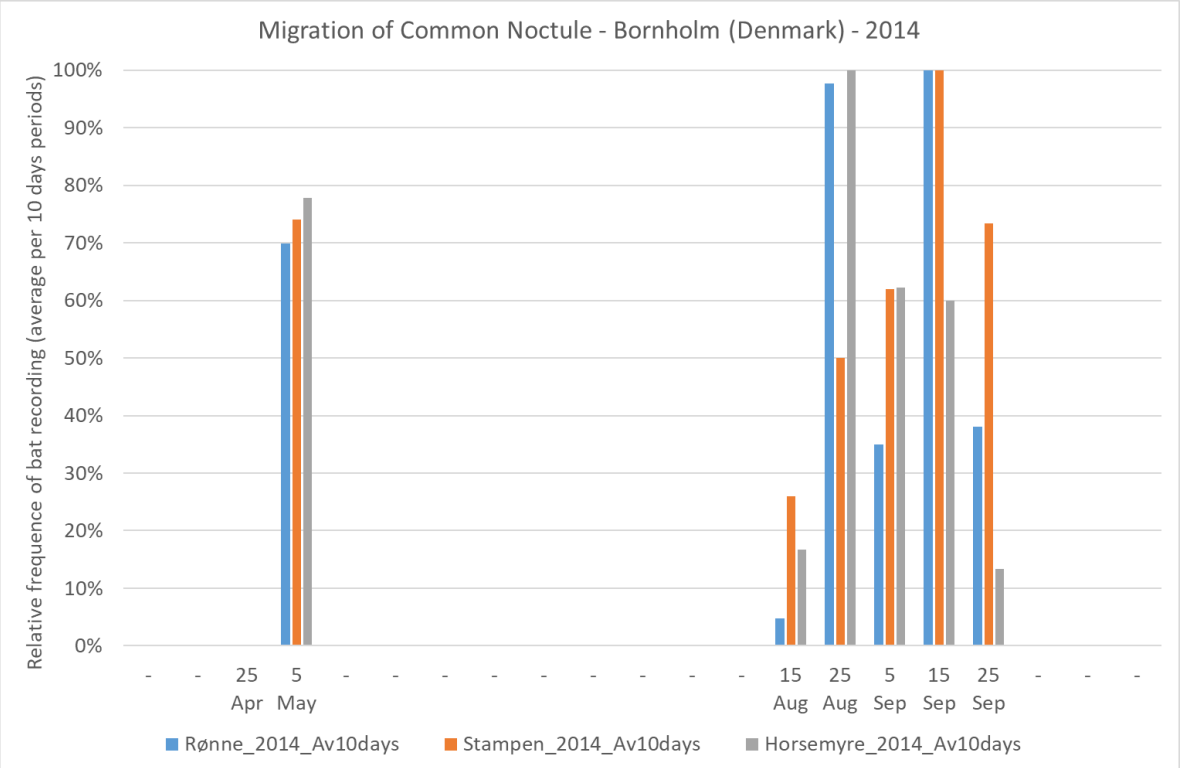

Figure 13 - Activity of Common noctule at the southern coast of Bornholm (figure based on data from (Amphi Consult , 2015). Remark: The survey only includes data collection from 22 April to 7 May and from 13 August to 25 September 2014.

For both species (Figure 12 & Figure 13), the duration of the spring migration seems short, whereas the autumn migration is much longer and may already start in mid-August and carry on until early October. It should, however, be considered that the survey in 2014 (Amphi Consult , 2015) did not cover mid-May to early-June, nor October.

4.6 CLIMATE CHANGE AND THE TIMING OF BAT MIGRATION

The triggering of the actual bat migration period is linked to the presence of the specific types of insects, which are the main feeding source for each bat species (Hawkes, et al., 2023). Change in winter temperature and change in the timing of spring and autumn may influence the insect abundance and occurrences. How exactly this influences the timing of the bat migration and how quickly the bats will adapt to the changing conditions, are yet still unknown. However, an 8-year data series from Falsterbo, in southernmost Sweden, indicates a change in the migration time for Nathusius's pipistrelle from a median of the autumn migration in late August 2012 to late September 2019 (Bach P. , 2021).

It is likely that especially the autumn migration is highly sensitive to changes in temperature and wind conditions during August, September, and October. All bat species in Northern Europe feed on insects, and insect number and diversity greatly follow the temperature. High temperature in the autumn may therefore prolong the time with large numbers of insects in Scandinavia, and thereby delay the exit of bats from the breeding areas. The migration in spring is less predictable because the bats does not know the conditions at the end destination, and the timing of the exit from the wintering areas is pre-dominantly driven by other factors such as day length and temperature.

4.7 FEEDING BATS DURING BREEDING SEASON

During summer, most bats are located at or in close proximity to their breeding sites and here they are feeding on the abundant insects within this area. However, when the weather is suitable, some bat species may also forage at sea. Just how far from the shoreline the bats feed, and how often they feed at sea, is so far not documented. It is expected that most activity occurs along the coast where most insects are found, and less far away from the coast. None of the offshore studies in the Baltic Sea show significant numbers of bats offshore during the midsummer period, from mid-June to mid-August. However, several studies show large number of bat recordings in late August and early September (Seebens-Hoyer, et al., 2021). These late summer/early autumn recording may be a mixture of migrating- and feeding bats.

5 DATA AND RESULTS

5.1 GENERAL OFFSHORE PATTERNS

From March 2022 and until October 2023, the detectors mounted on the offshore PAM-buoys recorded sound from 97 bats, averaging to 3.2 recordings of bats per buoy each year. Due to some technical issues with the detectors during 2022, only sound from 17 bats were recorded. Therefore, recordings from 2023 with 80 recordings in total, averaging to 5.3 recordings for each buoy, may give a better estimate of the actual representation of bats in the pre-investigation area.

The number of recorded bats vary between the buoys. Hence, the recordings were unevenly distributed (Figure 14). The highest numbers of bats recorded occurred on the detectors placed nearest the shoreline to the western part of Bornholm. For details on species level, see Appendix 1.

Five bat species were recorded offshore in the pre-investigation area. The Common noctule, the Nathusius's pipistrelle and the Parti-coloured bat were the most frequently recorded species and may thus be considered the most important species in the area. Soprano pipistrelle was only recorded once inside the pre-investigation area even though it is the most frequent species on the southern coast of Bornholm. These four species was selected as focus migrating species and will be presented in detail below.

The last bat recorded offshore was the Daubenton's bat It was recorded four times offshore on the buoys nearest to Bornholm (see Figure 32). These recordings are considered to be offshore feeding bats from Bornholm and the Daubenton's bat are therefore not treated in further detail as a species potentially migrating through the pre-investigation area.

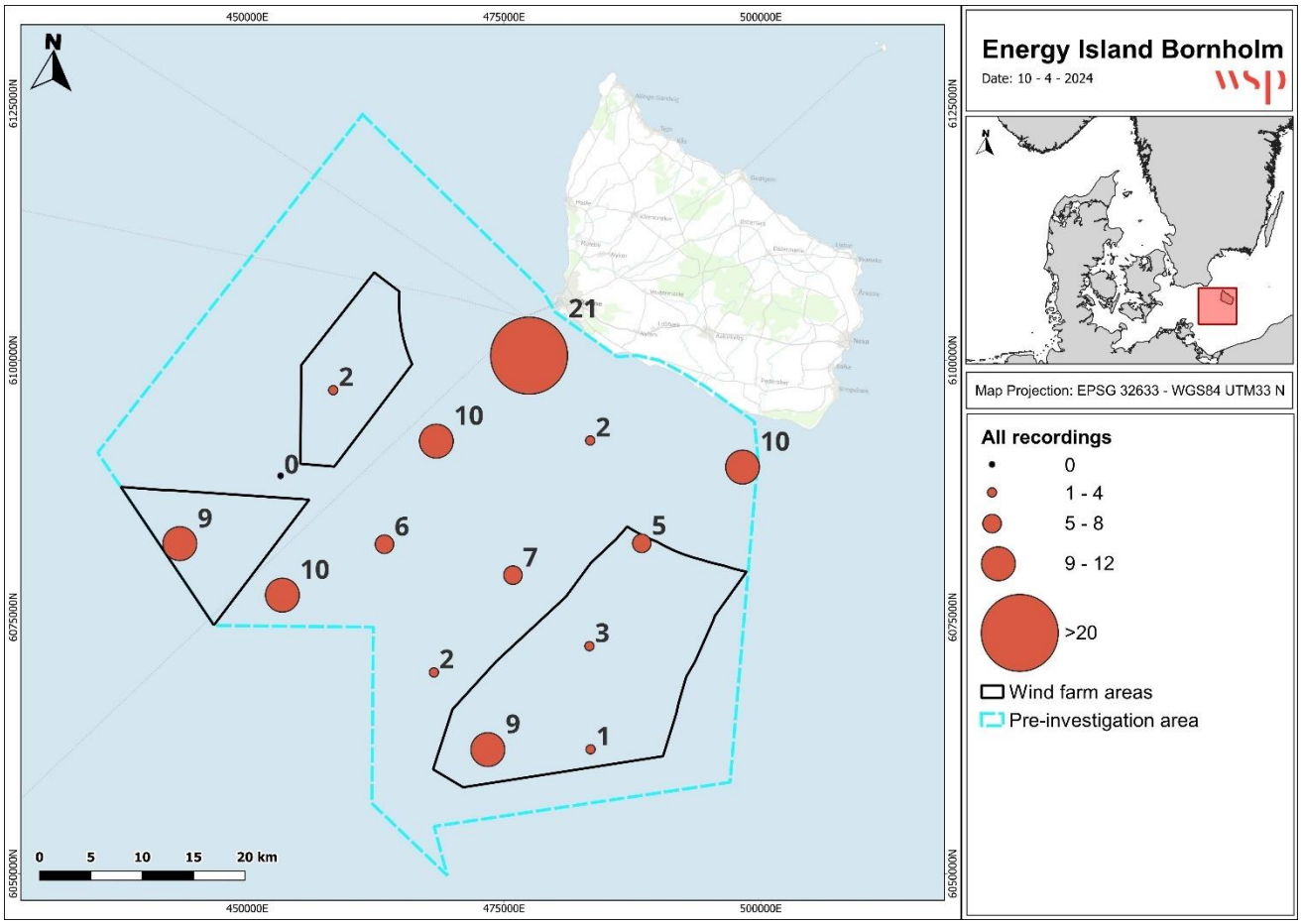

Figure 14 - Number of bat recordings per buoy for all species in 2022 and 2023 (n=97). The wind farm areas shown on the map are suggested areas only.

5.2 SEASONAL VARIATION IN RECORDINGS

5.2.1 OFFSHORE RECORDINGS

The seasonal patterns of the recorded bats offshore showed a clear autumn migration for both Common noctule, Nathusius's pipistrelle and Parti-coloured bat (Figure 15). Merely one single recording of Soprano pipistrelle on the offshore buoys, despite the considerable activity recorded at the coastline, indicates that most of the Soprano pipistrelle stay onshore. Four recordings of Daubenton's bat in September on the two buoys nearest to the shoreline of Bornholm (app. 6 km off the coast), are considered as offshore feeding bats from Bornholm, and not as migrating bats. Few recordings of the Parti-coloured bat may be the Serotine bat, since the difference between the two species can be difficult to distinguish. However, The Serotine bat is not considered to be a long-distance migratory species.

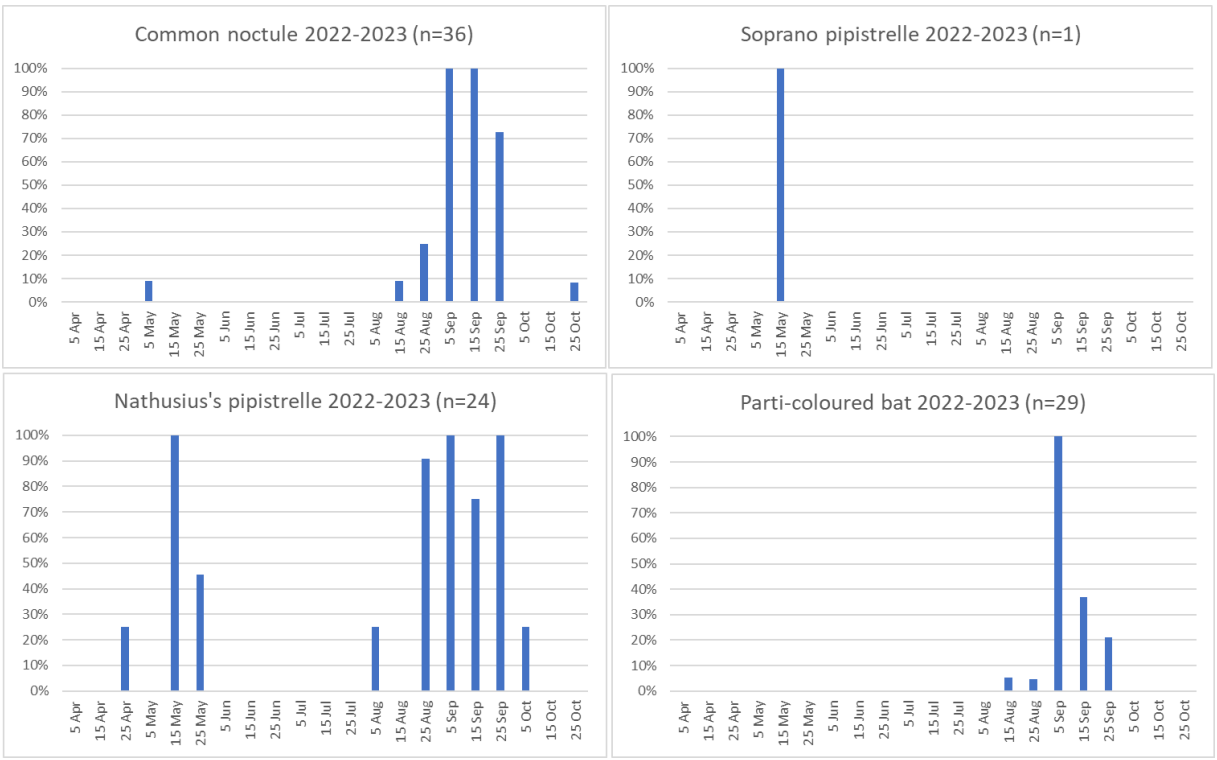

Figure 15 – Relative bat activity of the four most relevant bat species recorded at fifteen buoys within the pre-investigation area. The figures show an average of bat activity of the fifteen detectors during two years of deployment for each species. The scale is relative to the maximum value. "n=xx" gives the total number of recordings included in the calculations. Four recordings of Daubenton's bat and three recordings with uncertain id as Serotine bat or Parti-coloured bat are not included in this figure. See section 5.1 for further details.

5.2.2 COASTAL RECORDINGS

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 may clearly indicate when a migration through the pre-investigation area occurs. Hence, a land-based survey was set up, and the survey included data collection from September 2021 to October 2023.

The dataset collected from the onshore coastal detectors is very large and contains thousands of files. Therefore, this chapter only contains summaries of onshore recordings for the four most dominant species

which are considered potential migraters through the pre-investigation area. The three long-distance migrants: the Common noctule, the Nathusius's pipistrelle, the Parti-coloured bat, and the short-distance migrant: the Soprano pipistrelle are selected as focus species, based on their abundance in the data collected by the offshore buoys. For details on each species on each site, please see Appendix 2.

BORNHOLM SOUTHWEST COAST

The area around Rønne and the western part of the south coast of Bornholm appears to be an important site for breeding bats. Therefore, the pattern of migrating bats, in focus for this survey, is more mixed than for most other sites in this study (Figure 16). Peaks of the activity in June and August for the Common noctule, the Nathusius's pipistrelle and the Soprano pipistrelle are most likely due to local breeding and feeding individuals. For the Nathusius's pipistrelle, this part of the island seems most important in the spring, which indicates some migrations. In autumn, the Common noctules occurs more frequent than during spring, whereas the Nathusius's pipistrelles show less activity. Based on the geography of the coast, Rønne seems more likely to be a departure point for an autumn migration of the Common noctule, and may also be an arrival points for several species in the spring. For smaller bats like the Nathusius's pipistrelle and Soprano pipistrelle, the migration could be broad fronted along the southern coast of Bornholm. However, a full understanding of these differences will need more detailed analyses on more sites along the coast.

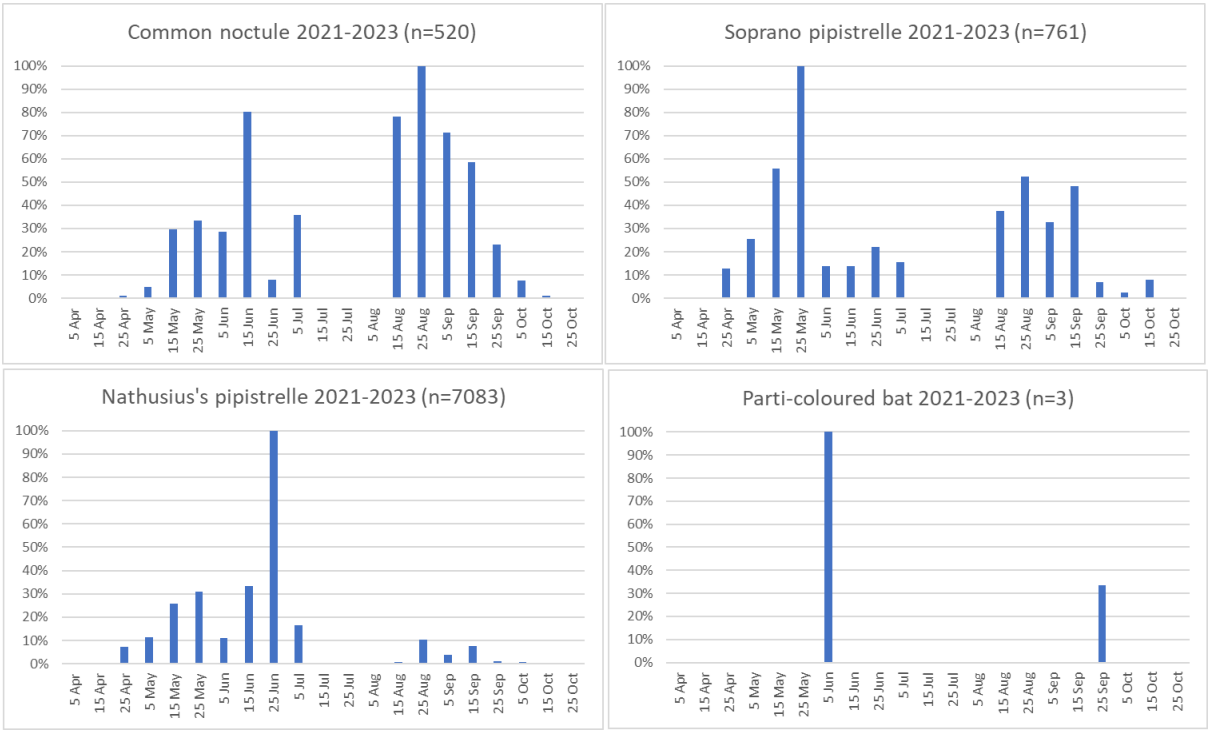

Figure 16 – Relative bat activity of the four most relevant bat species at the southwest coast of Bornholm. The figures show an average of two detectors during three years of deployment for each species. The scale is relative to the night activity with maximum value (=100 %). "n=xxx" gives the total number of recordings included in the calculations.

BORNHOLM SOUTHEAST COAST

The southeastern coast of Bornholm includes the southernmost part of the island, Dueodde. This part of the island seems to be less used by Nathusius's pipistrelle and Common noctule (Figure 17). Both species prefer broad-leaved trees for their breeding, and the area on the southernmost part of Bornholm are mainly dominated by conifers. The patterns of the recordings in this part of the island may therefore provide a better picture of the migrating bats. Except for the Nathusius's pipistrelle, other migrating bats are more or less restricted to the autumn season, which also support the likelihood of migration. A high activity of Common noctule seems to indicate a concentration of individuals on these coastal areas in late August and early September. The Nathusius's pipistrelle shows the largest activity in mid-May and mid-September. The Soprano pipistrelle occurs with high activity in September. However, it is uncertain if these bats are migrating or just there for feeding.

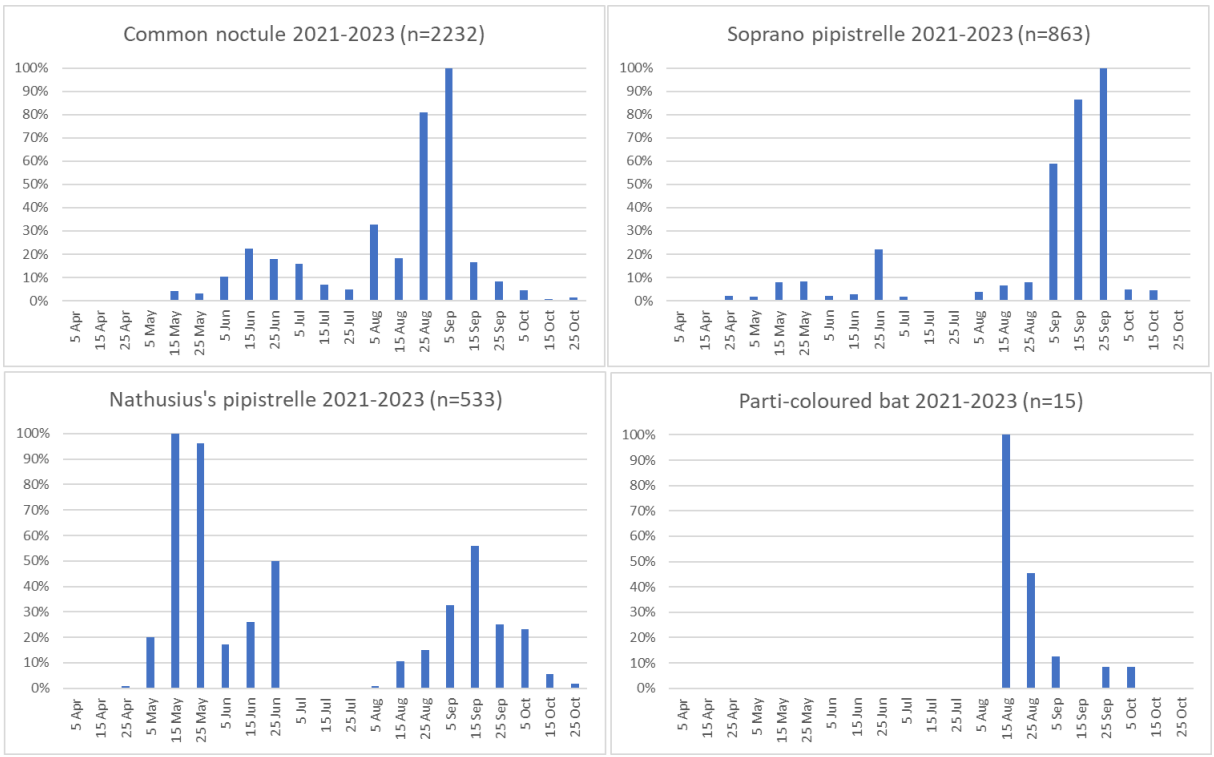

Figure 17 – Relative bat activity of the relevant four bat species at the southeast coast of Bornholm. The figures show an average of two detectors during two and a half years of deployment for each species. The scale is relative to the night activity with maximum value (=100 %). "n=xxx" gives the total number of recordings included in the calculations.

BORNHOLM NORTHERN COAST

The northern coast of Bornholm includes the rocky area of Hammeren. The patterns of bat activity are quite different from the patterns recorded on the south coast (Figure 18). In contrast to the southern coast of Bornholm, the Nathusius's pipistrelle is almost exclusively present in spring from early May to early June. These bats were most likely on their migration route towards the north. Alternatively, these bats could be migrating bats arriving from Sweden. The migration route through Sweden to Bornholm is not unlikely. Even though the distance from central western Europe is slightly longer when choosing this migration route, it benefits from shorter sea crossings and may therefore be less risky for the bats. The Common noctule, the Soprano pipistrelle and the Parti-coloured bat are less common on the northern part of Bornholm than on the southern coast.

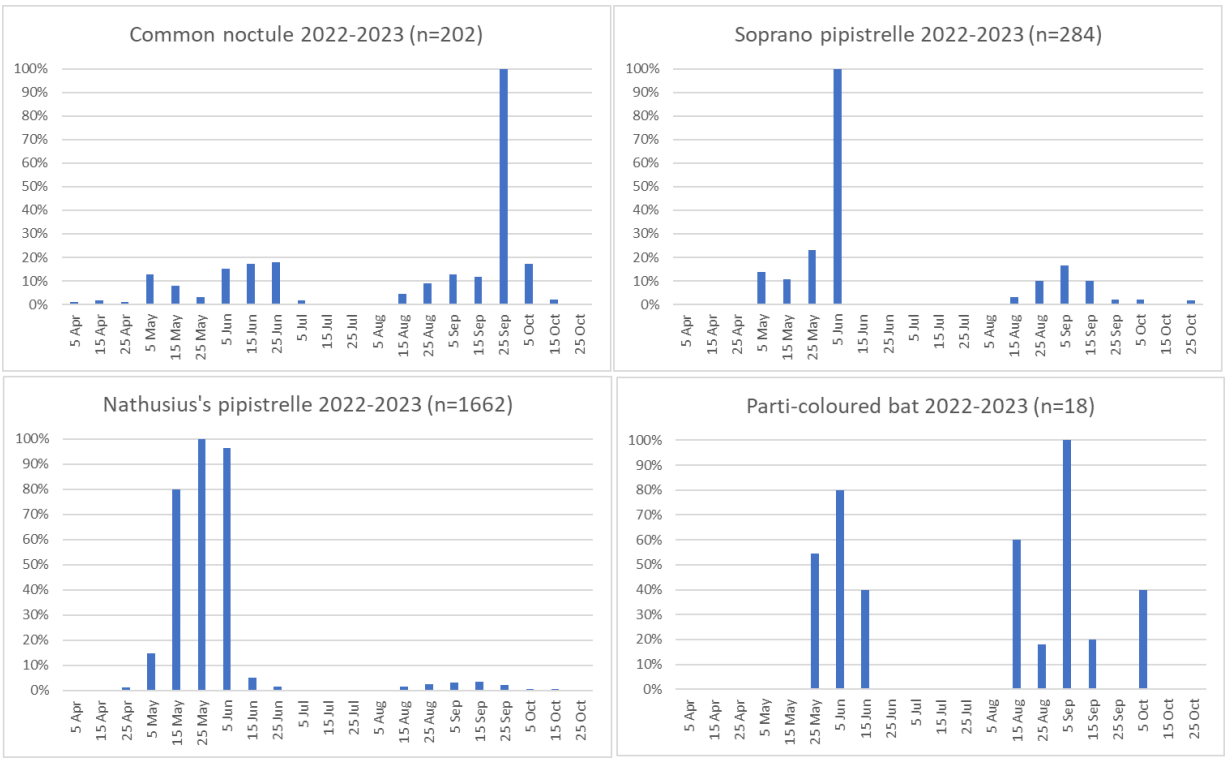

Figure 18 – Relative bat activity of the relevant four bat species at Northern Bornholm, Hammeren. The figures show an average of the two detectors during two years of deployment for each species. The scale is relative to the night activity with maximum value (=100 %). "n=xxx" gives the total number of recordings included in the calculations.

CHRISTIANSØ

The island of Christiansø is of interest due to its relatively isolated position, the absence of breeding bats and its location, approximately 20 km from Bornholm. Therefore, all bats on the island are migrating or only rare visitors during feeding. The present data shows that only the Common noctules and the Nathusius's pipistrelle occur on the island in significant numbers (Figure 19), which also indicates that this is mainly a stop for the long-distance migratory bats. General patterns show higher activity during autumn than during spring, which is diffent from the patterns observed at the northern parts of the island Bornholm (see above). Together with the information from Utklippan, there are indications of a migration route from easternmost Sweden across the Baltic Sea to the island of Bornholm. This migration route over Christiansø and Utklippan may be part of the same route as the bats crossing the pre-investigation area, excluding the migration species breeding on Bornholm. The magnitude of the migration route is uncertain. However, the bats migrating via this route may be part of a rather small population on the Baltic Islands, Öland and Gotland.

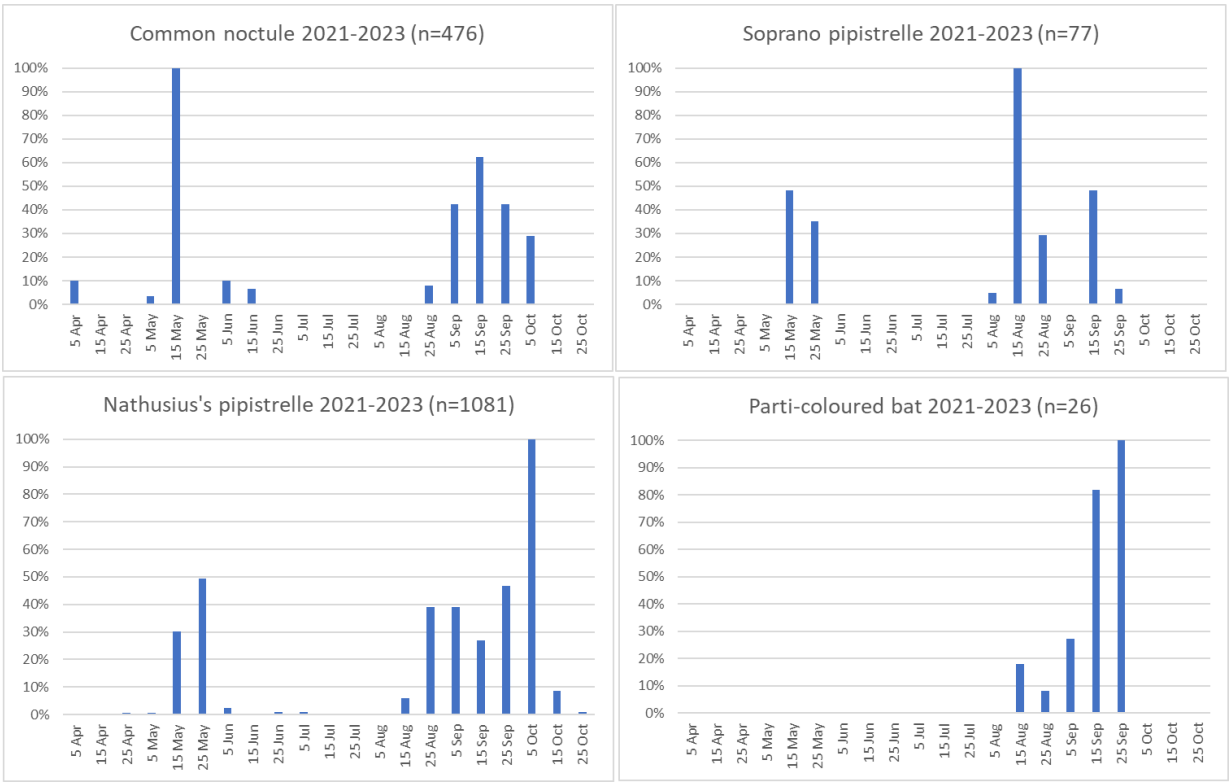

Figure 19 – Relative bat activity of the relevant four bat species on Christiansø. The figures show an average of the two detectors during two and a half years of deployment for each species. The scale is relative to the night activity with maximum value (=100 %). "n=xxx" gives the total number of recordings included in the calculations.

UTKLIPPAN, SWEDEN

The patterns of bat activity on the small island Utklippan are very similar to the patterns on Christiansø (Figure 20). Based on the position of these two small islands and the timing of peak migration for each species, it seems likely that there is a migration route between Utklippan and Christiansø. Compared to Christiansø, the recorded activity level is higher on the detector at Utklippan. These differences could be explained by the difference in size of these two island groups, where Christiansø and the surrounding islands represent an area more than twice the size of Utklippan. Also, the differences in the actual location of the two detectors and lack of trees at Utklippan can explain the concentration around the lighthouse and the building at Utklippan. Furthermore, the relative short distance to the Swedish coast could add to the explanation of the high bat activity measured.

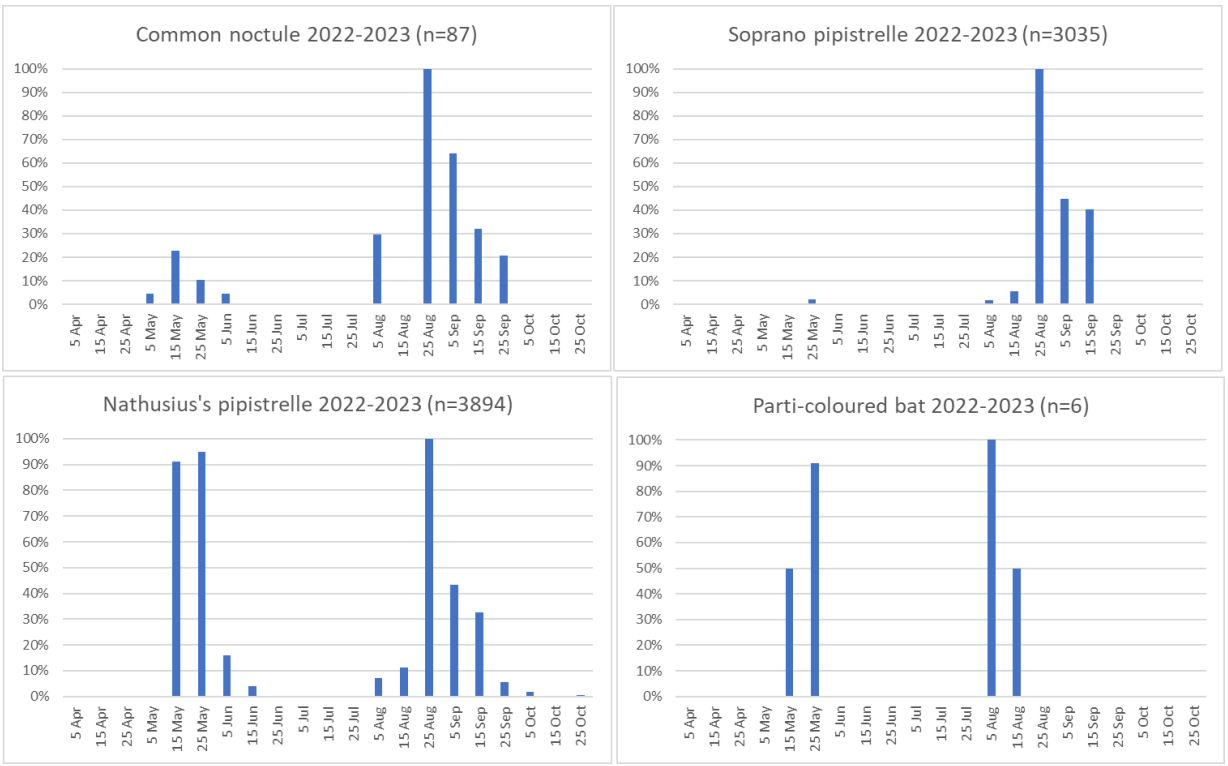

Figure 20 - Relative bat activity of the relevant four bat species on Utklippan. The figures show an average of the two detectors during two years of deployment for each species. The scale is relative to the night activity with maximum value (=100 %). "n=xxx" gives the total number of recordings included in the calculations.

RÜGEN, GERMANY

If bats migrate through the pre-investigation area between Bornholm and Germany, Rügen is most likely to be their starting point in the spring and arrival point in the autumn. Timing of the activity also show a pattern of migrating bats (Figure 21). However, the activity may also include local bats and visitors from a large forest of eastern Rügen.

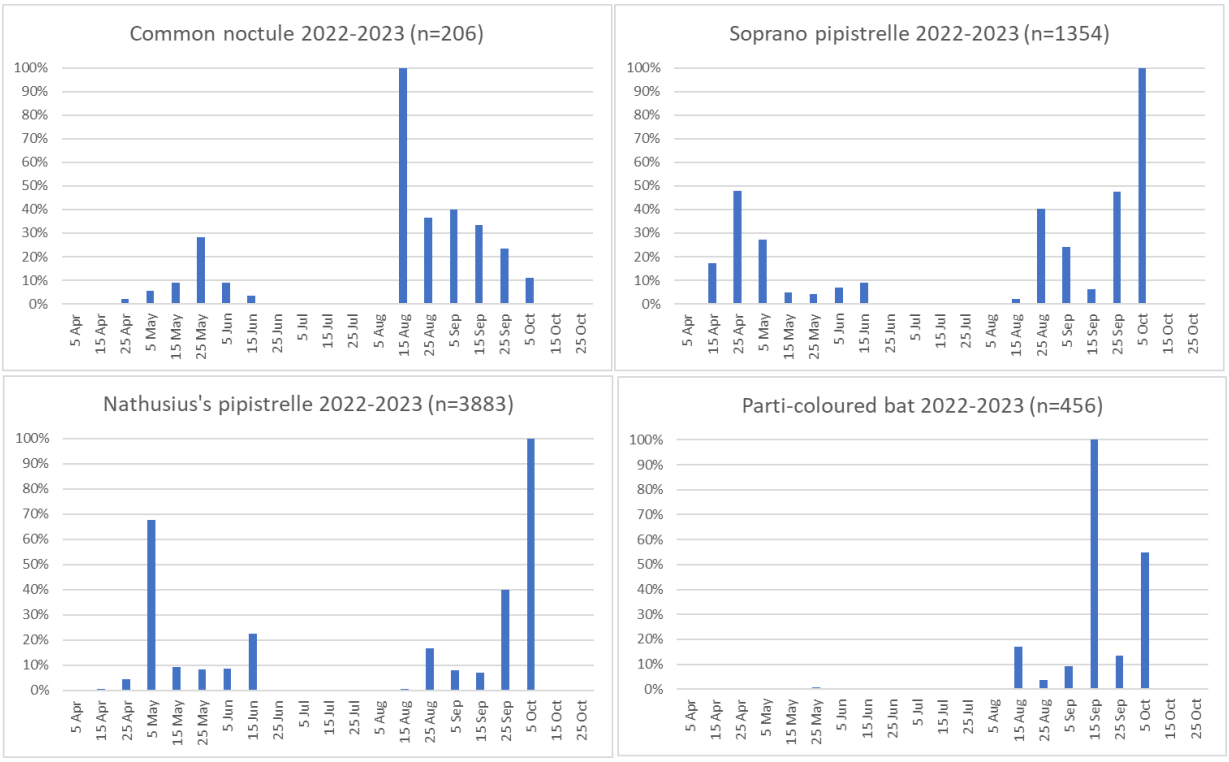

Figure 21 - Relative bat activity of the relevant four bat species on Rügen. The figures show an average of the two detectors during two years of deployment for each species. The scale is relative to the night activity with maximum value (=100 %). "n=xxx" gives the total number of recordings included in the calculations.

KÅSABERGA IN SOUTHERN SWEDEN

Kåsaberga is placed on the southern coast of Sweden nearest the island of Bornholm. The number of bat recordings is high for all species except for the Parti-coloured bat (Figure 22). The peak of the spring migration for the Nathusius's pipistrelle is some days later than the peak of the migration in the pre-investigation areas and on the southern coast of Bornholm. The peak of the Nathusius's pipistrelle match well with the peak found on the northern spit of Bornholm (Hammeren). This might suggest that migration of Nathusius's pipistrelle occur from Sweden to Bornholm at least some years. Similar timing of the spring migration might also be the case for Soprano pipistrelle and Common noctule. The peaks for the autumn migration for all species at Kåsaberga peak is in general earlier than similar peaks at Bornholm. The reason for this is unknown. It seems, however, unlikely that bats from this part of Sweden should migrate through the island of Bornholm on their migration to western part of Europe.

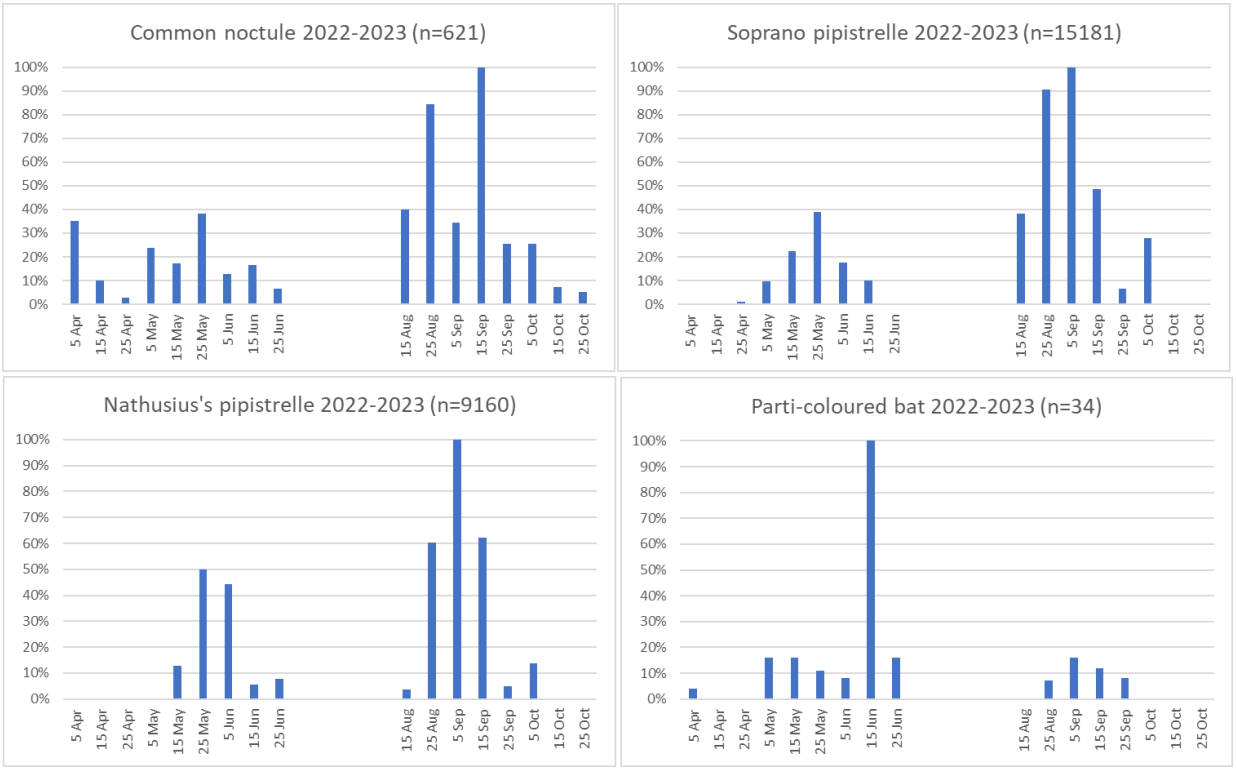

Figure 22 – Relative bat activity of the relevant four species of bat at Kåsaberga in southern Sweden. The figure shows an average of two detectors during two years of deployment – The scale is relative to the to the nights with maximum value (=100 %). "n=xxx" gives the total number of recordings included in the calculations.

5.3 TIME OF OFFSHORE RECORDINGS

The time during the night where a specific recording of a bat species took place, is very relevant to understand the strategy for the sea crossing related to each specific bat species. The data illustrated on Figure 23 and Figure 24 clearly indicates that the bats prefer to cross the open sea during the dark hours. Only one bat was recorded at dusk (defined as from half an hour before sunset until one an hour after sunset), and none were recorded during dawn (one hour before sunrise). Crossing open sea during dawn, daylight or dusk results in a higher probability of becoming preyed upon by predators such as gulls.

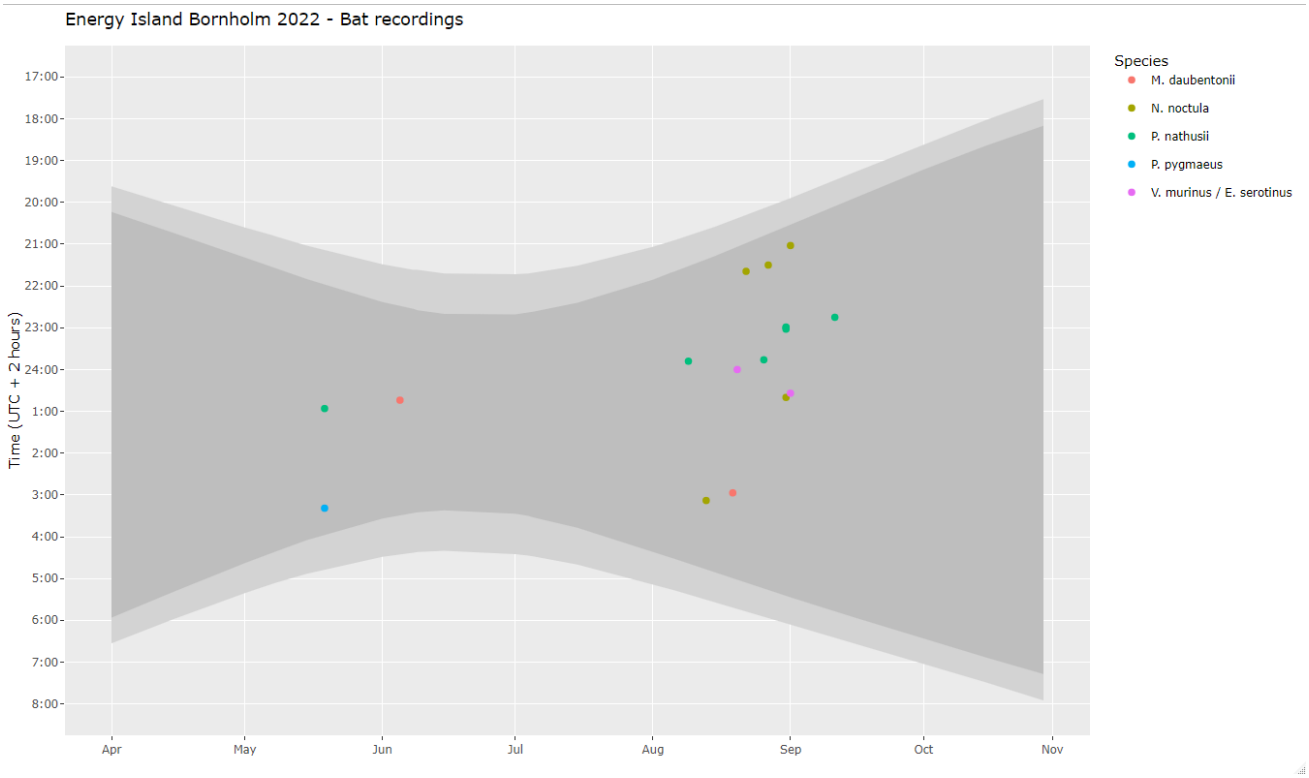

Figure 23 - Time of all bat recordings on the buoy-based detectors in 2022. Shaded areas indicate the nights. Pale shading indicates the dusk from sunset to the sun is more than 6 degrees under the horizon and similar in the morning until sunrise (see suninfo.dk for more information).

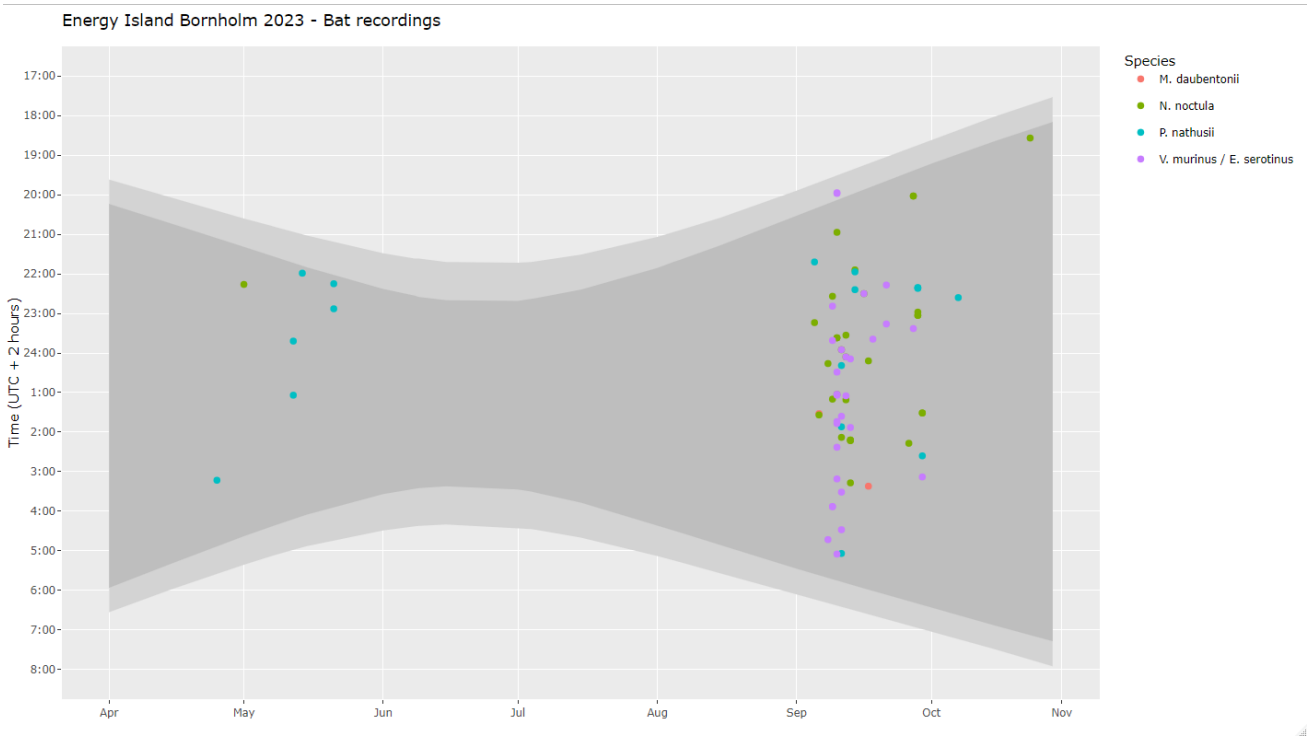

Figure 24 - Time of all bat recordings on the buoy-based detectors in 2023. Shaded areas indicate the nights. Pale shading indicates the dusk from sunset to the sun is more than 6 degrees under the horizon and similar in the morning until sunrise (see suninfo.dk for more information).

5.4 OFFSHORE RECORDING AND WEATHER CONDITION

Weather conditions are known to influence the migration of bats in offshore areas (Lagerveld, Jonge Poerink, & Geelhoed, 2021), and more specifically temperature, wind speed and wind direction are known to be the most significant parameters determining the level of bat activity (Lagerveld, Jonge Poerink, & Geelhoed, 2021).

5.4.1 TEMPERATURE

Figure 25 illustrates the air temperature (in degrees Celsius (°C)) for registration of bats on the buoy-based survey in the pre-investigation area. Only 89 out of the 97 recording of bats offshore are included in the analysis due to the lack of available Metocean temperature data for eight bat recordings. This figure indicates a clear difference between the temperature intervals within the spring and autumn migrations. During spring, bats are recorded at nights with temperatures ranging from 6 to 14°C, whereas most recording in autumn occur at temperatures above 16°C. The seawater in the Baltic Sea is relatively cold during spring and relatively warm during autumn, and this may influence the air temperature in the different seasons. However, a potential combination of migrating and feeding bats in late summer and early autumn are important to consider. Feeding activities from bats offshore are only expected to occur during warmer nights with temperatures above 16°C. Most likely, the feeding activity is strictly linked to the occurrence of insects in the marine area. Migrating bats, especially the Nathusius's pipistrel, are not dependent on the presence of insects and migrate over the marine areas even when temperatures are lower.

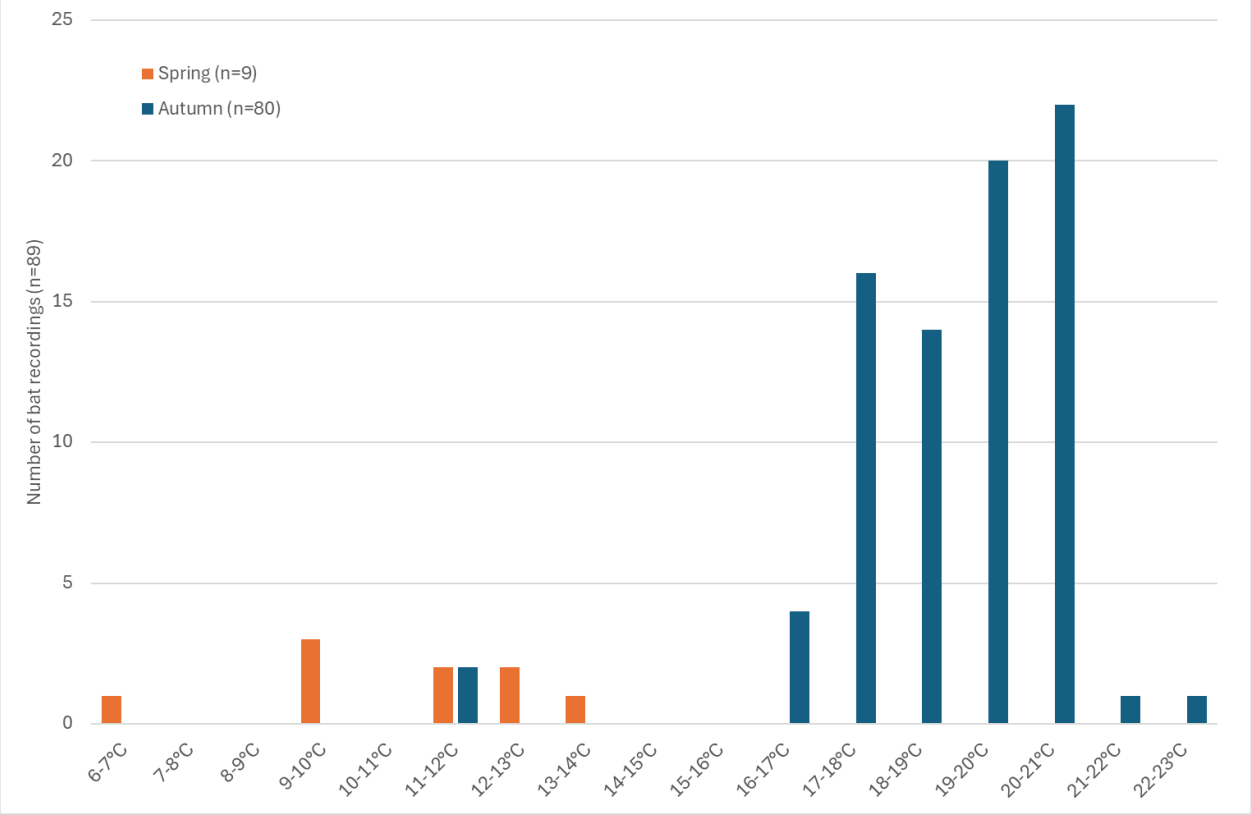

Figure 25 – Number of bat recordings compared to air temperature (in degrees Celsius) (data on temperature from Metocean buoys in the area). The figure is based on 89 data points. Metocean data was not available for 8 recordings.

5.4.2 WIND SPEED

Wind speed is known to be an important factor for the presence of bats offshore (Lagerveld, Jonge Poerink, & Geelhoed, 2021). Bats mainly tend to fly offshore at nights with ideal (low) wind speeds. Especially feeding bats might avoid strong wind speed because of the absence of their prey. For migrating bats, the preference for low wind speed is more likely linked to the risk of depleting energy resources and the risk of not reaching land before sunrise. Bats are small animals, and strong winds will often cause change in their direction and in worst case, they will not be able to reach the destination before sunrise. 96 out of 97 recordings of bats could be combined with Metocean wind speed data. Data from the pre-investigation area indicates that most bats were recorded when wind speed was lower than 6-7 m/s measured 4 meter above sea level (Figure 26). Merely ten out of 96 recordings, with information available on wind speed, occurred at wind speeds in excess of 6 m/s, indicating that 90 % of all bats fly in the offshore pre-investigation area in conditions with wind speeds of 6 m/s or lower. Five bat out of 96 were recorded during wind speed higher than 7 m/s, indicating that 95 % of all bats fly in the offshore pre-investigation area in conditions with wind speed of 7 m/s or lower.

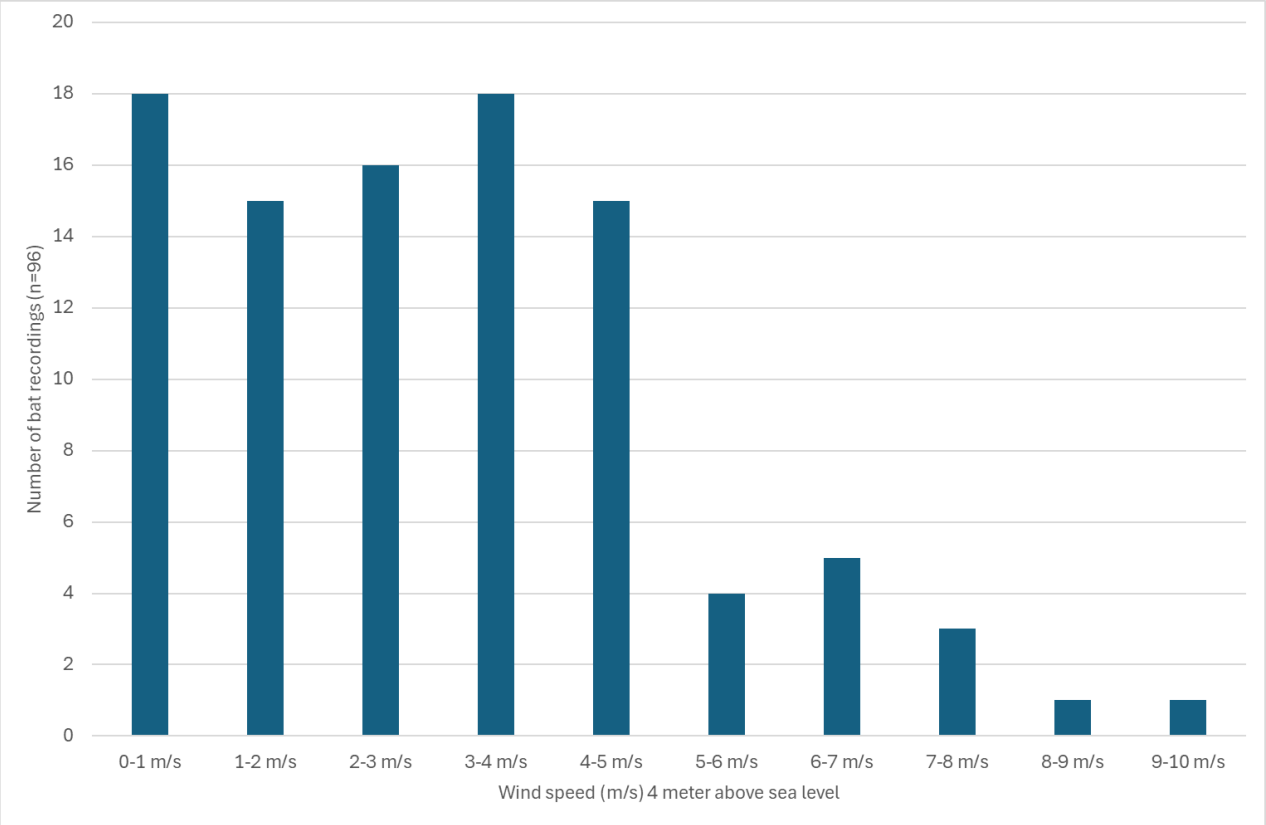

Figure 26 – Number of bat recordings compared to wind speed measured 4 meter above sea level (data on wind speed from Metocean buoys in the area). The figure is based on 96 data points. Metocean data was available for all but one recording.

5.4.3 WIND DIRECTION

Wind direction may also influence the bat activity offshore (Lagerveld, Jonge Poerink, & Geelhoed, 2021).

An analysis of the 89 bat recordings from the detectors mounted on PAM- buoys (Figure 27 & Figure 28) with corresponding Metocean data, indicates that during spring, the majority of the bats were recorded during prevailing easterly winds. This might be due to the fact, that easterly winds often are combined with higher temperature and low wind speed during high pressure weather conditions. However, the very few bat recordings (only 8 with corresponding Metocean data on wind direction) in the spring, makes it difficult to draw any conclusions regarding the preference of the bats.

In autumn, the number of bat recordings are higher (81 with corresponding Metocean data on wind direction), and bat recordings intend to peak during periods with prevailing wind directions from north or south. Data suggest that most bats prefer migrating with a tailwind or in weak headwind conditions. Strong winds perpendicular to the main migration route can increase the risk of drifting and consequently loss of control over their direction.

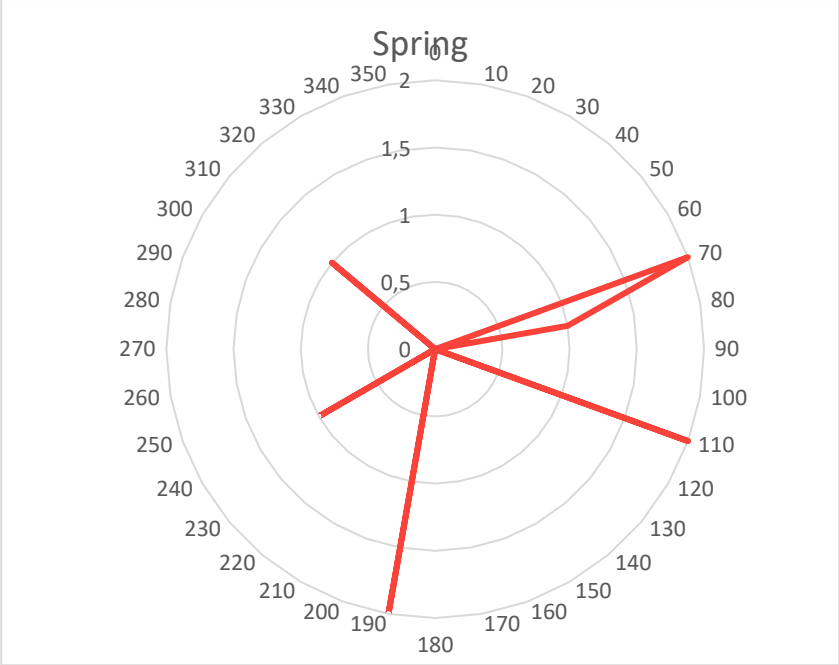

Figure 27 – Number of bat recordings compared to wind direction in spring (data on wind direction from Metocean buoys in the area). The figure is based on eight data points. Metocean data was available for all but one recording.

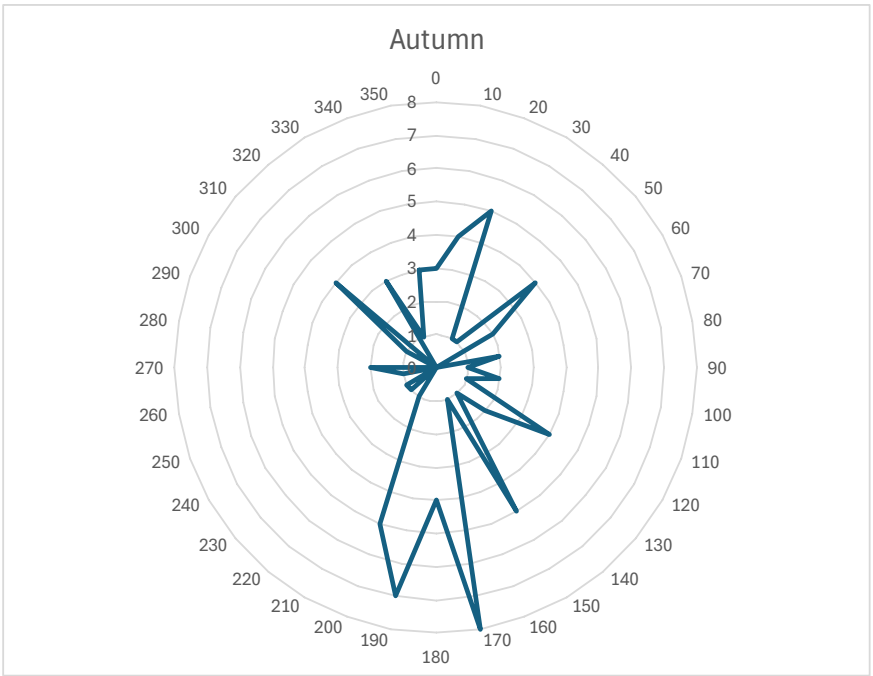

Figure 28 - Number of bat recordings compared to wind direction in autumn (data on wind direction from Metocean buoys in the area). The figure is based on 81 data points. Metocean data was available for all but seven recordings.

6 STATUS

Based on the recordings from the buoy-based bat detectors in the pre-investigation area, four species were selected to be in focus: the Common noctule, the Nathusius's pipistrelle, the Soprano pipistrelle and the Parti-coloured bat. All these four species were recorded on the detectors offshore. Other species might visit the pre-investigation area occasionally, but these occasions are considered to be so rare, that the pre-investigation area most likely is not crucial for their population both on a local scale and globally.

6.1 COMMON NOCTULE – STATUS IN THE PRE-INVESTIGATION AREA

The Common noctule is commonly recorded along the south coast of Bornholm during autumn in the present survey. Data on the activity of the Common noctule acquired from the detectors mounted on the PAM-buoys in the pre-investigation area back this up, as this data indicates tendencies for migration during late August and September. However, the number of offshore recordings is low compared to other surveys from the Western Baltic. There can be two reasons for these differences. Most likely, the area is less important for migration of the Common noctule. Even though some bats may migrate across the Baltic Sea between Bornholm and Rügen, the migration occurs on a broad front with low densities of bats. An alternative explanation could also be a matter of flight height. Unfortunately, our knowledge on the flight height of migrating bats is very limited. Especially Common noctule could potentially migrate at high altitudes, a pattern known from passerine birds. Bird radar surveys during spring and autumn conducted as part of the survey scheme for the Bornholm Energy Island, often showed bird migrations in heights of 300 to 700 meters. It is therefore likely that this observed migration activity are birds. However, some of these migrations could also be due to migration activity from the Common noctules.

6.2 NATHUSIUS'S PIPISTRELLE – STATUS IN THE PRE-INVESTIGATION AREA

The Nathusius's pipistrelles were recorded with high activities along the south coast of Bornholm both in spring and in autumn. Highest activity was in May and September, which fit with the recordings offshore. Together, the activity along the coast and recordings from the offshore survey indicates, that the migration occurs over a broad front with low densities of bats. Most of the migrating bats in the strait between Rügen and Bornholm may be bats from the population on Bornholm. However, the survey from Christiansø and Utklippan indicate a flyway for some bats continuing from Bornholm onwards to Blekinge and maybe to the area of middle Baltic Sea such as Öland, Gotland and even Finland. The exact overlap between these populations among the recorded bats in the pre-investigation area is impossible to assess based on the data from this survey. In the future, radio tagging or maybe satellite tagging may be tools to get more information on the migrating bats.

6.3 PARTI-COLOURED BAT – STATUS IN THE PRE-INVESTIGATION AREA

The present survey documents that the Parti-coloured bat occurs around Bornholm. The Parti-coloured bat is not considered to be breeding on Bornholm (Møller, Baagøe, & Degn, 2013), and it is likely that the bats recorded in the pre-investigation area and along the coast belongs to populations from Sweden, Germany or Poland. Few offshore recordings may be the Serotine bat. The ultrasound of the Serotine bat overlaps with the sound from the Parti-coloured bat, and it is therefore difficult to distinguish the two species in some of the recording. However, the Serotine bat is normally considered to be a short distance migratory species and rarely observed offshore.

6.4 SOPRANO PIPISTRELLE – STATUS IN THE PRE-INVESTIGATION AREA

The present survey may indicate that the Soprano pipistrelle only migrates across the Baltic Sea in low numbers. Even though a considerable activity is recorded along the south coast of Bornholm, only one single Soprano pipistrelle was recorded during the offshore survey.

6.5 OTHER BATS – STATUS IN THE PRE-INVESTIGATION AREA

A few other bat species were recorded during the offshore survey. Individuals of the Daubenton's bat were recorded four times on the detectors mounted on the two PAM-buoys nearest Bornholm, app. 6 km from the coast. These recordings are considered to be non-migrating bats due to the short distance to the coast. The Daubenton's bat is often observed feeding over the sea in coastal regions. It is likely, that this type of feeding behaviour can occur at a distance of up to 10 km from the coast. The areas suggested for wind farms, are situated more than 15 km off the coast of the island Bornholm, and it seem unlikely that the Daubenton's bat will occur this far offshore

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8 APPENDIX 1 – SPECIES DISTRIBUTION

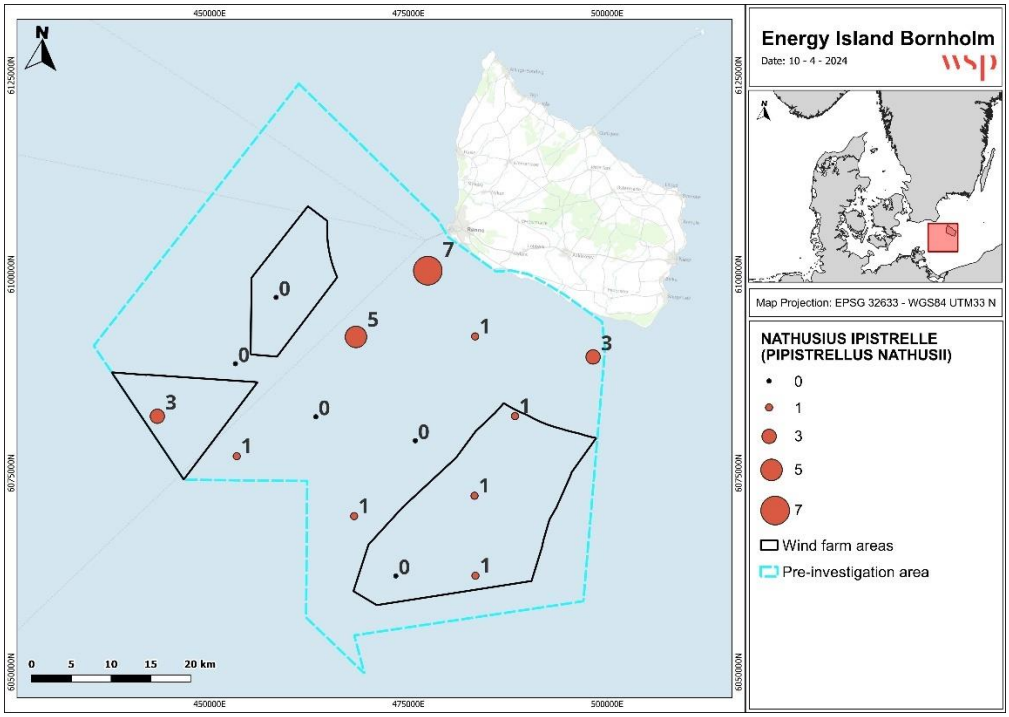


Figure 29 – Number of bat recordings per buoy. Nathusius's pipistrelle 2022 and 2023 (n=24). The wind farm areas shown on the map are suggested areas only.

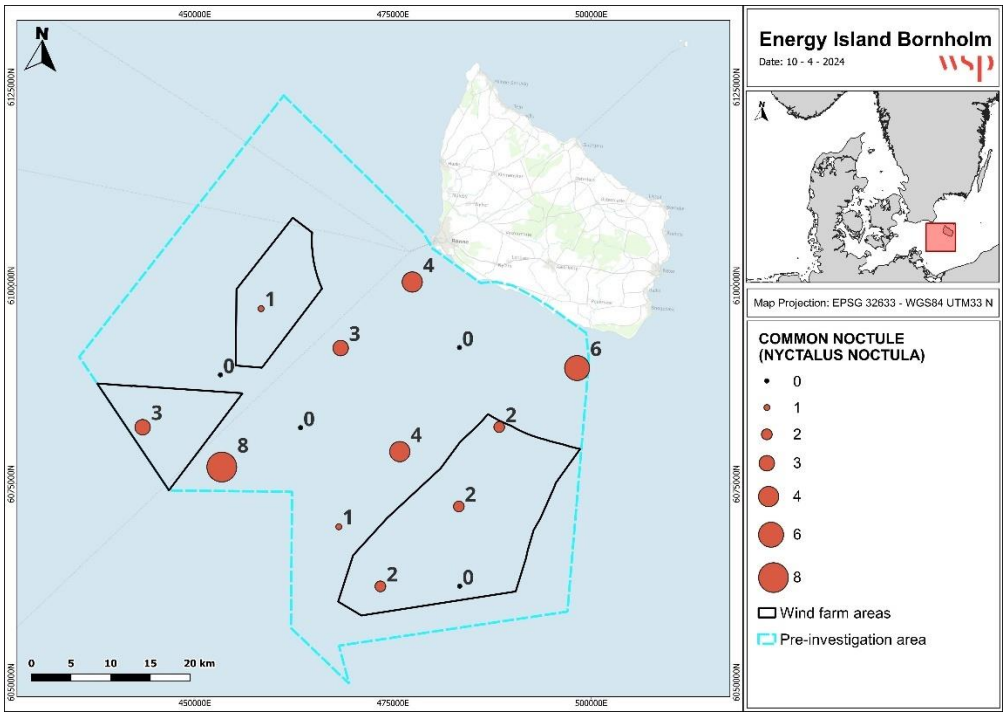


Figure 30 – Number of bat recordings per buoy. Common noctule 2022 and 2023 (n=36). The wind farm areas shown on the map are suggested areas only.

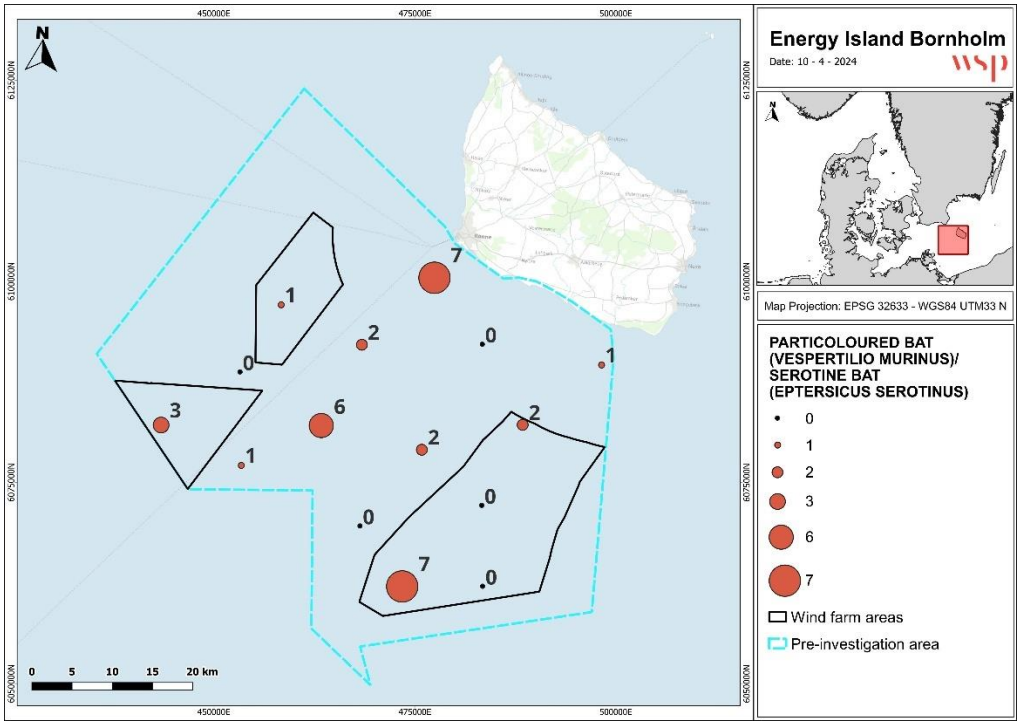


Figure 31 – Number of bat recordings per buoy. Parti-coloured bat/Serotine 2022 and 2023 (n=32). The wind farm areas shown on the map are suggested areas only.

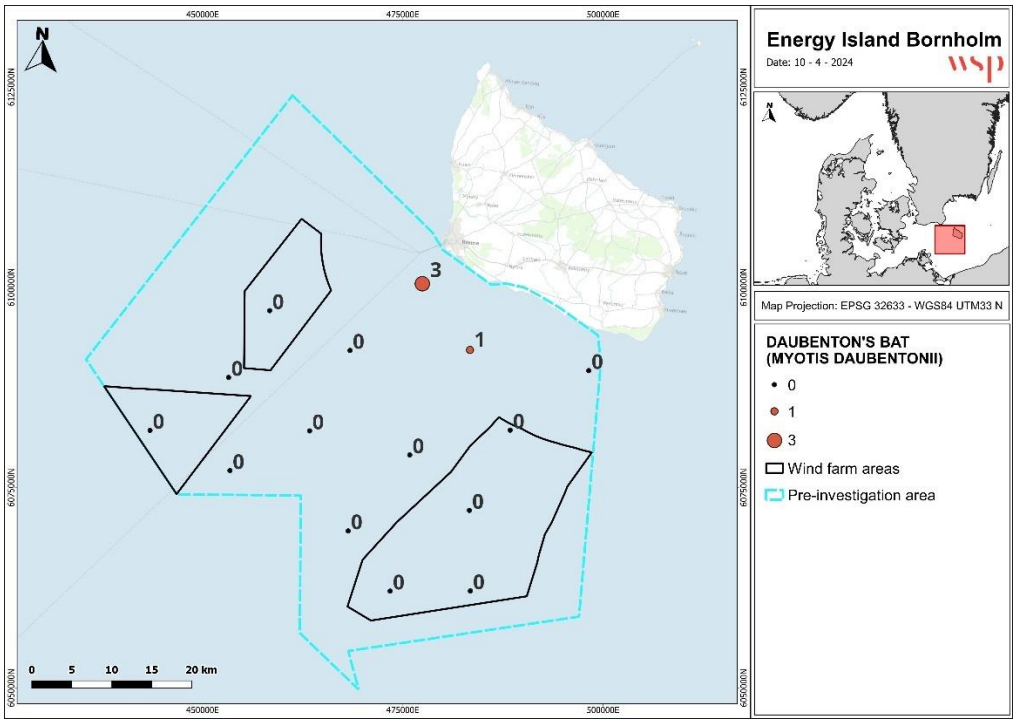


Figure 32 – Number of bat recordings per buoy. Daubenton's bat 2022 and 2023 (n=4). The wind farm areas shown on the map are suggested areas only.

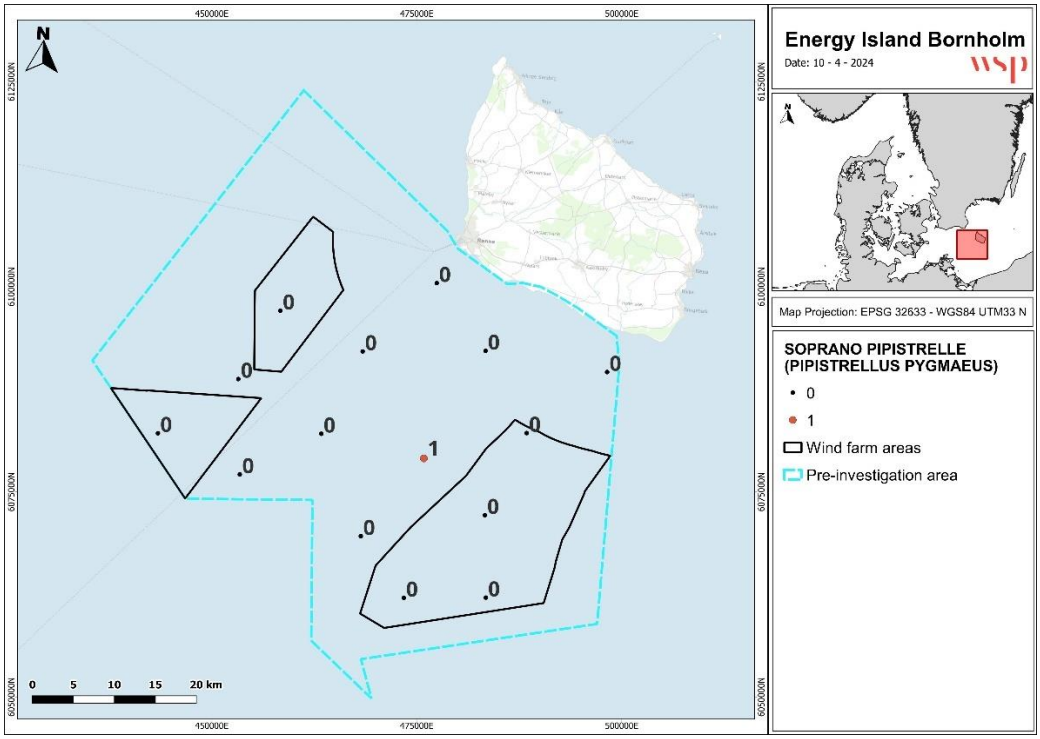
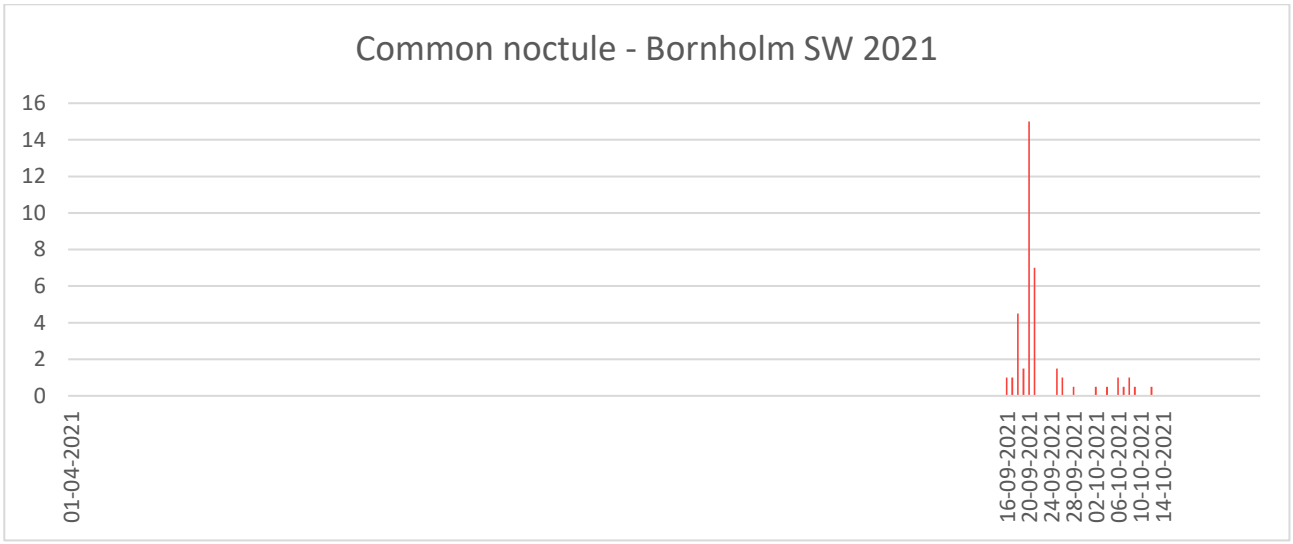
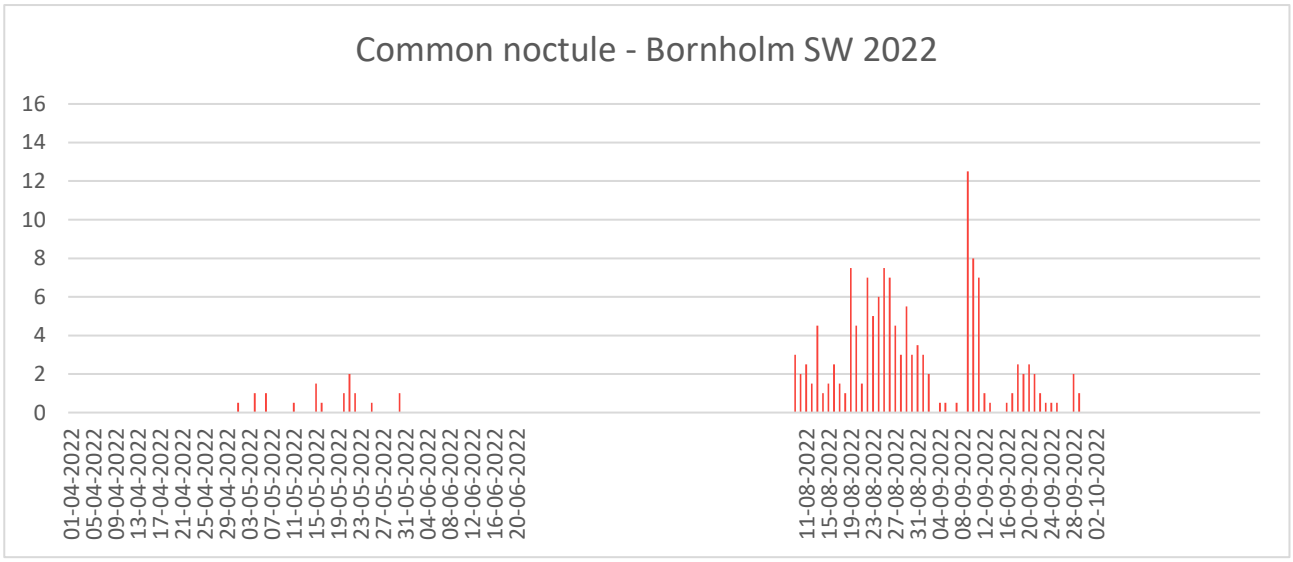


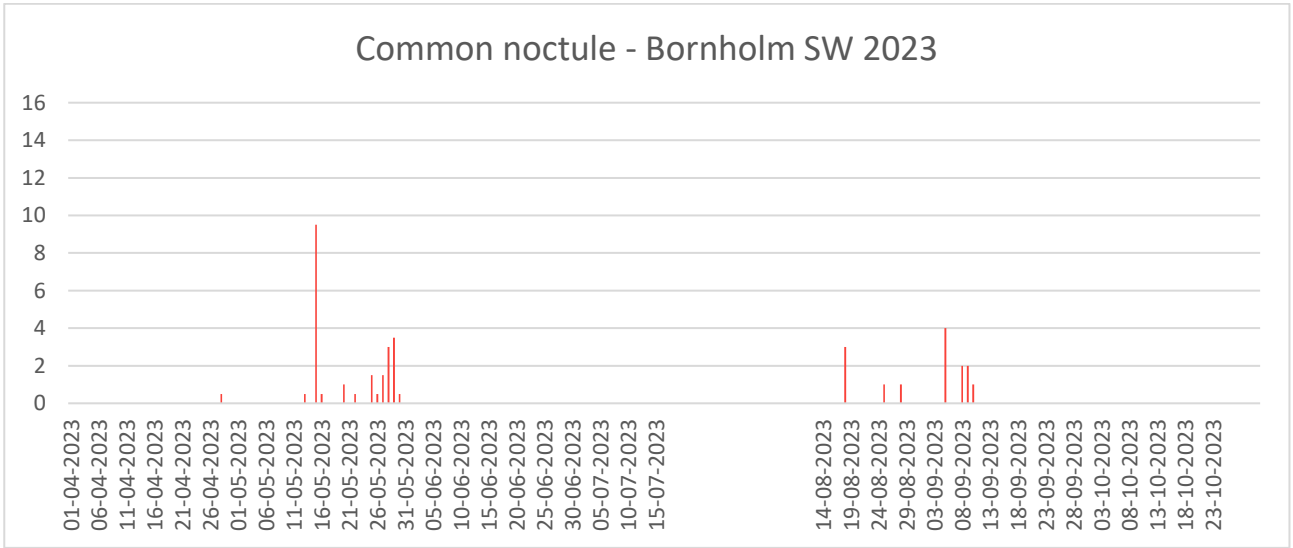
Figure 33 – Number of bat recordings per buoy. Soprano pipistrelle 2022 and 2023 (n=1). The wind farm areas shown on the map are suggested areas only.

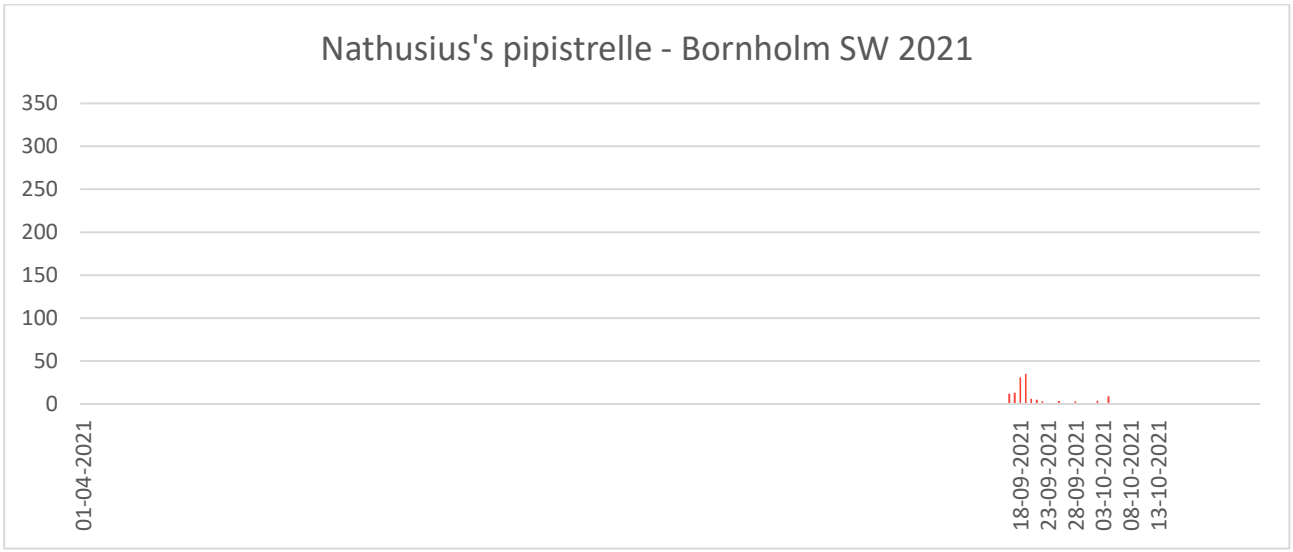
9 APPENDIX 2 – RECORDINGS PER NIGHT

The figures show average number of recordings per night per detector. Date-legends on the X-axis show periods with monitoring.








Nathusius's pipistrelle - Bornholm SW 2021
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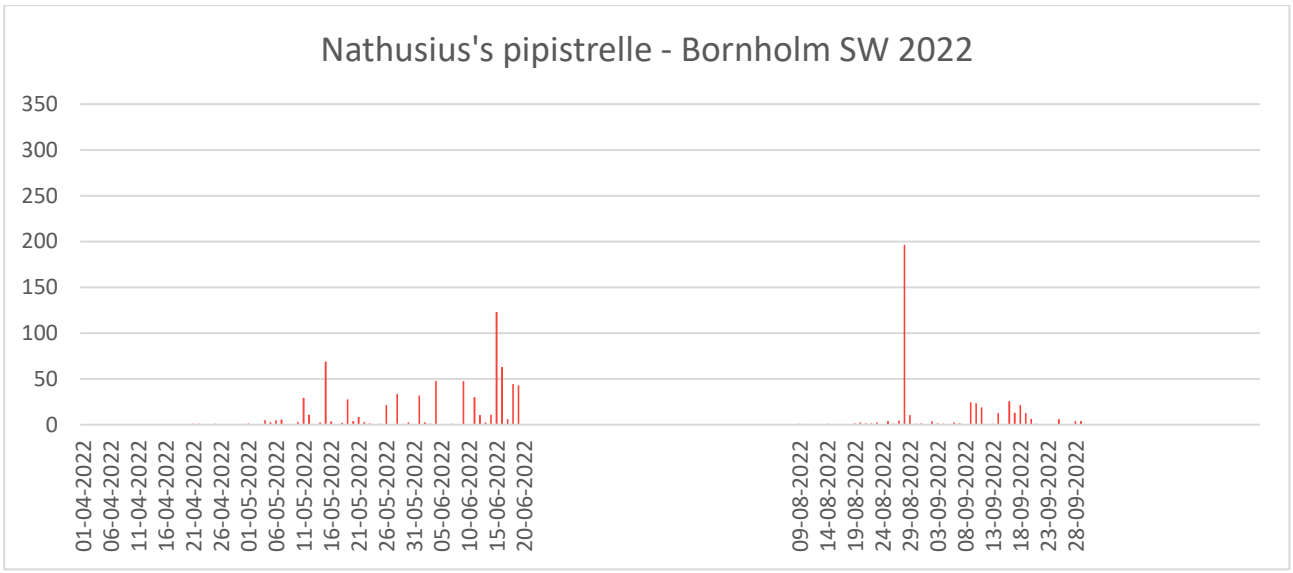
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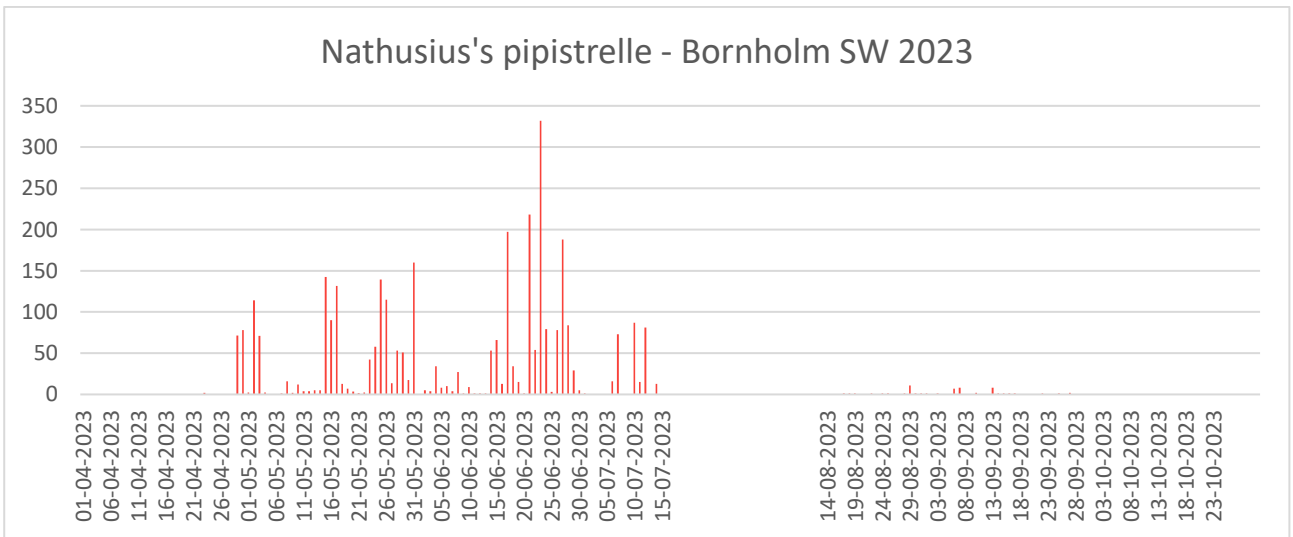
Nathusius's pipistrelle - Bornholm SW 2023
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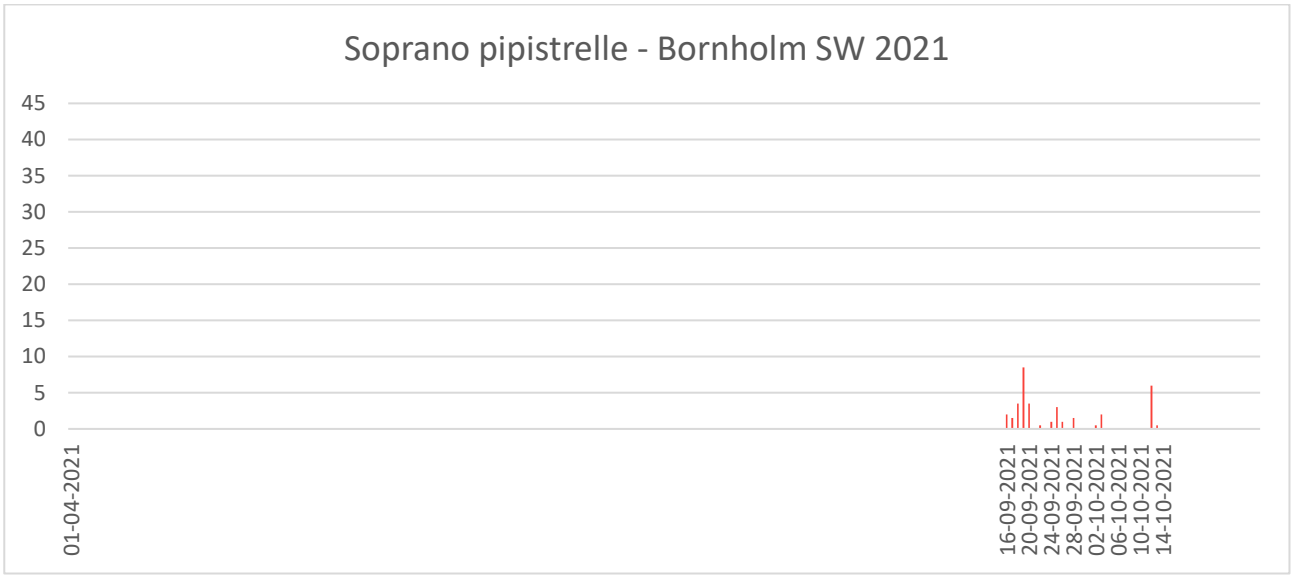
Soprano pipistrelle - Bornholm SW 2021
45
40
35
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25
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10
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16-09-2021
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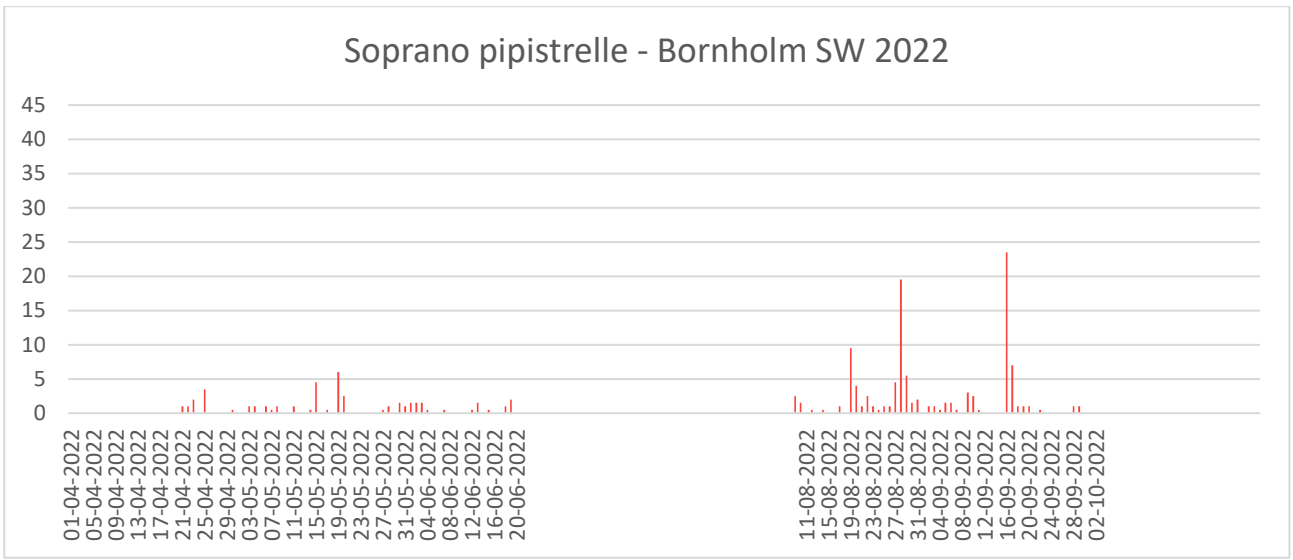
Soprano pipistrelle - Bornholm SW 2022
45
40
35
30
25
20
15
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01-04-2022
05-04-2022
09-04-2022
13-04-2022
17-04-2022
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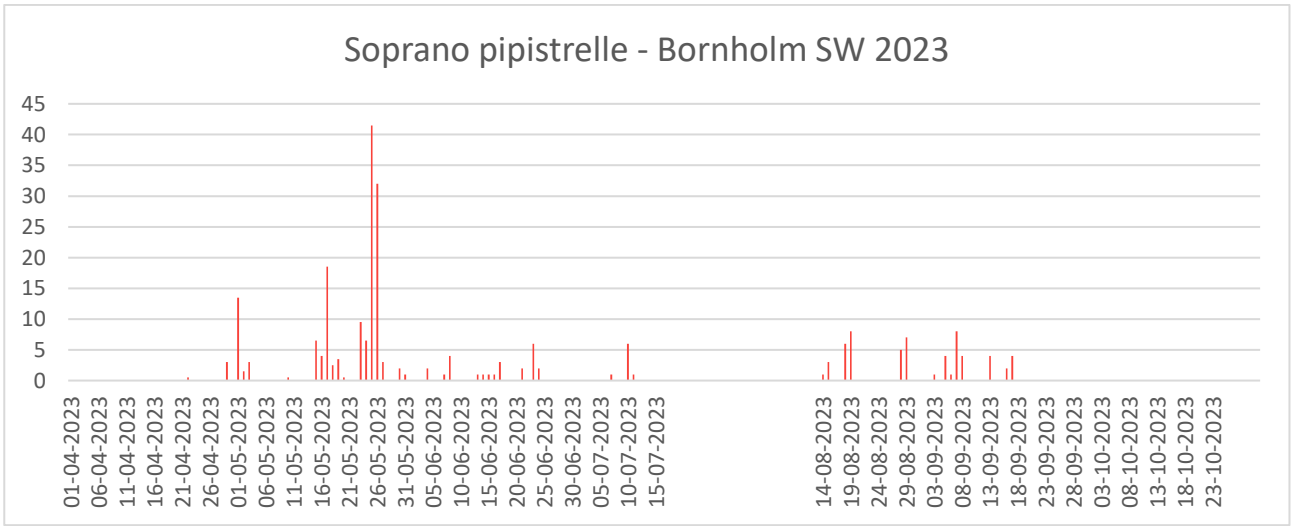
Soprano pipistrelle - Bornholm SW 2023
45
40
35
30
25
20
15
10
5
0
01-04-2023
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11-04-2023
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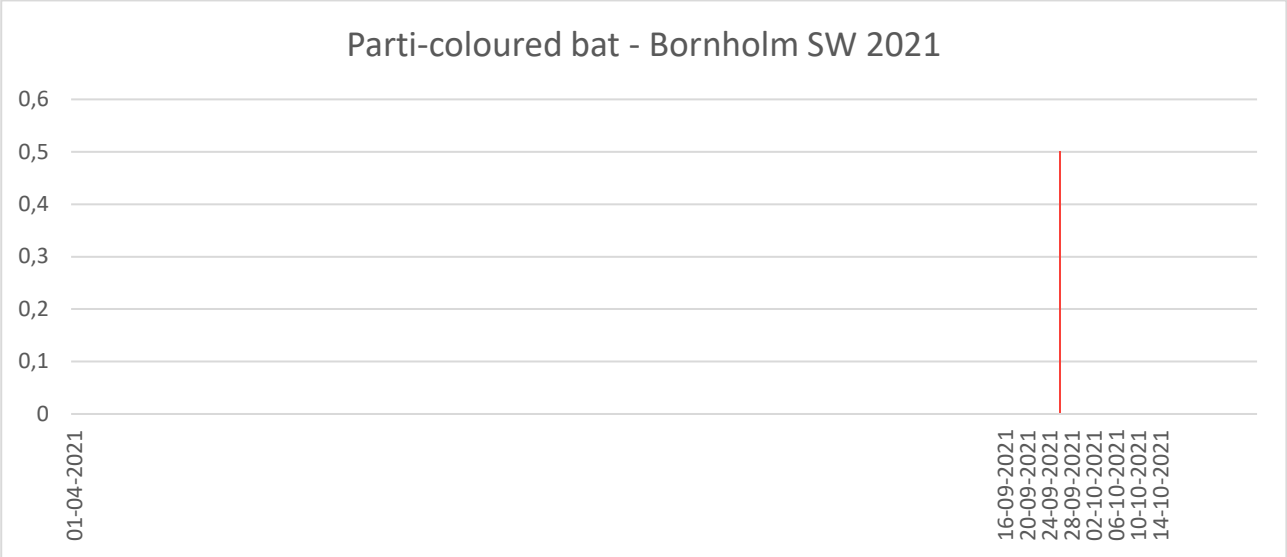
Parti-coloured bat - Bornholm SW 2021
0,6
0,5
0,4
0,3
0,2
0,1
0
01-04-2021
16-09-2021
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24-09-2021
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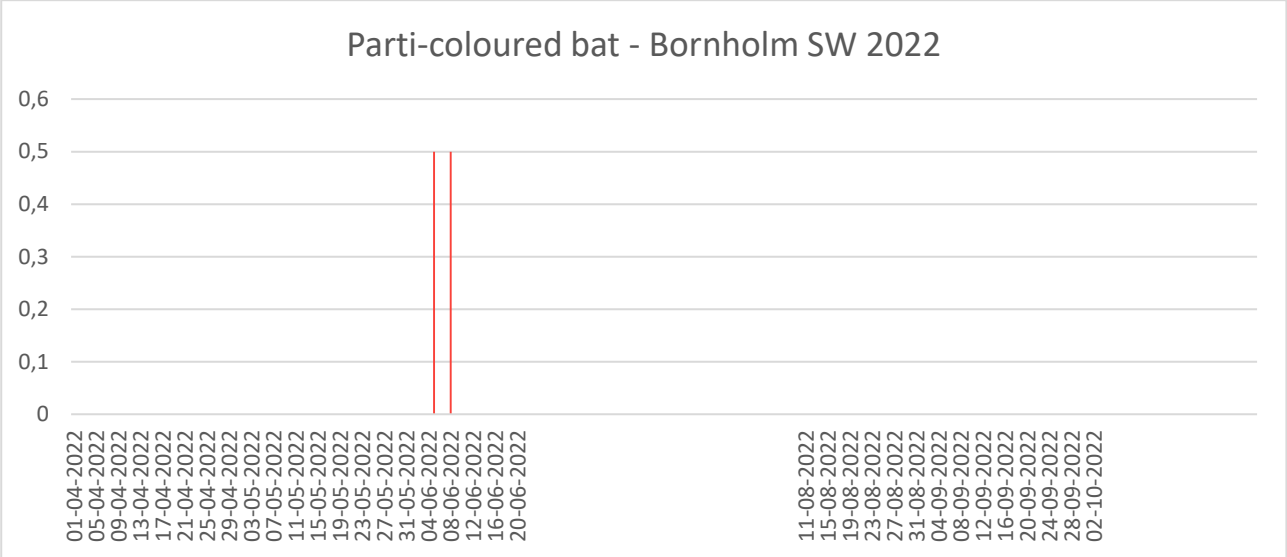
14-10-2021


Parti-coloured bat - Bornholm SW 2022
0,6
0,5
0,4
0,3
0,2
0,1
0
01-04-2022
05-04-2022
09-04-2022
13-04-2022
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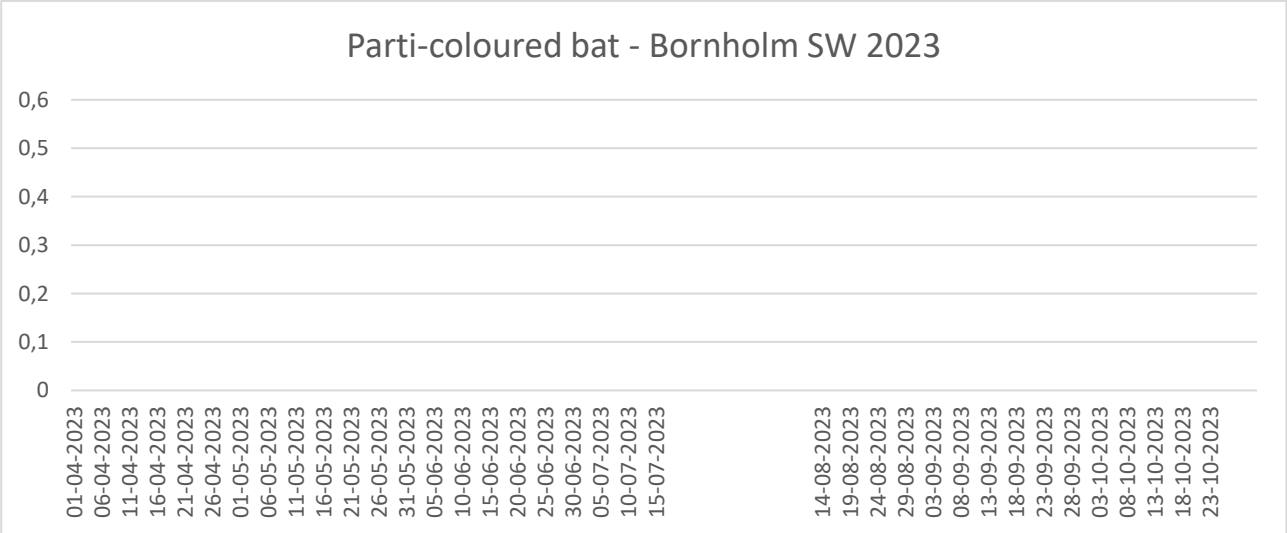
Parti-coloured bat - Bornholm SW 2023
0,6
0,5
0,4
0,3
0,2
0,1
0
01-04-2023
06-04-2023
11-04-2023
16-04-2023
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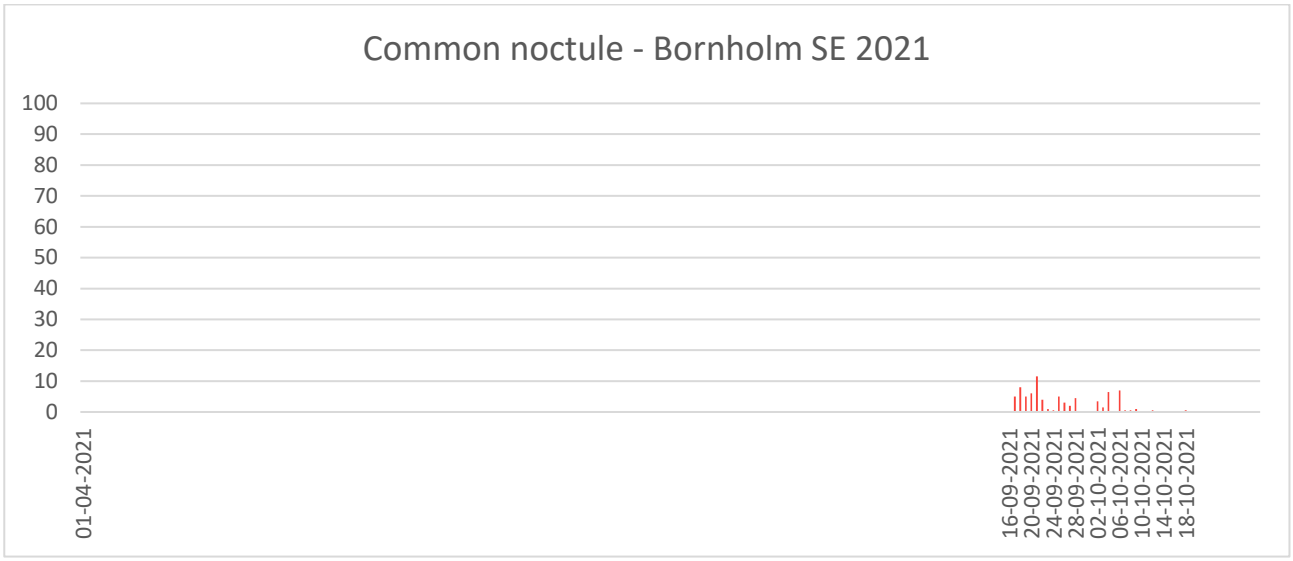
Common noctule - Bornholm SE 2021
100
90
80
70
60
50
40
30
20
10
0
01-04-2021
16-09-2021
20-09-2021
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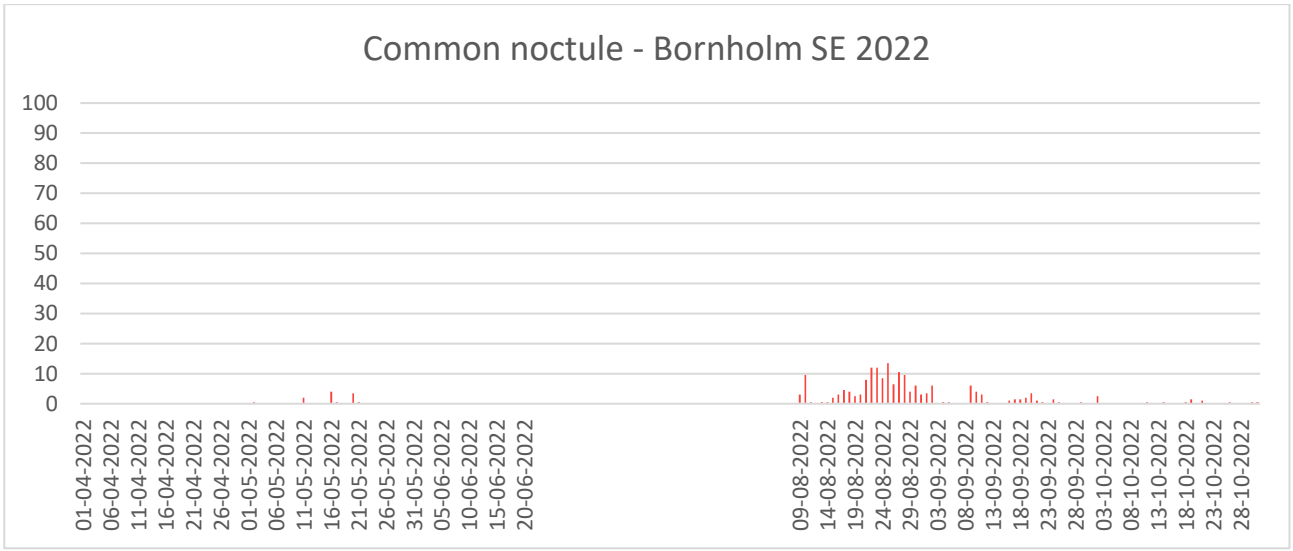
Common noctule - Bornholm SE 2022
100
90
80
70
60
50
40
30
20
10
0
01-04-2022
06-04-2022
11-04-2022
16-04-2022
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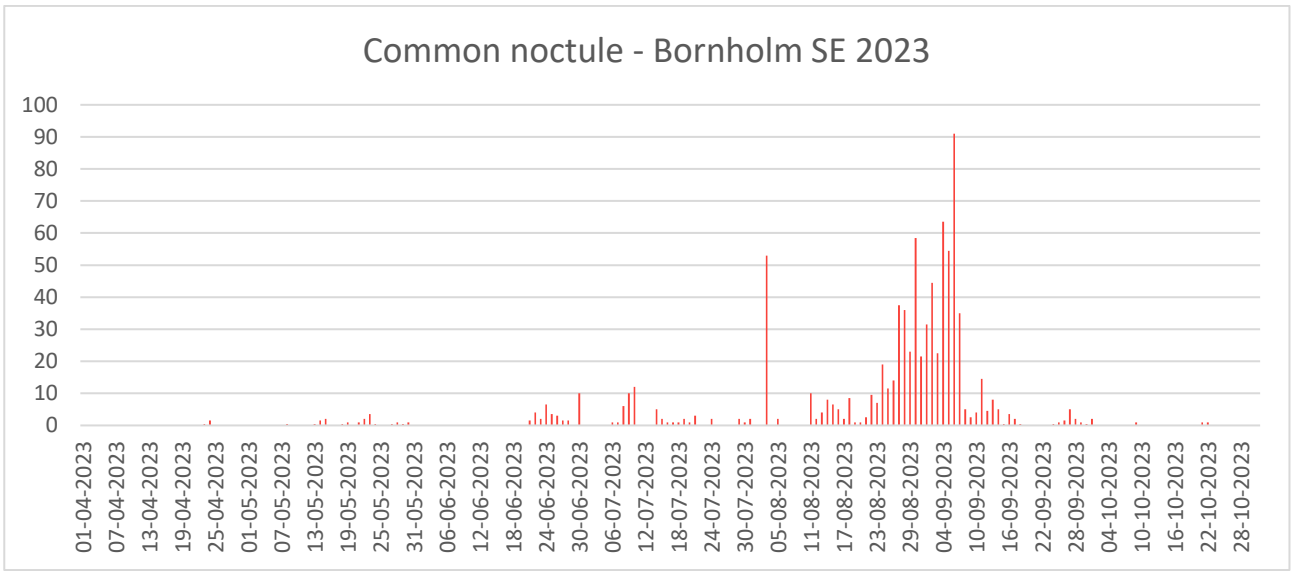
Common noctule - Bornholm SE 2023
100
90
80
70
60
50
40
30
20
10
0
01-04-2023
07-04-2023
13-04-2023
19-04-2023
25-04-2023
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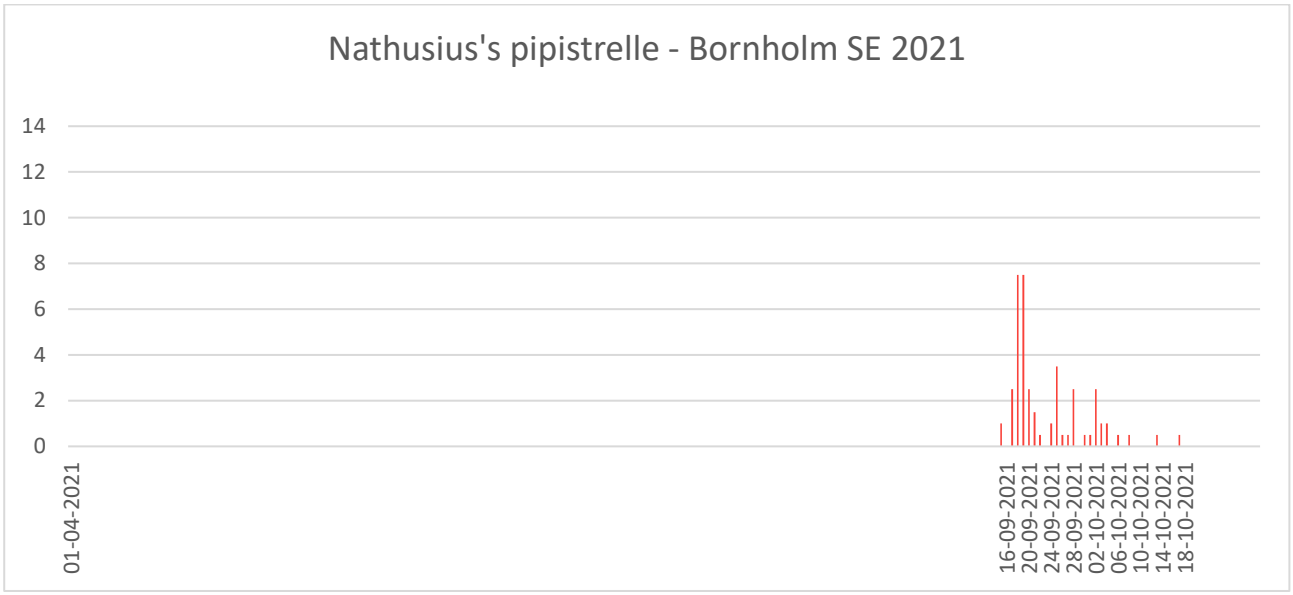
Nathusius's pipistrelle - Bornholm SE 2021
14
12
10
8
6
4
2
0
01-04-2021
16-09-2021
20-09-2021
24-09-2021
28-09-2021
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06-10-2021
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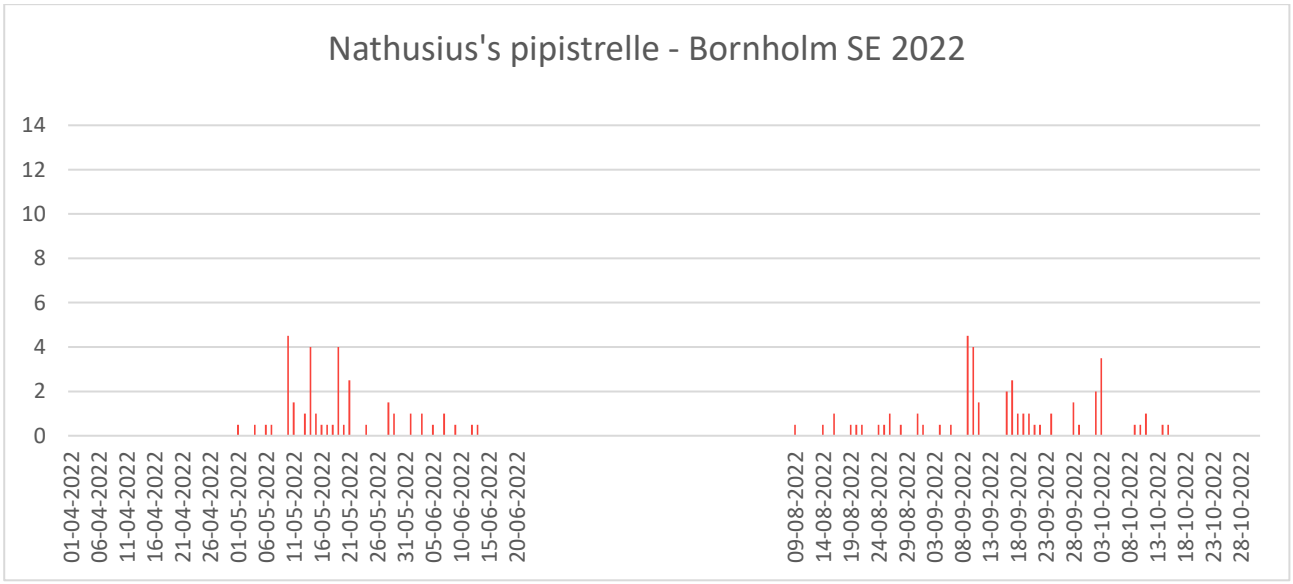
Nathusius's pipistrelle - Bornholm SE 2022
14
12
10
8
6
4
2
0
01-04-2022
06-04-2022
11-04-2022
16-04-2022
21-04-2022
26-04-2022
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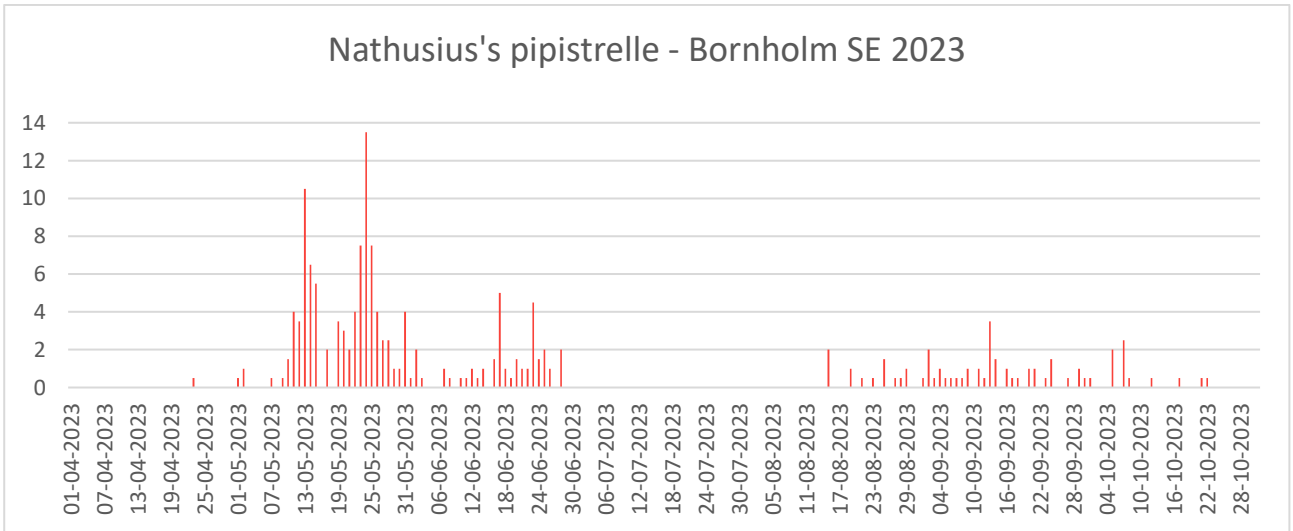
Nathusius's pipistrelle - Bornholm SE 2023
14
12
10
8
6
4
2
0
01-04-2023
07-04-2023
13-04-2023
19-04-2023
25-04-2023
01-05-2023
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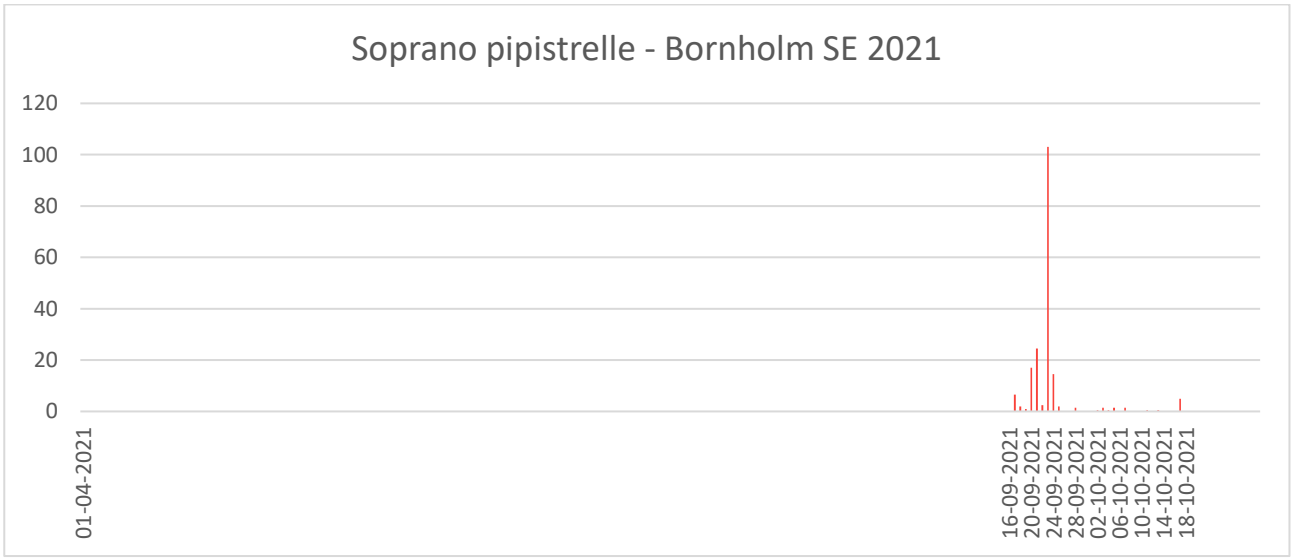
Soprano pipistrelle - Bornholm SE 2021
120
100
80
60
40
20
0
01-04-2021
16-09-2021
20-09-2021
24-09-2021
28-09-2021
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06-10-2021
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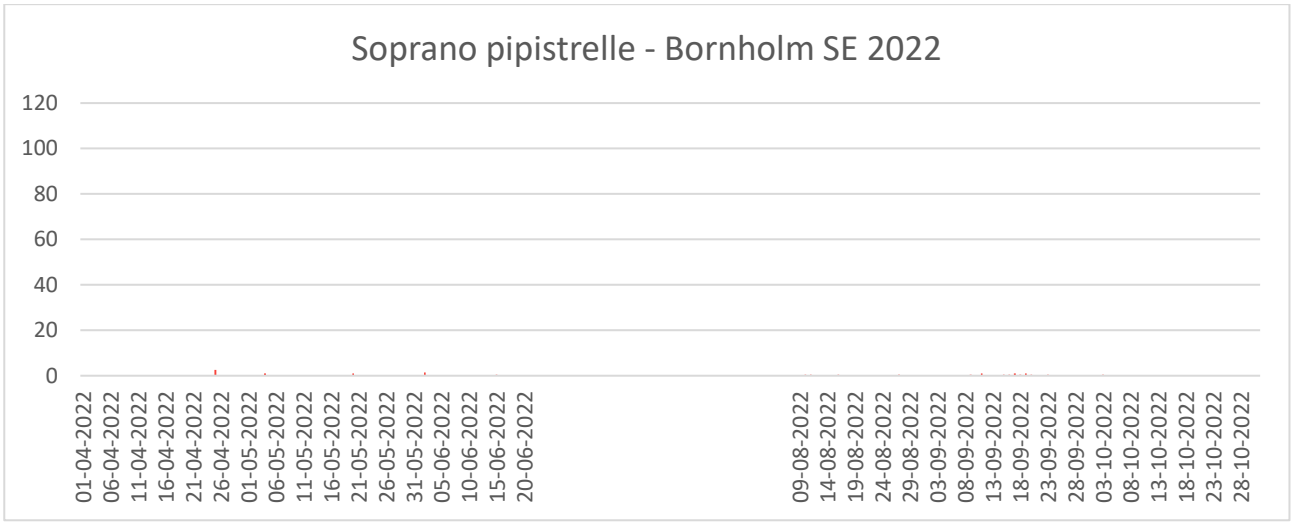
Soprano pipistrelle - Bornholm SE 2022
120
100
80
60
40
20
0
01-04-2022
06-04-2022
11-04-2022
16-04-2022
21-04-2022
26-04-2022
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18-09-2022
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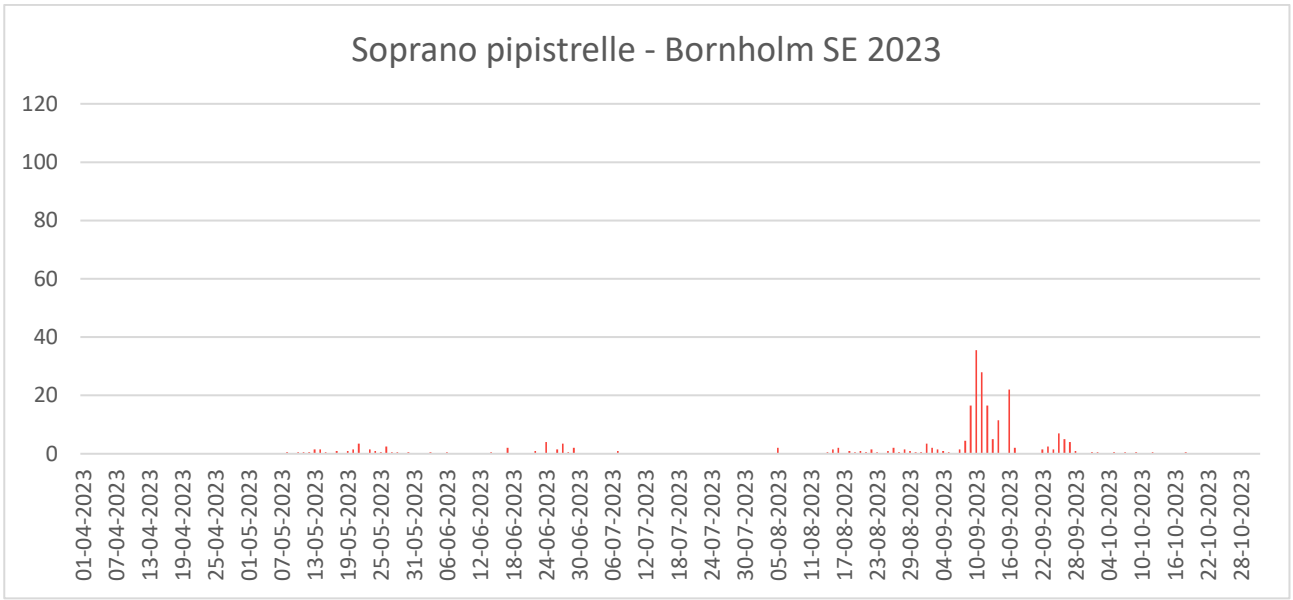
Soprano pipistrelle - Bornholm SE 2023
120
100
80
60
40
20
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01-04-2023
07-04-2023
13-04-2023
19-04-2023
25-04-2023
01-05-2023
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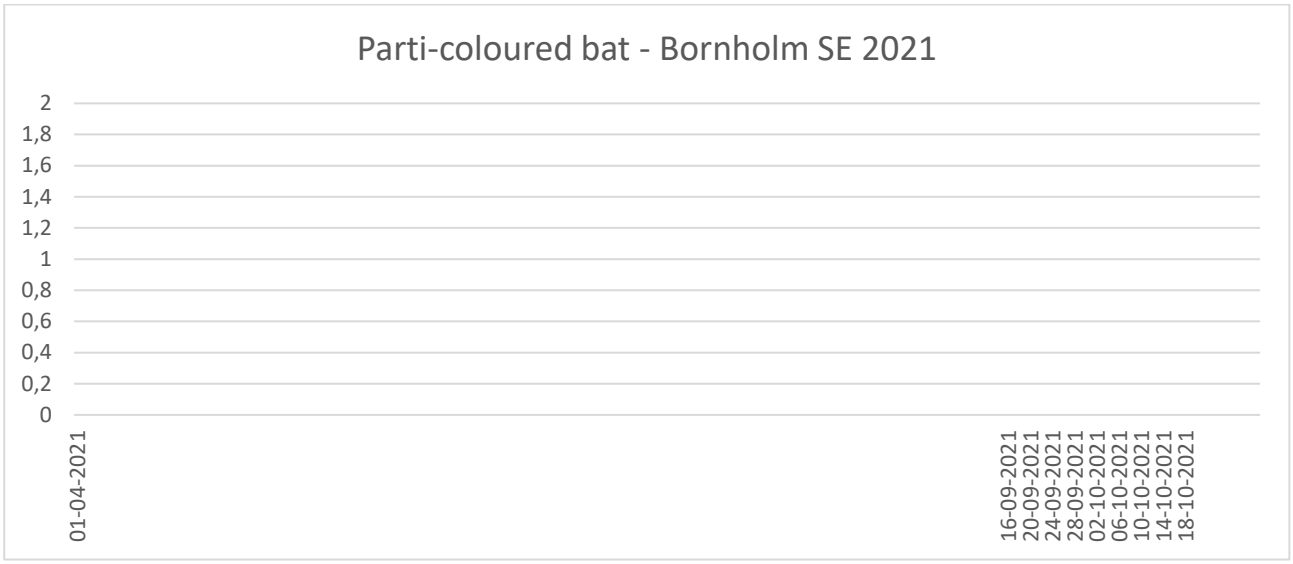
Parti-coloured bat - Bornholm SE 2021
2
1,8
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
01-04-2021
16-09-2021
20-09-2021
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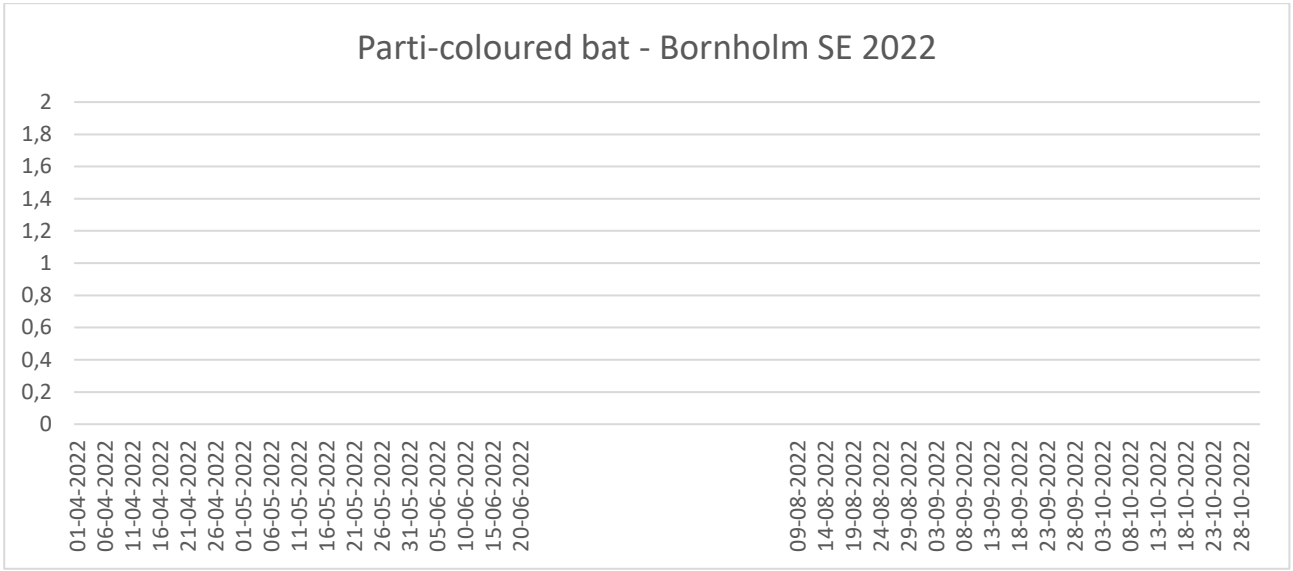
Parti-coloured bat - Bornholm SE 2022
2
1,8
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
01-04-2022
06-04-2022
11-04-2022
16-04-2022
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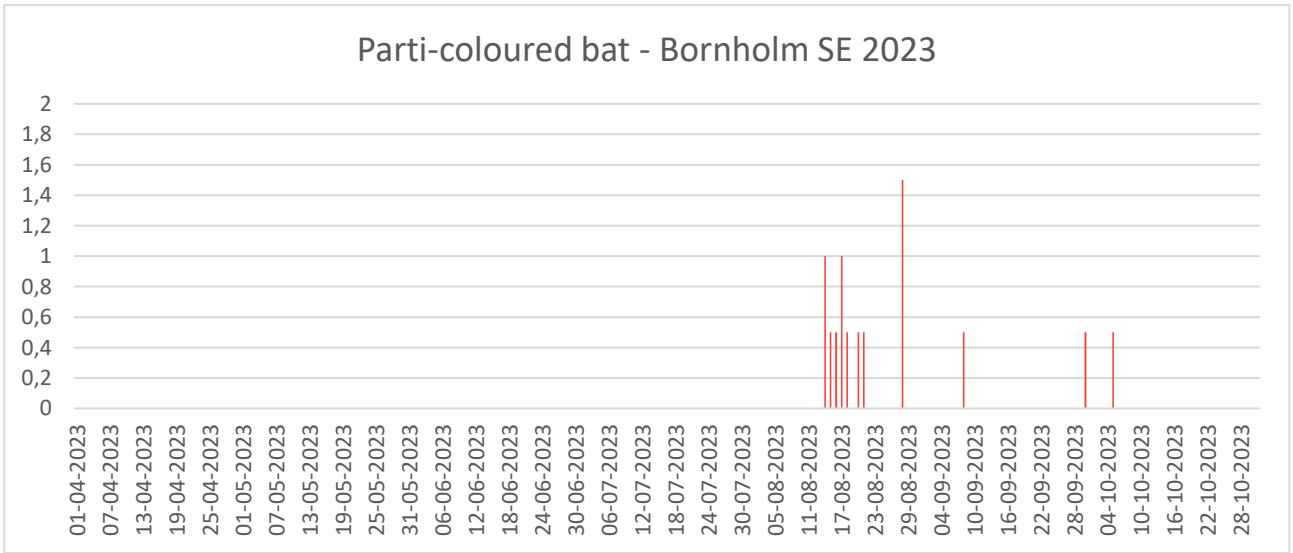
Parti-coloured bat - Bornholm SE 2023
2
1,8
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
01-04-2023
07-04-2023
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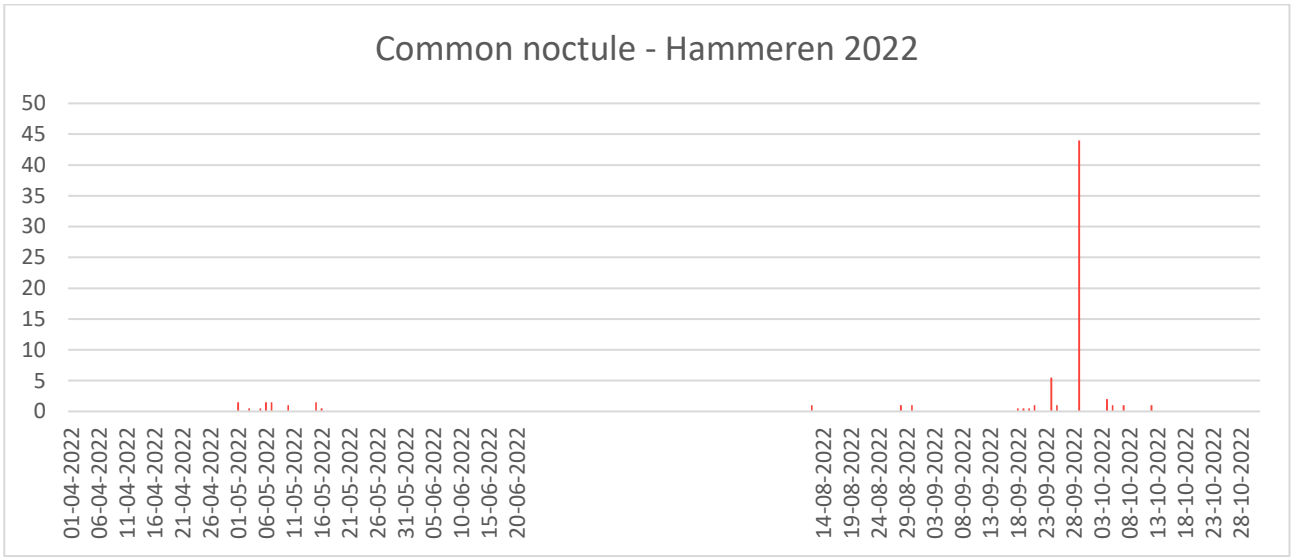
Common noctule - Hammeren 2022
50
45
40
35
30
25
20
15
10
5
0
01-04-2022
06-04-2022
11-04-2022
16-04-2022
21-04-2022
26-04-2022
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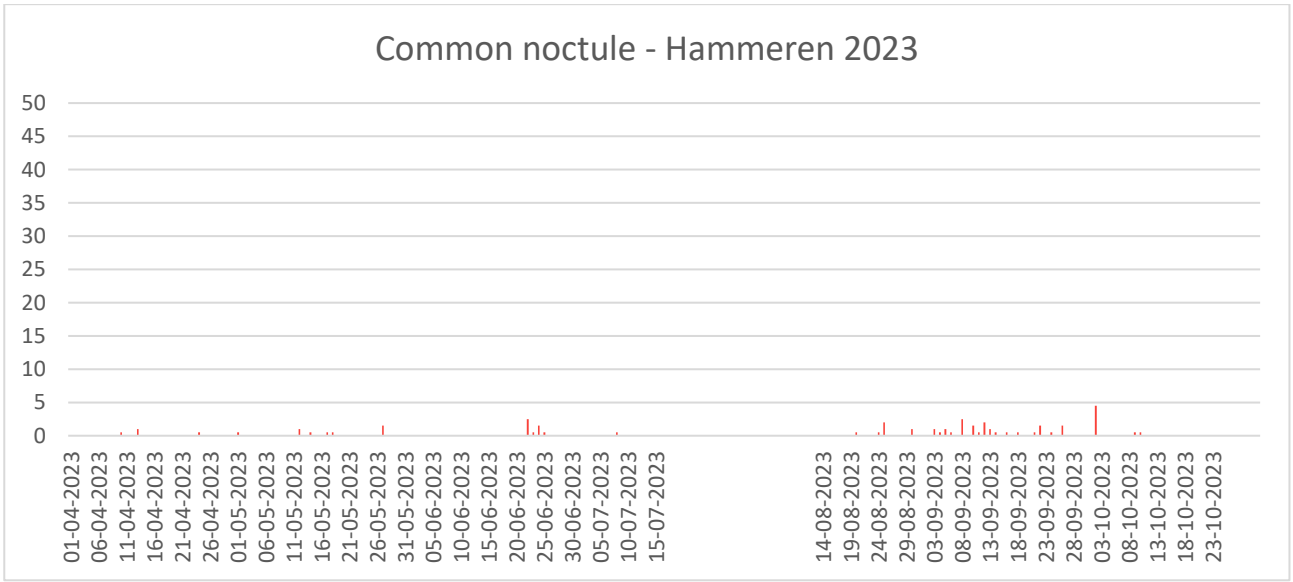
Common noctule - Hammeren 2023
50
45
40
35
30
25
20
15
10
5
0
01-04-2023
06-04-2023
11-04-2023
16-04-2023
21-04-2023
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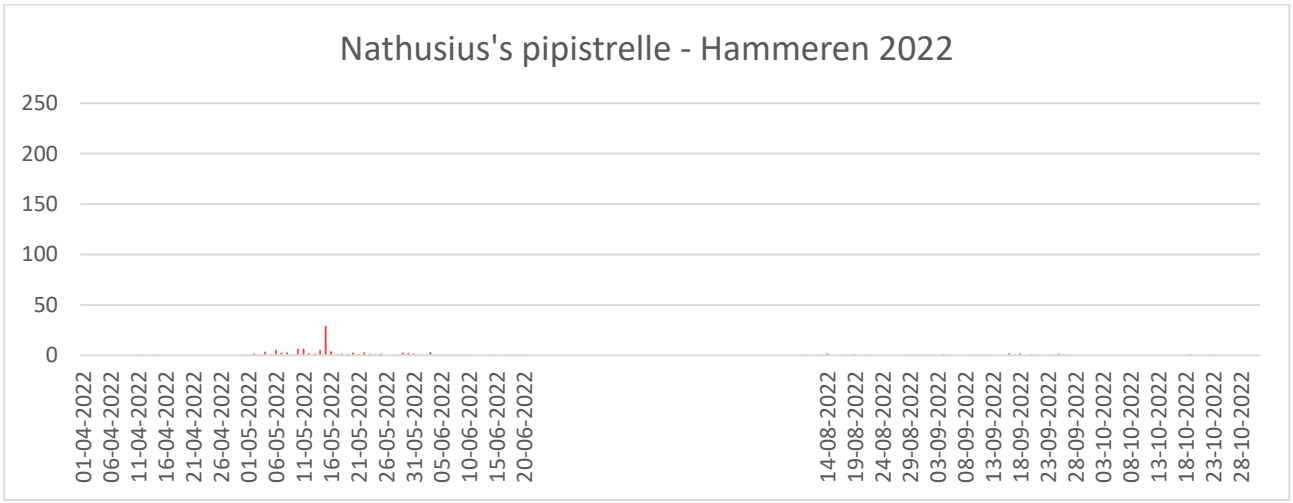
Nathusius's pipistrelle - Hammeren 2022
250
200
150
100
50
0
01-04-2022
06-04-2022
11-04-2022
16-04-2022
21-04-2022
26-04-2022
01-05-2022
06-05-2022
11-05-2022
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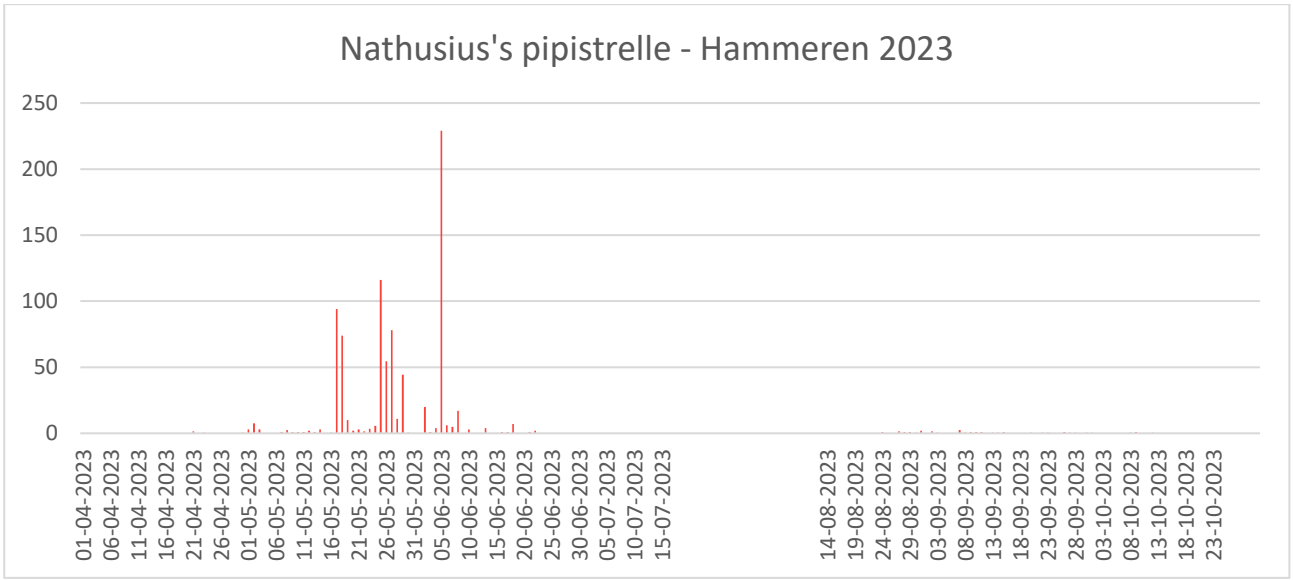
Nathusius's pipistrelle - Hammeren 2023
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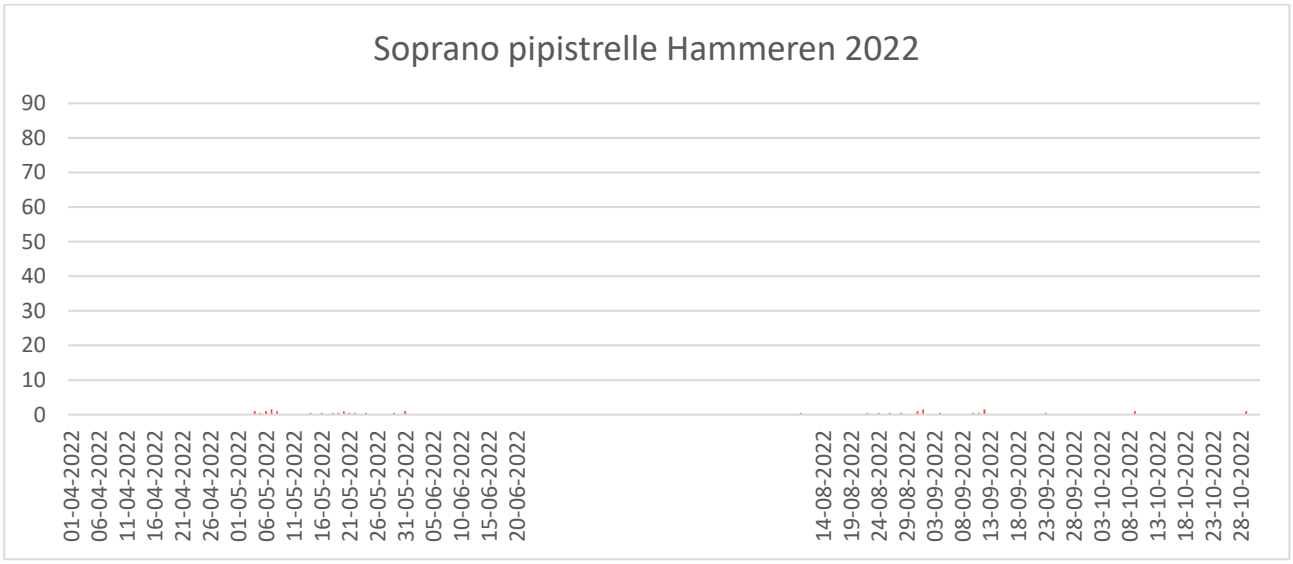
Soprano pipistrelle Hammeren 2022
90
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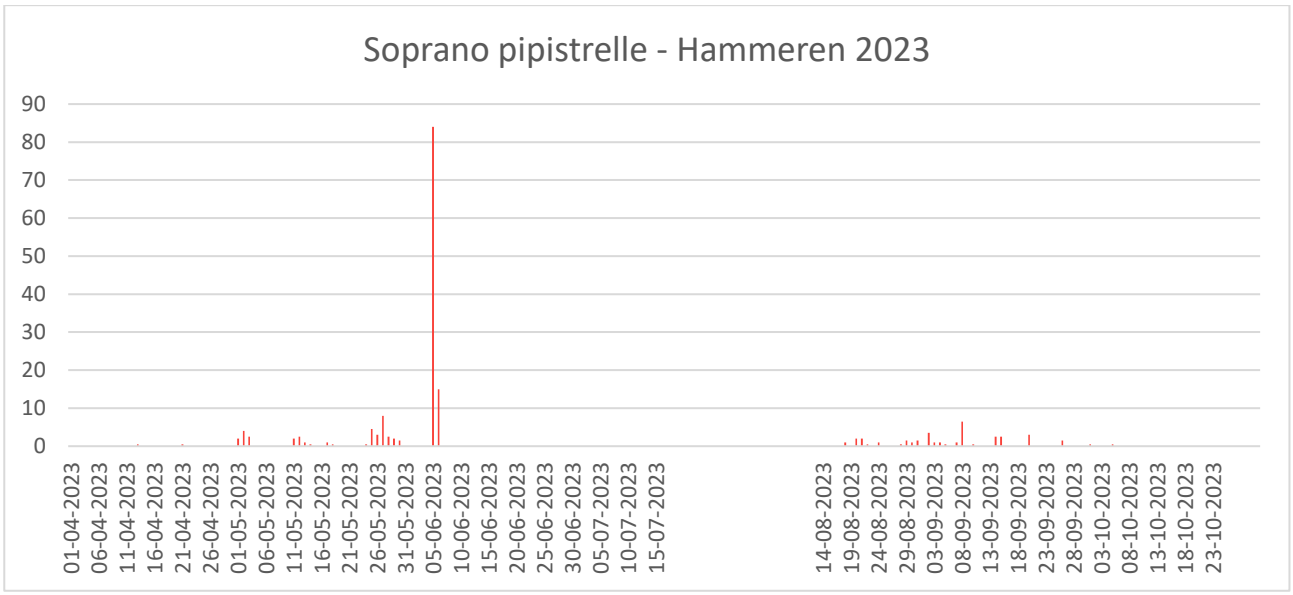
Soprano pipistrelle - Hammeren 2023
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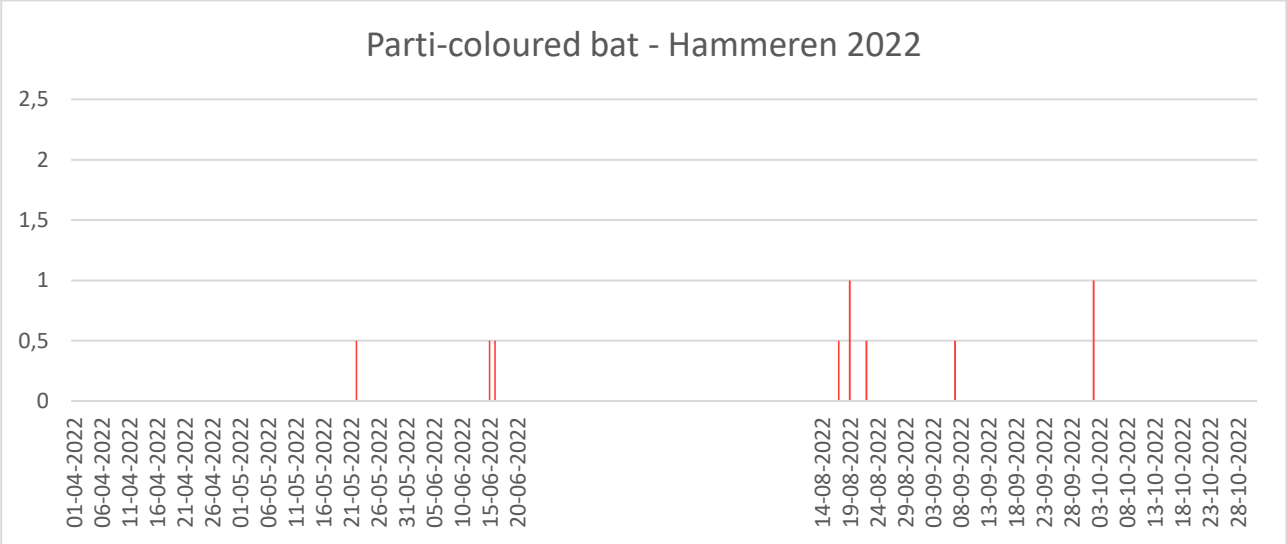
Parti-coloured bat - Hammeren 2022
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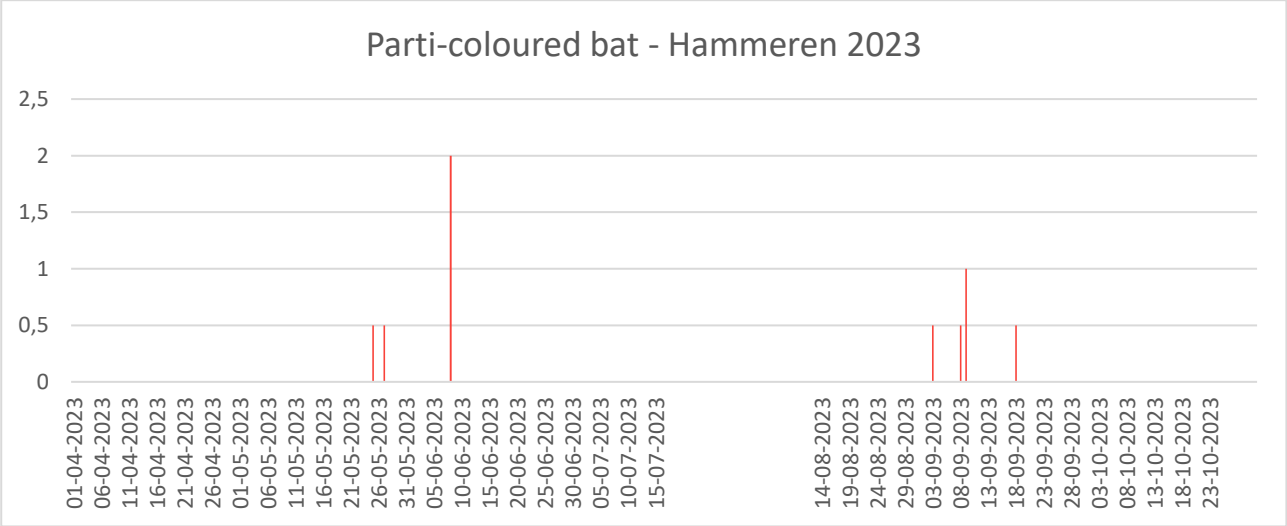
Parti-coloured bat - Hammeren 2023
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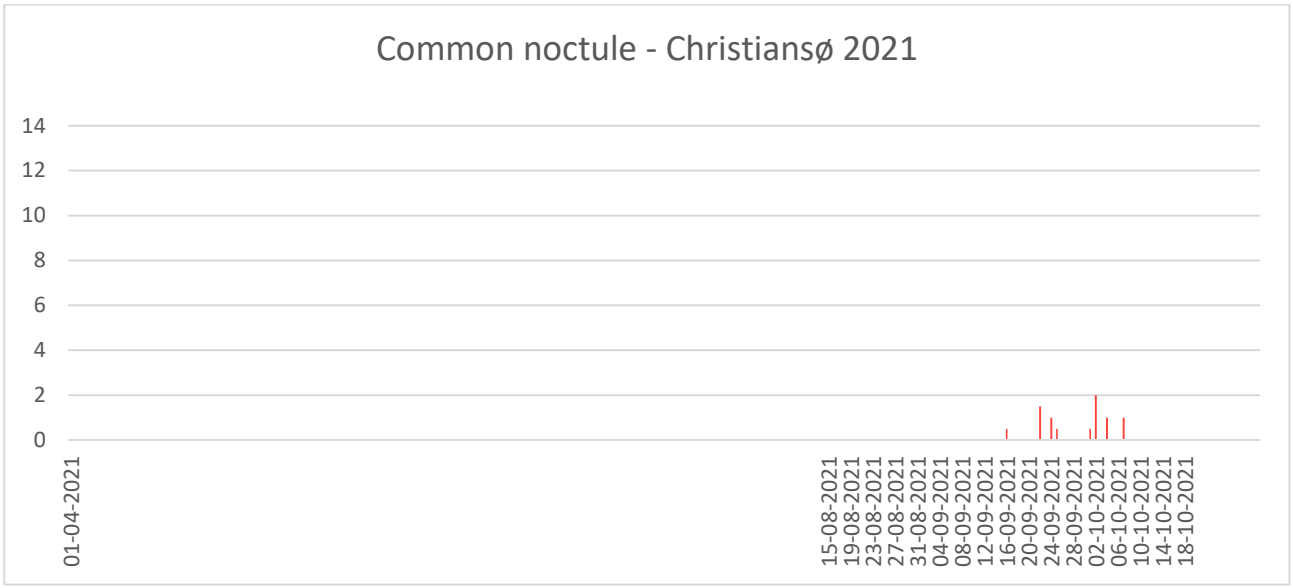
Common noctule - Christiansø 2021
14
12
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8
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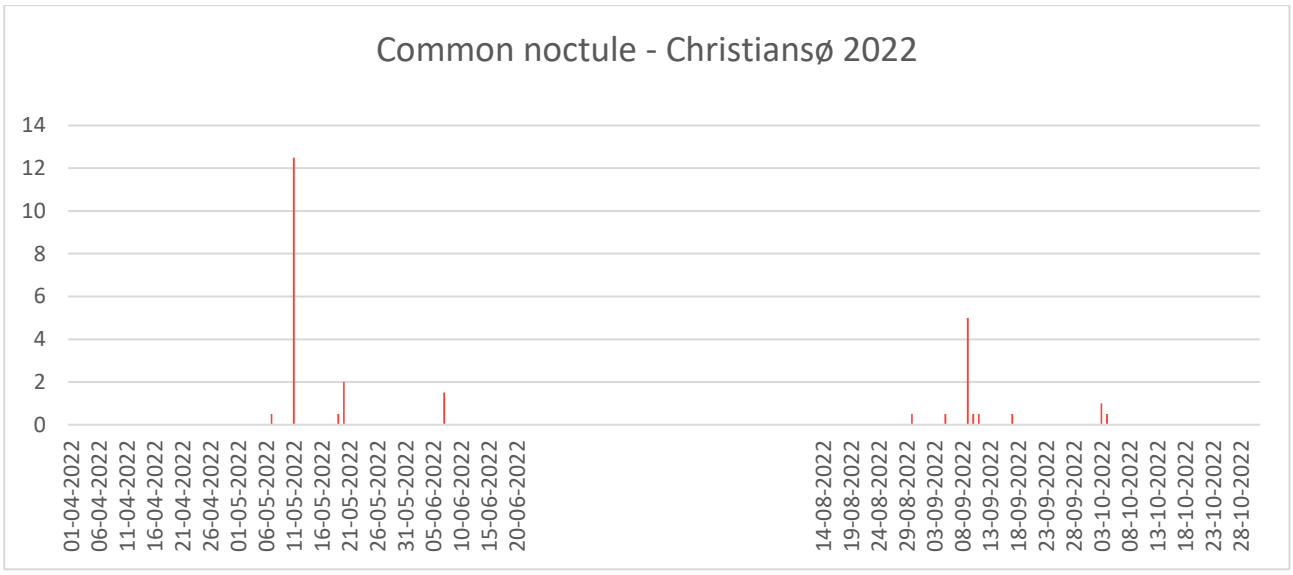
Common noctule - Christiansø 2022
14
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16-04-2022
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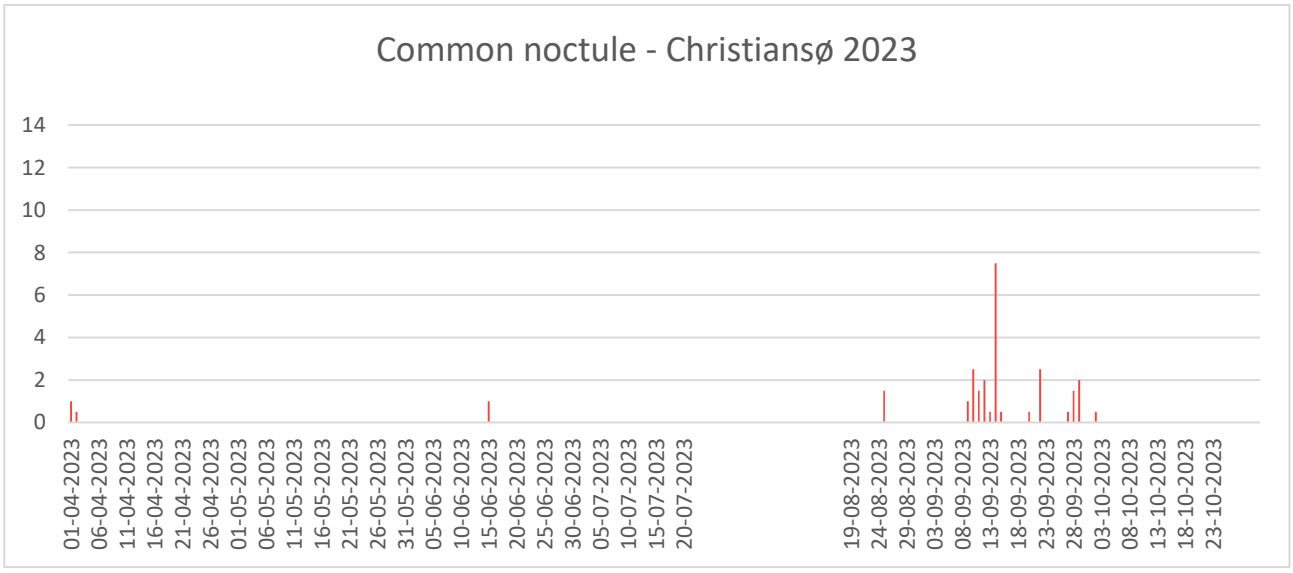
Common noctule - Christiansø 2023
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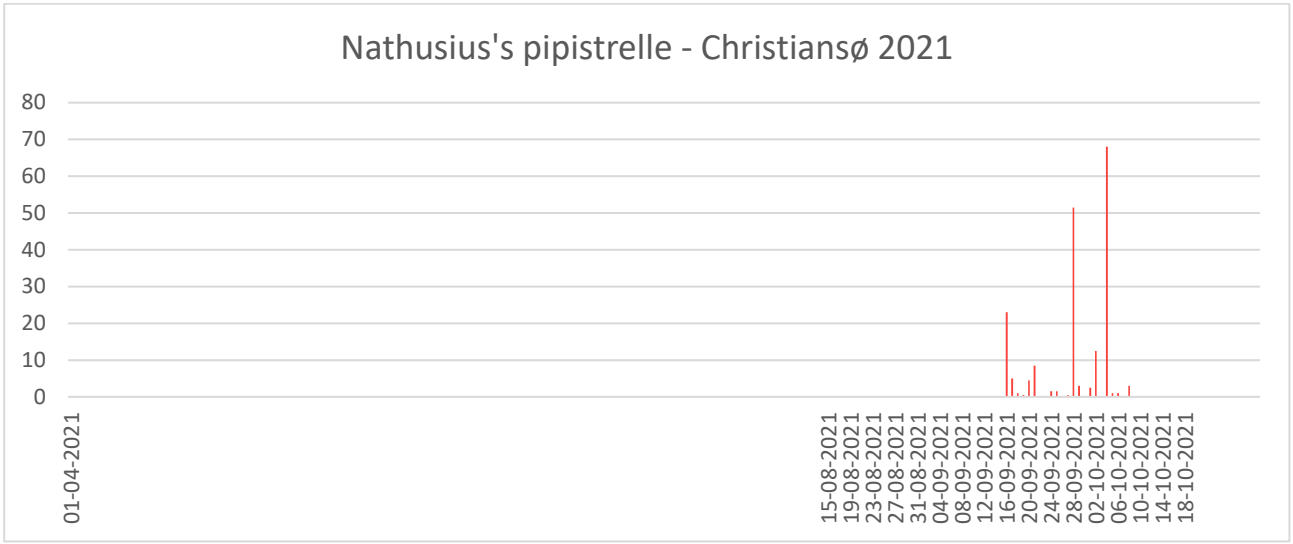
Nathusius's pipistrelle - Christiansø 2021
80
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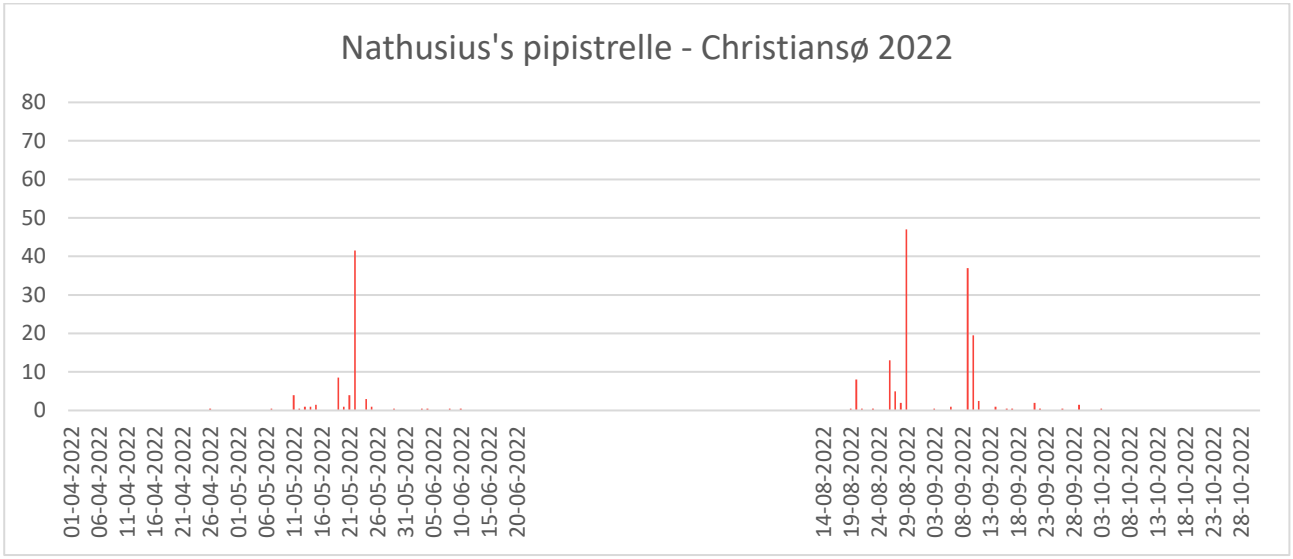
Nathusius's pipistrelle - Christiansø 2022
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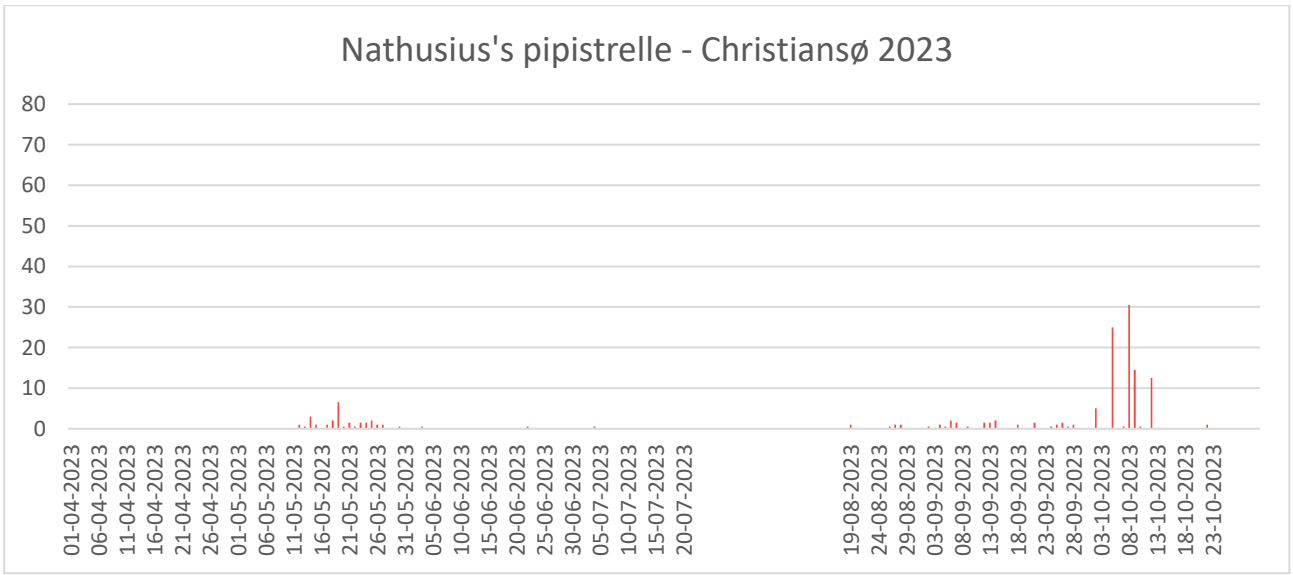
Nathusius's pipistrelle - Christiansø 2023
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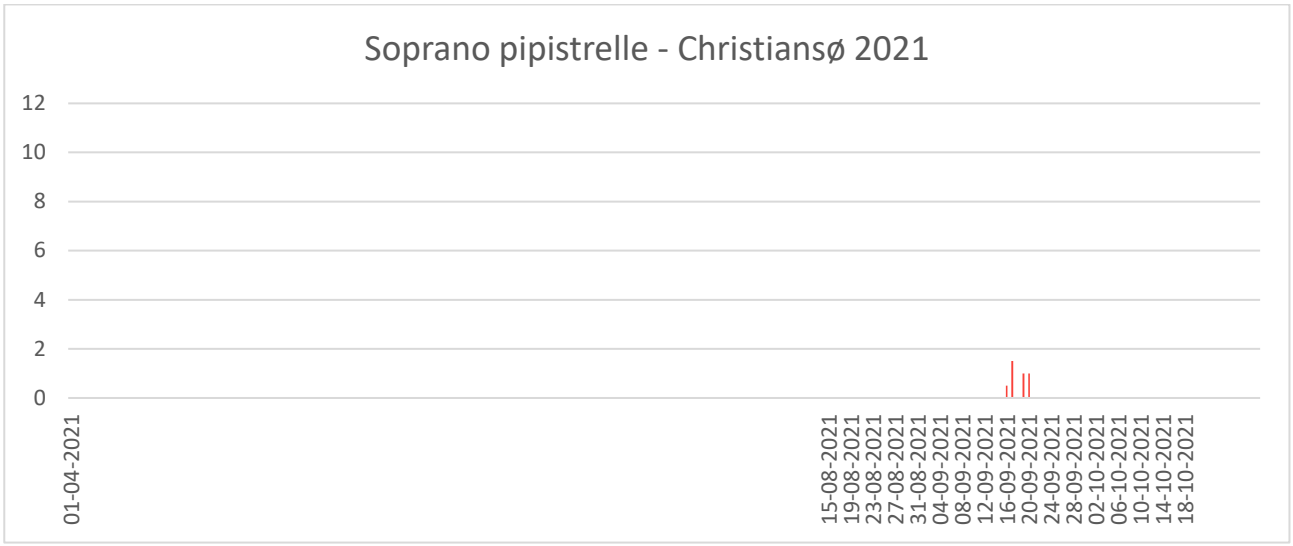
Soprano pipistrelle - Christiansø 2021
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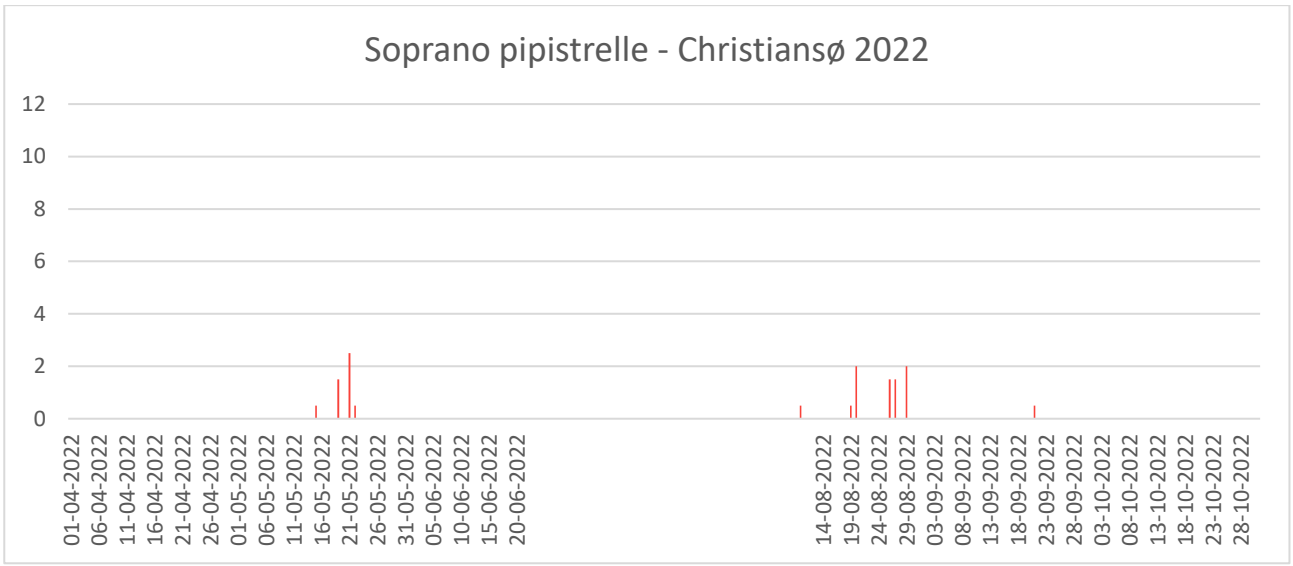
Soprano pipistrelle - Christiansø 2022
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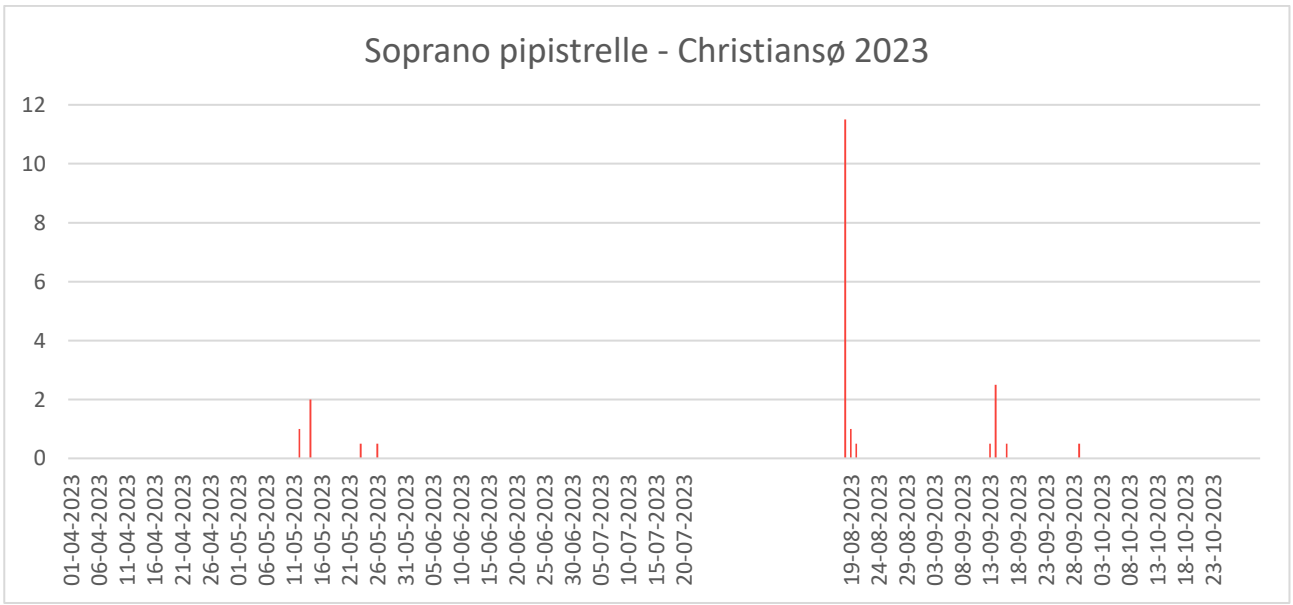
Soprano pipistrelle - Christiansø 2023
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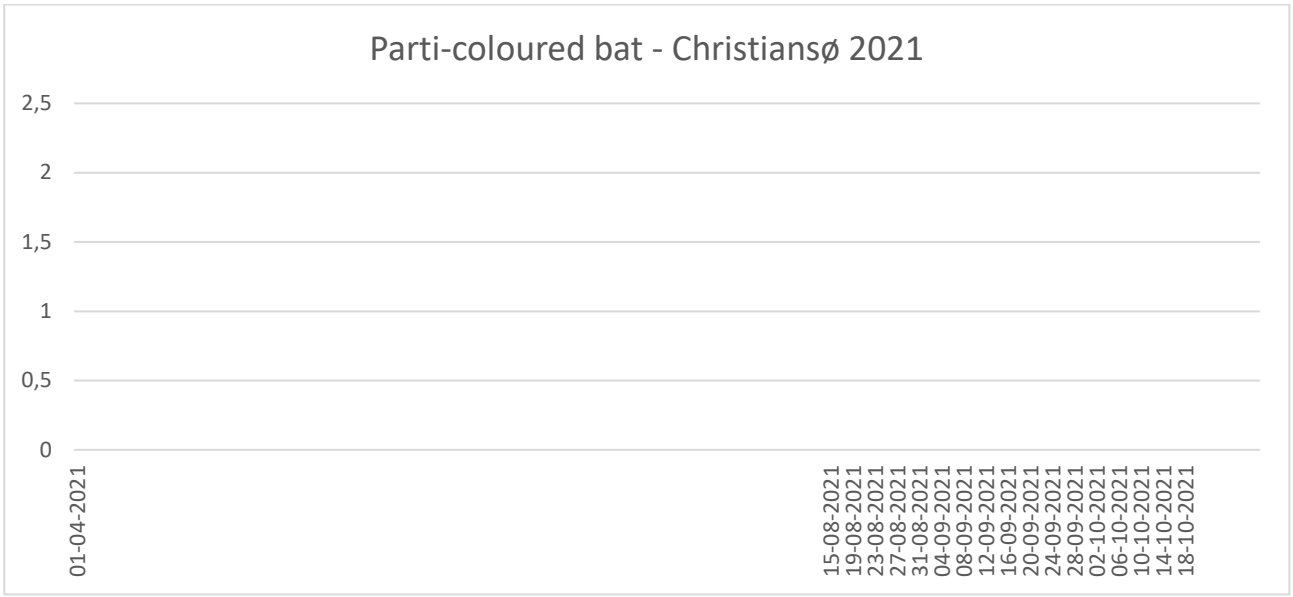
Parti-coloured bat - Christiansø 2021
2,5
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1,5
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0,5
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01-04-2021
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23-08-2021
27-08-2021
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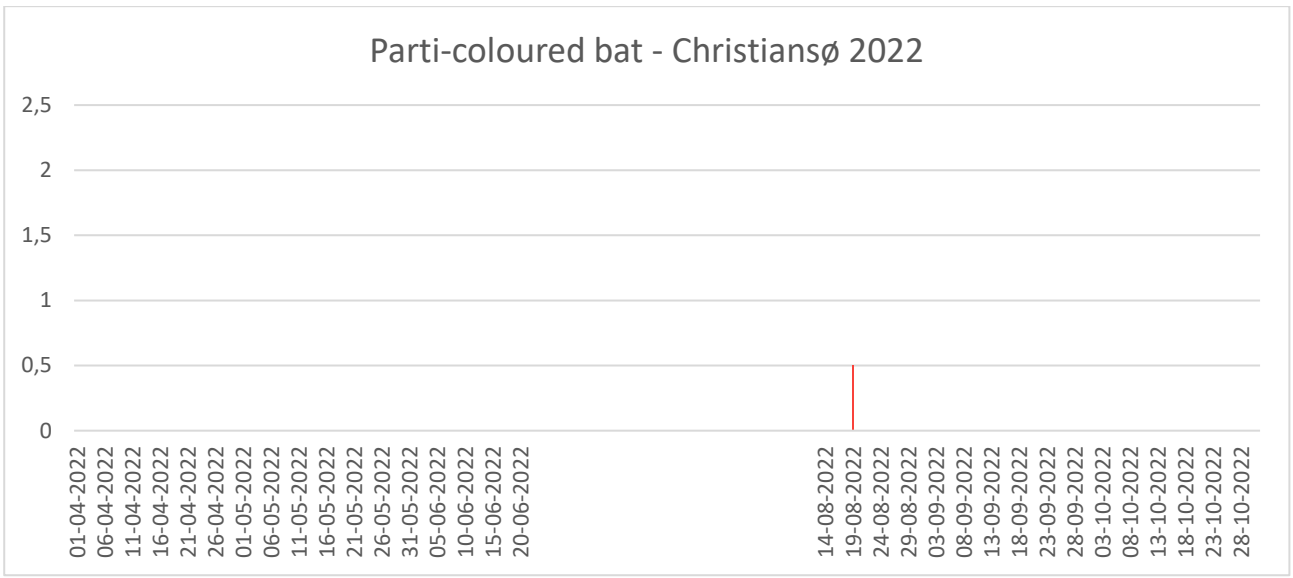
Parti-coloured bat - Christiansø 2022
2,5
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16-04-2022
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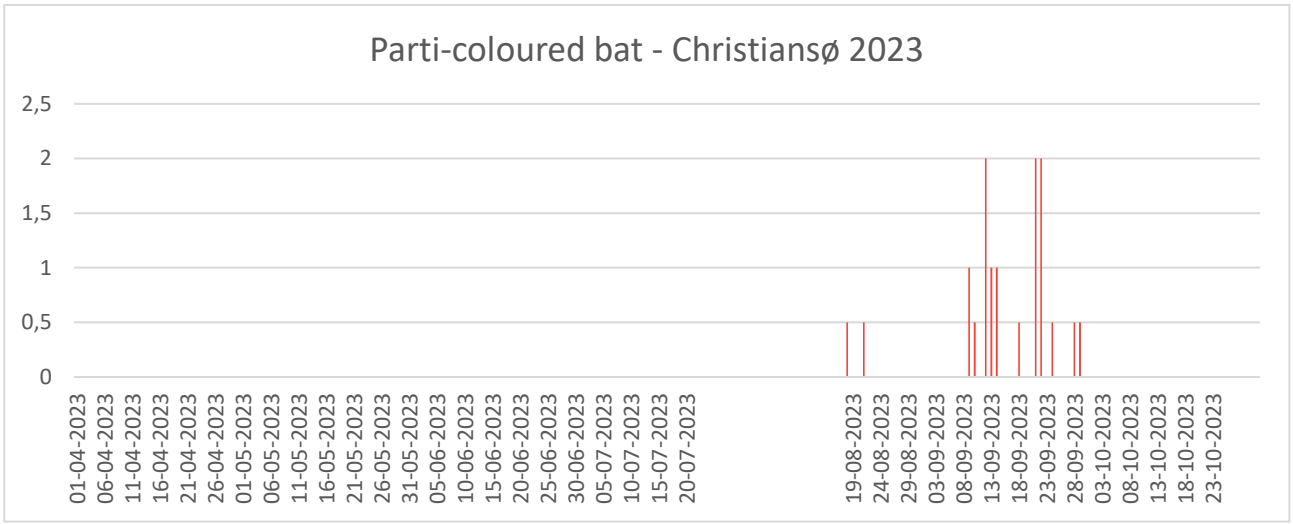
Parti-coloured bat - Christiansø 2023
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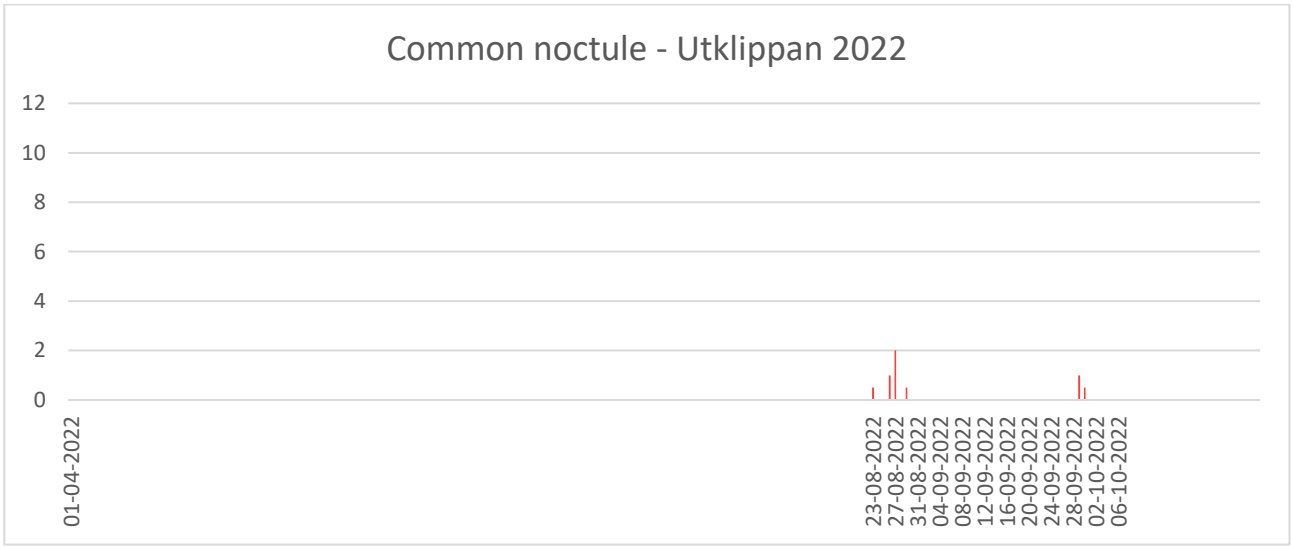
Common noctule - Utklippan 2022
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4
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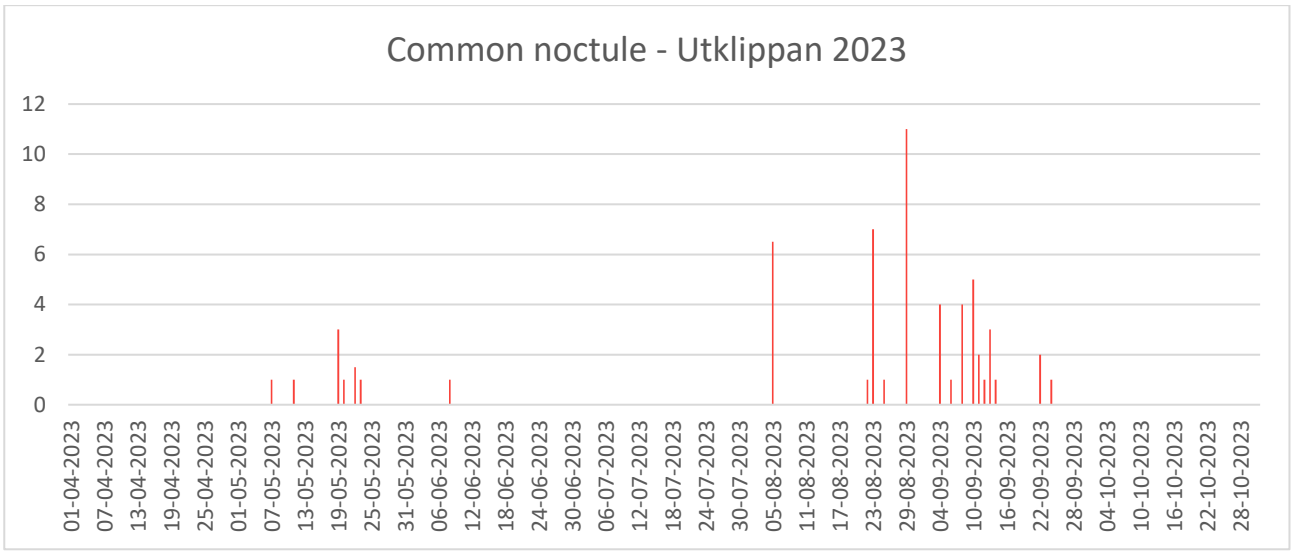
Common noctule - Utklippan 2023
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6
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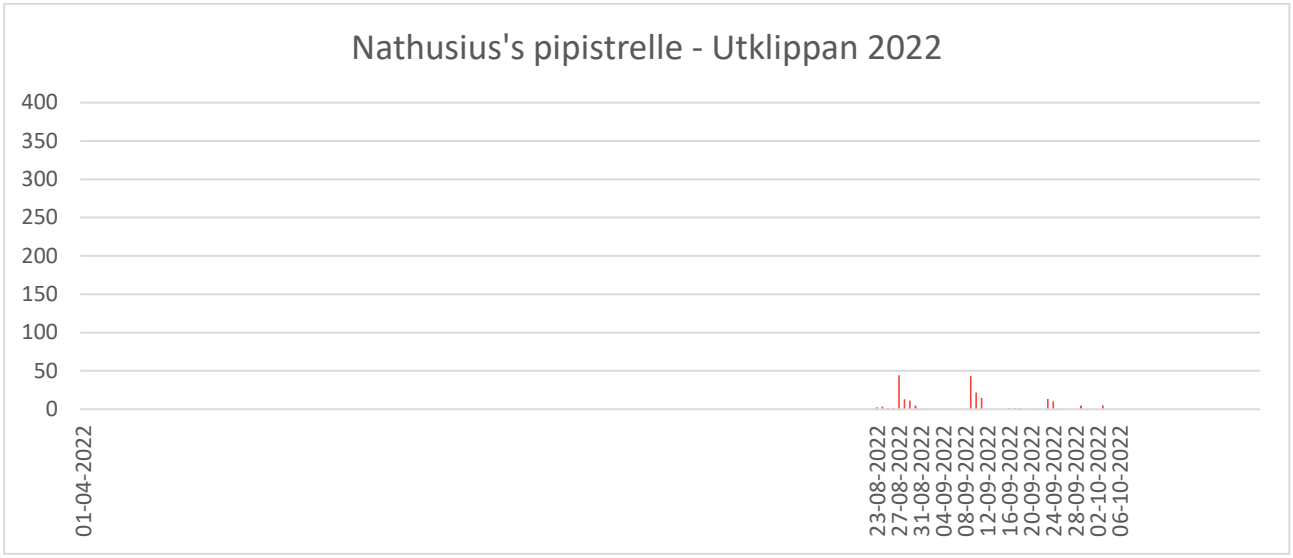
Nathusius's pipistrelle - Utklippan 2022
400
350
300
250
200
150
100
50
0
01-04-2022
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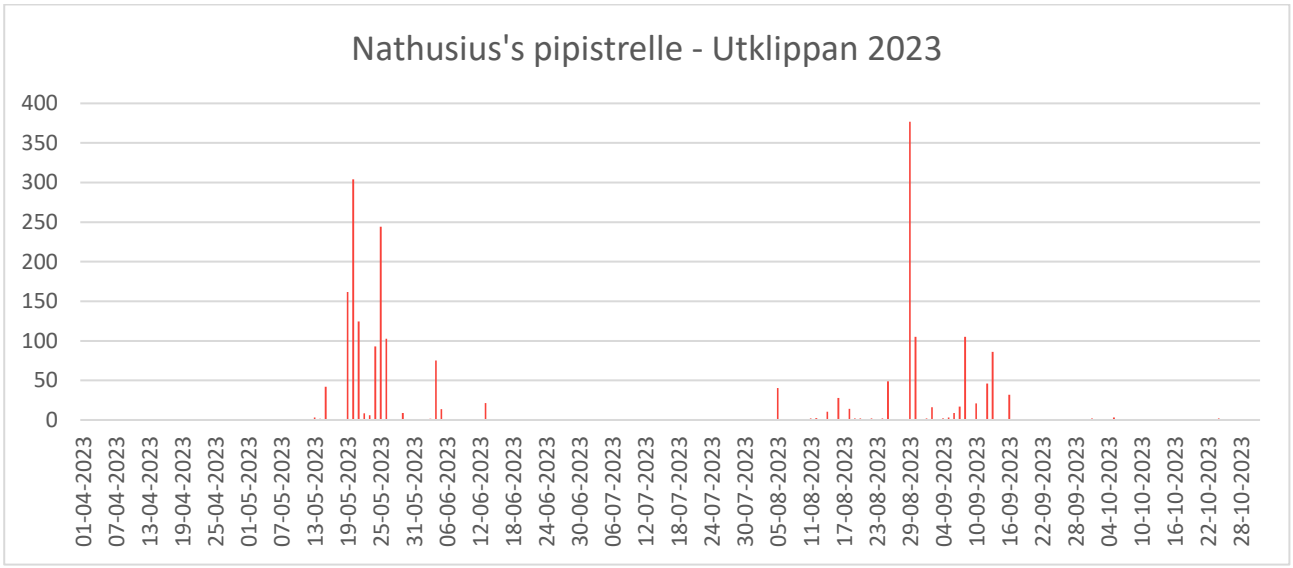
Nathusius's pipistrelle - Utklippan 2023
400
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100
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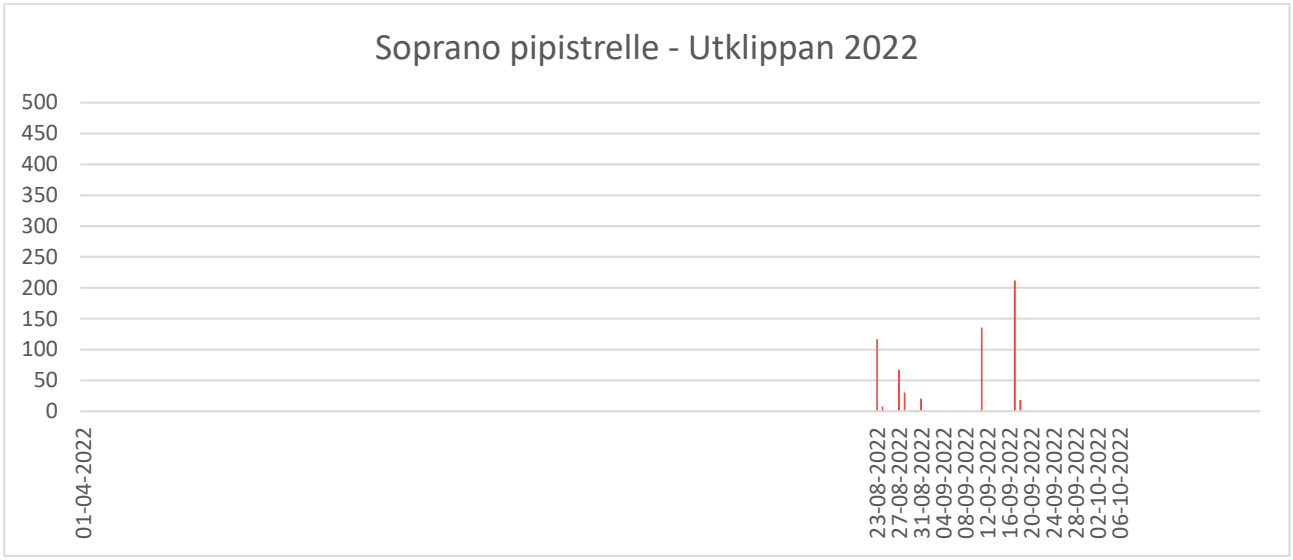
Soprano pipistrelle - Utklippan 2022
500
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250
200
150
100
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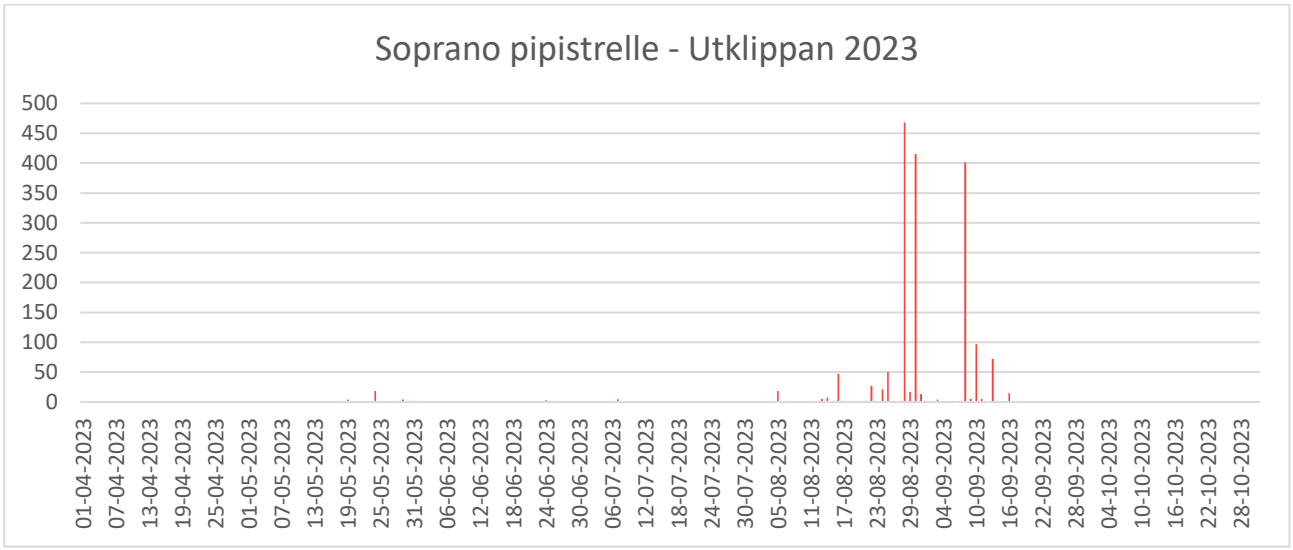
Soprano pipistrelle - Utklippan 2023
500
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01-04-2023
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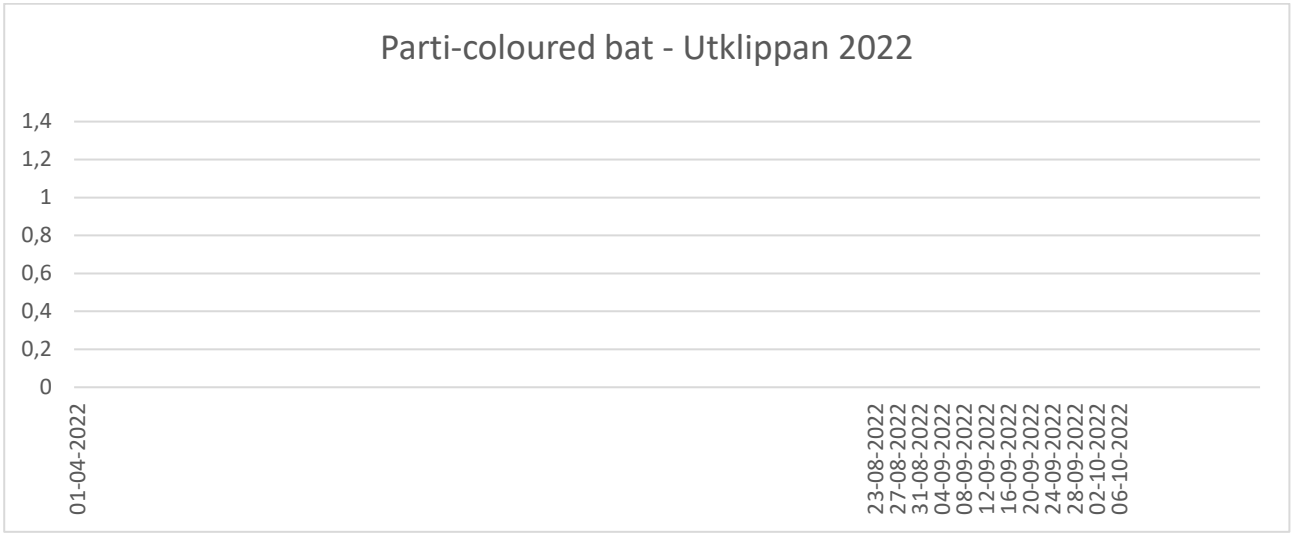
Parti-coloured bat - Utklippan 2022
1,4
1,2
1
0,8
0,6
0,4
0,2
0
01-04-2022
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31-08-2022
04-09-2022
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28-09-2022
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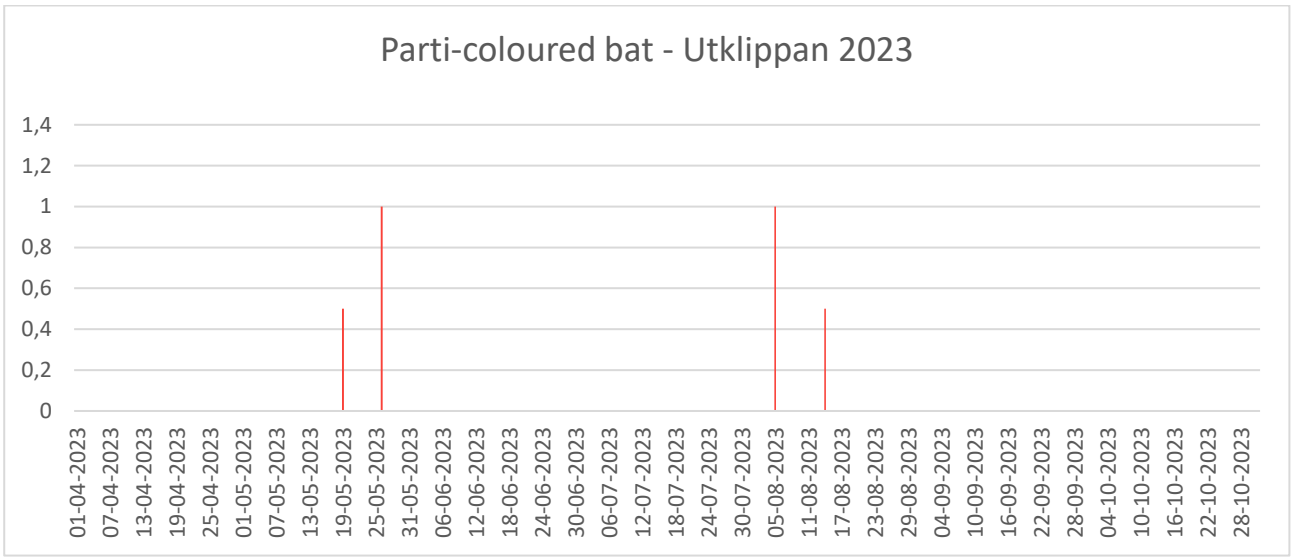
Parti-coloured bat - Utklippan 2023
1,4
1,2
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0,8
0,6
0,4
0,2
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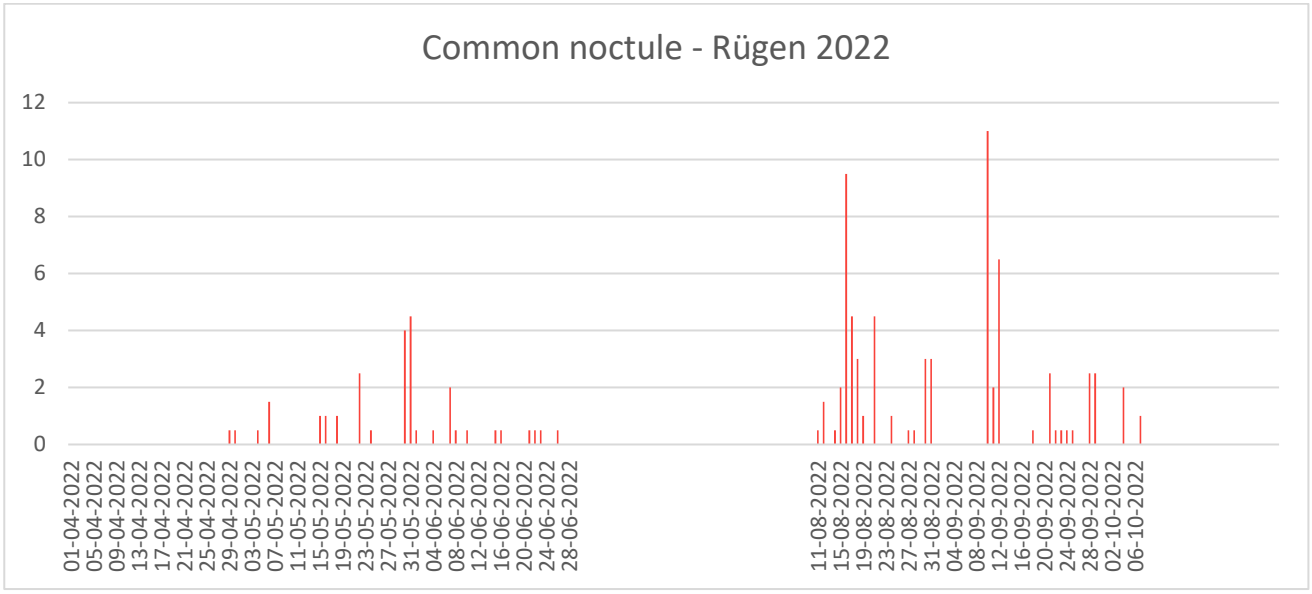
Common noctule - Rügen 2022
12
10
8
6
4
2
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13-04-2022
17-04-2022
21-04-2022
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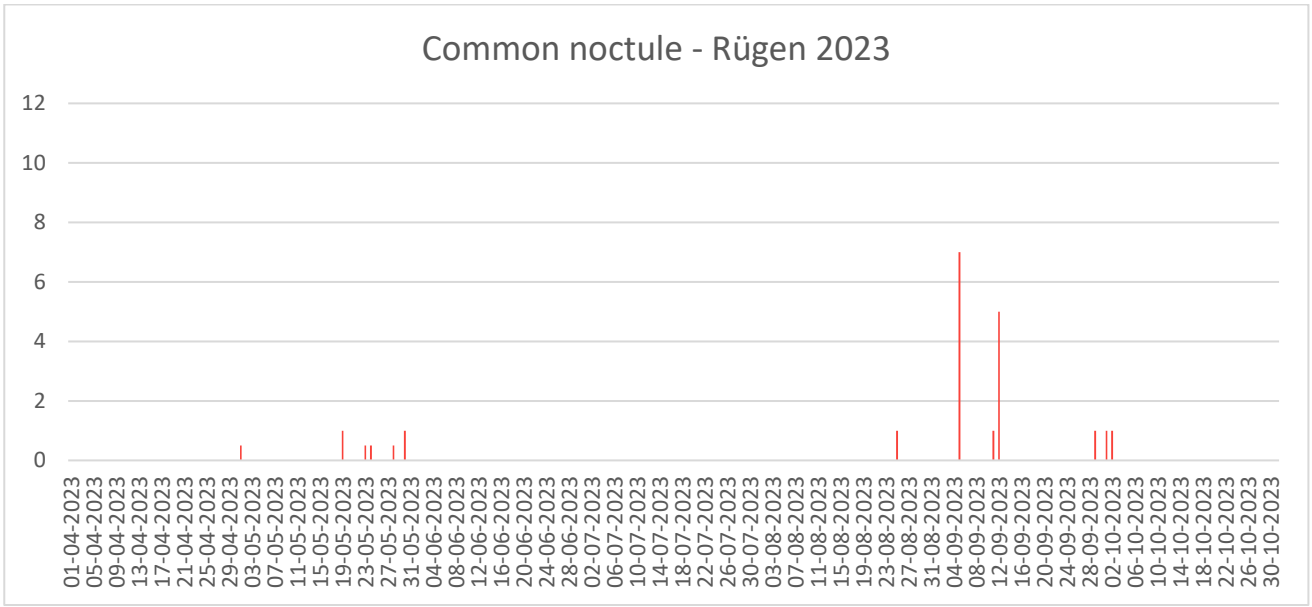
Common noctule - Rügen 2023
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10
8
6
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2
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05-04-2023
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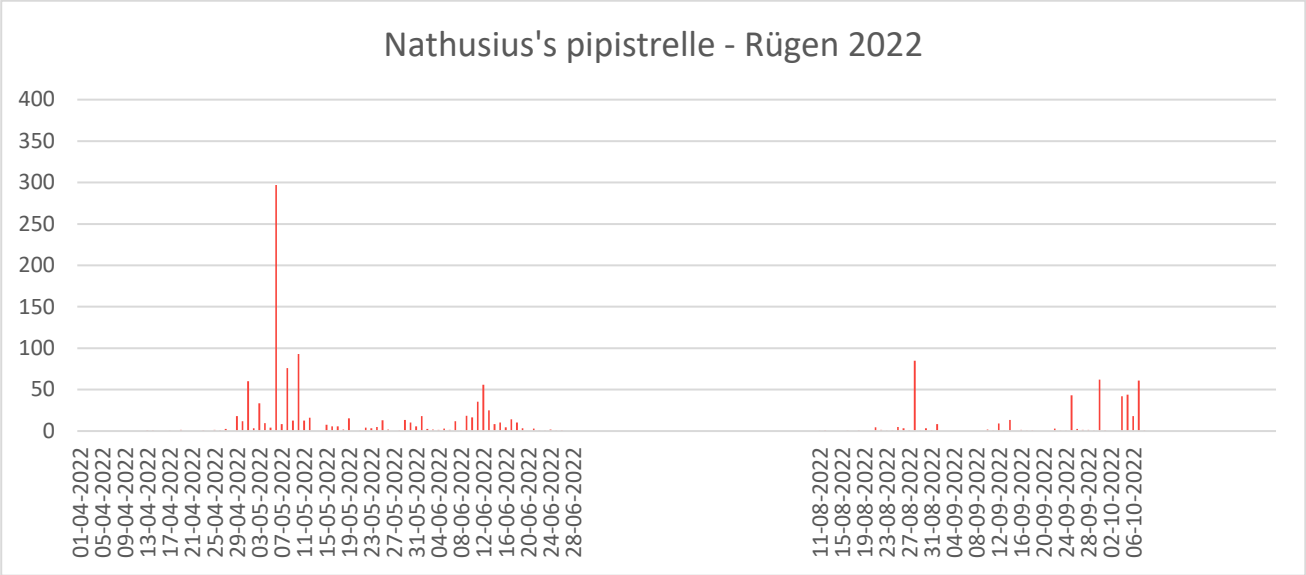
Nathusius's pipistrelle - Rügen 2022
400
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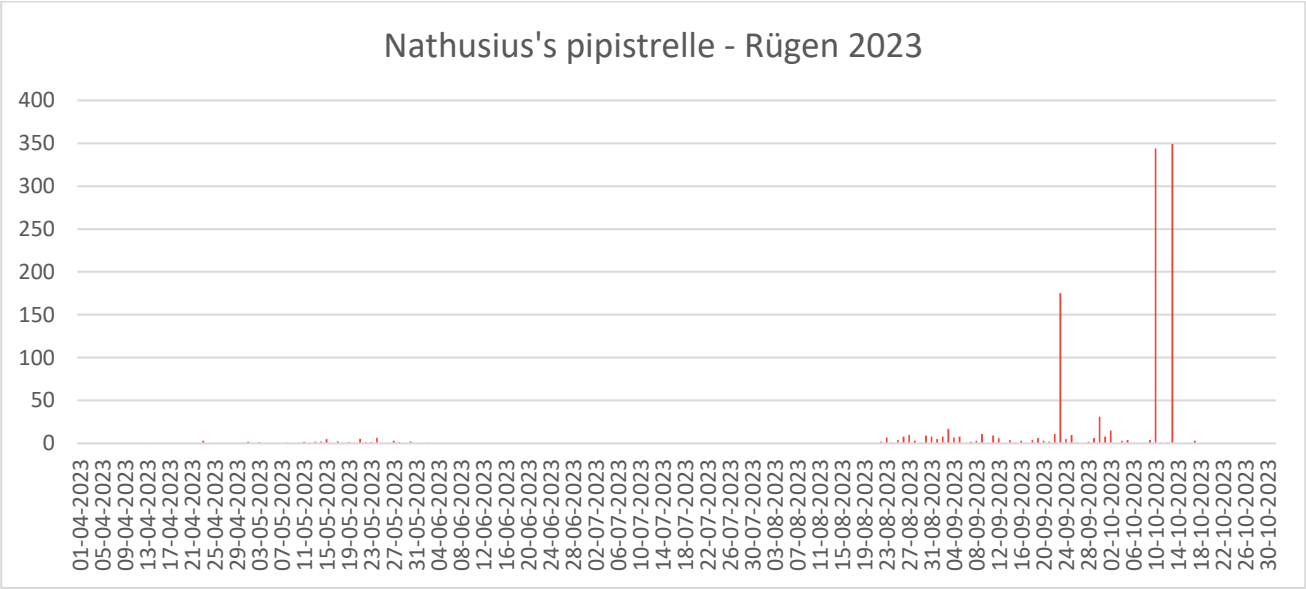
Nathusius's pipistrelle - Rügen 2023
400
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01-04-2023
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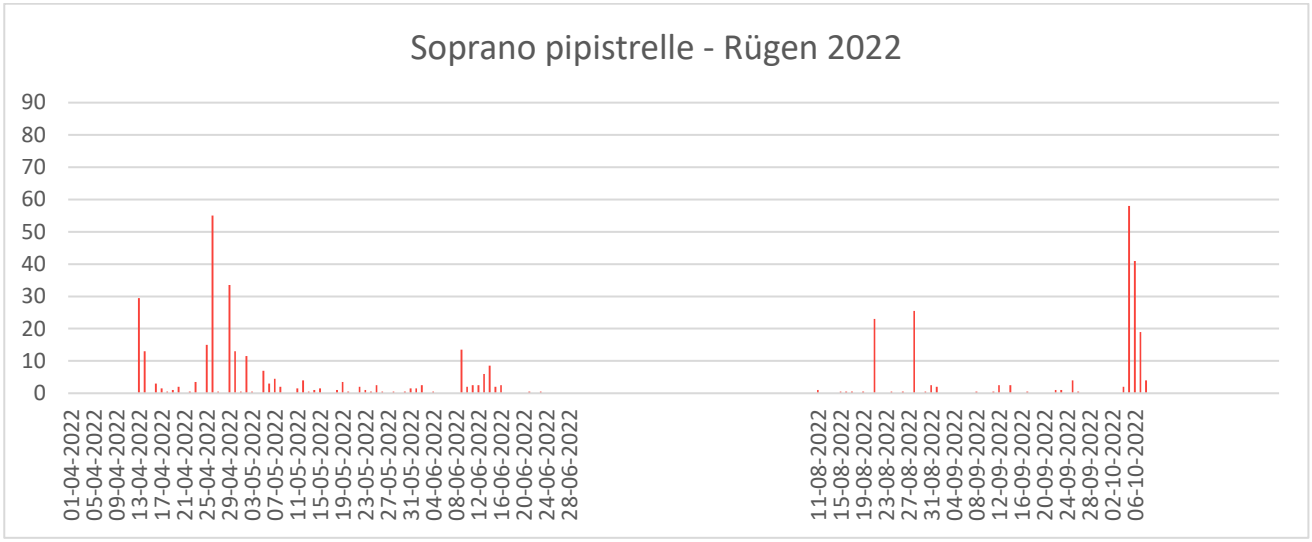
Soprano pipistrelle - Rügen 2022
90
80
70
60
50
40
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01-04-2022
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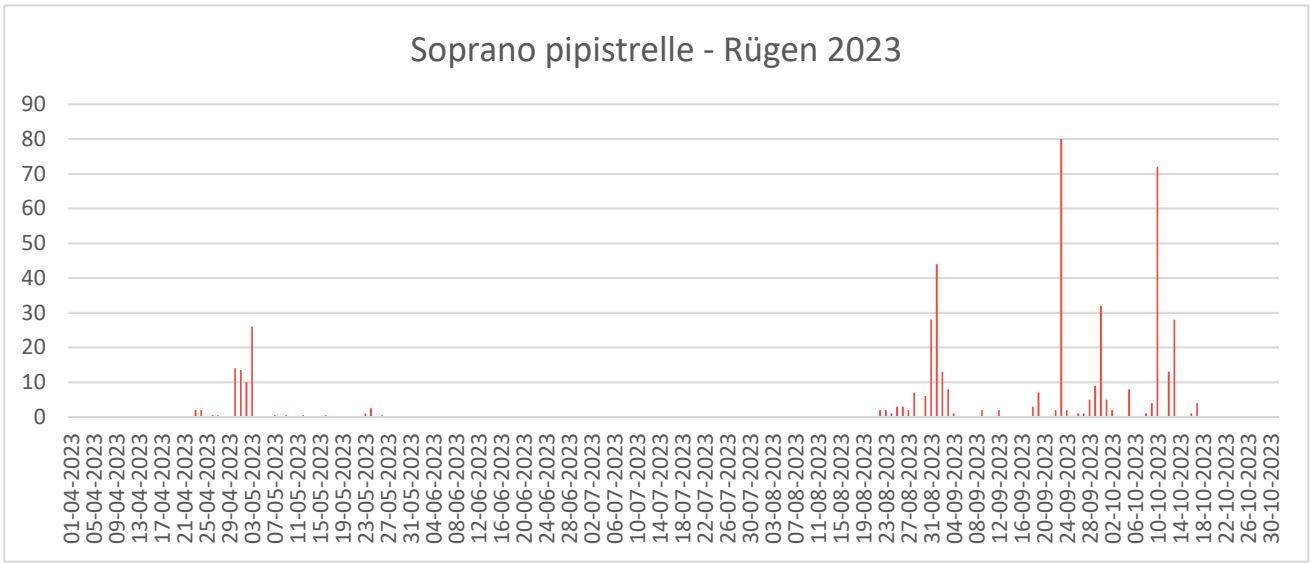
Soprano pipistrelle - Rügen 2023
90
80
70
60
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01-04-2023
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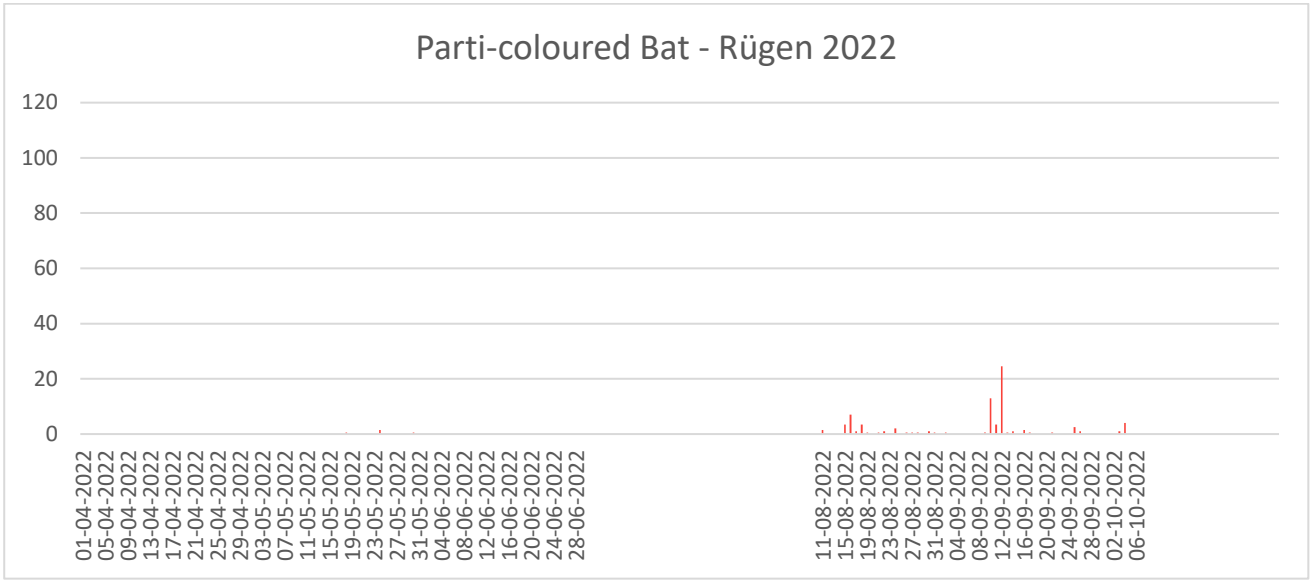
Parti-coloured Bat - Rügen 2022
120
100
80
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0
01-04-2022
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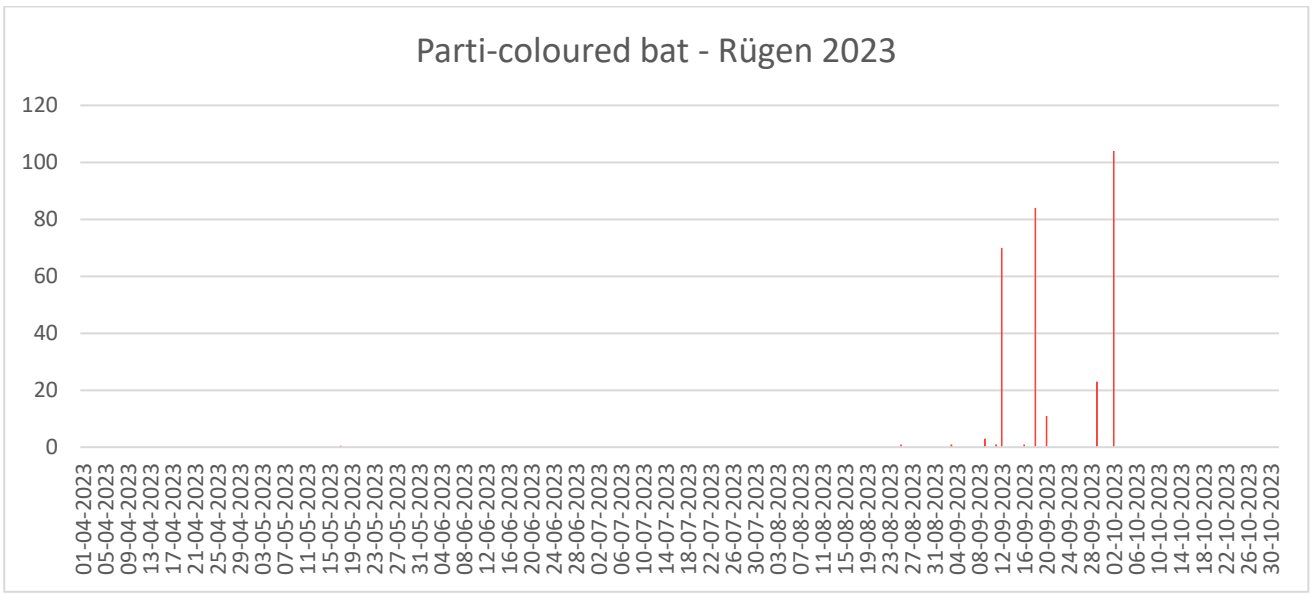
Parti-coloured bat - Rügen 2023
120
100
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01-04-2023
05-04-2023
09-04-2023
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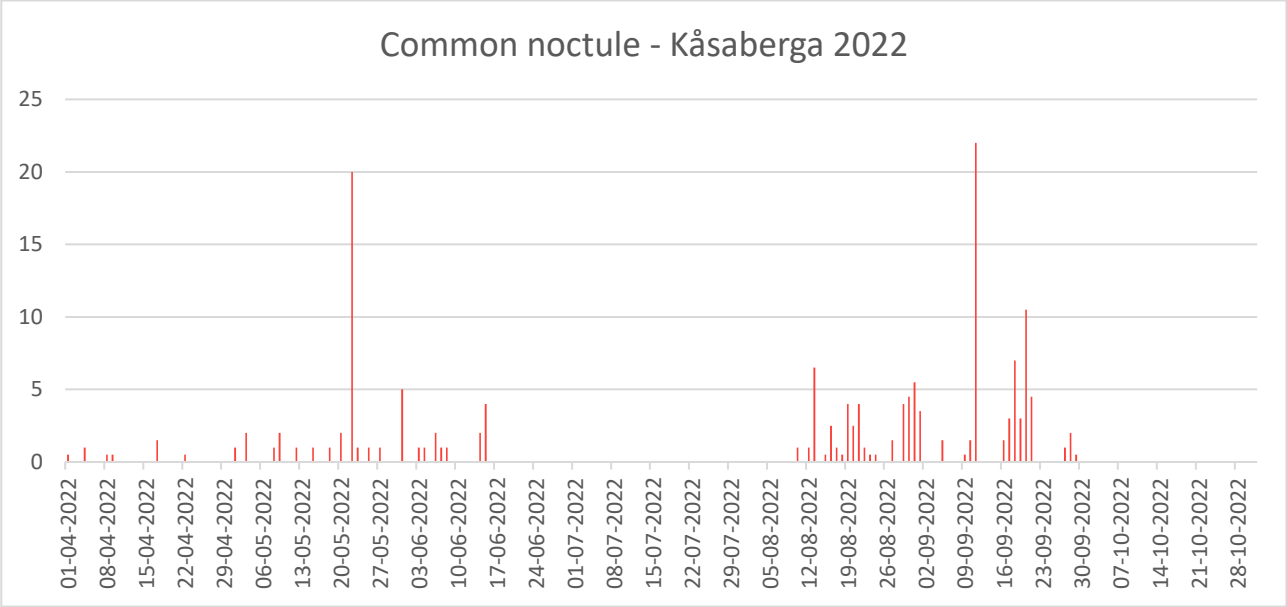
Common noctule - Kåsaberga 2022
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5
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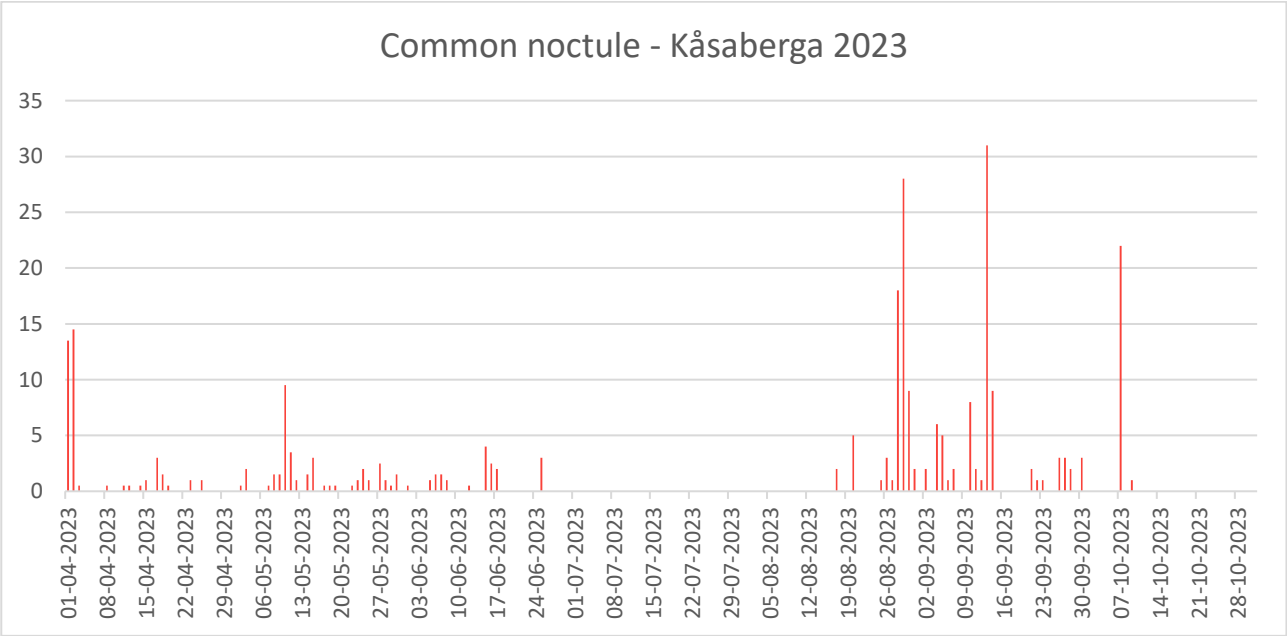
Common noctule - Kåsaberga 2023
35
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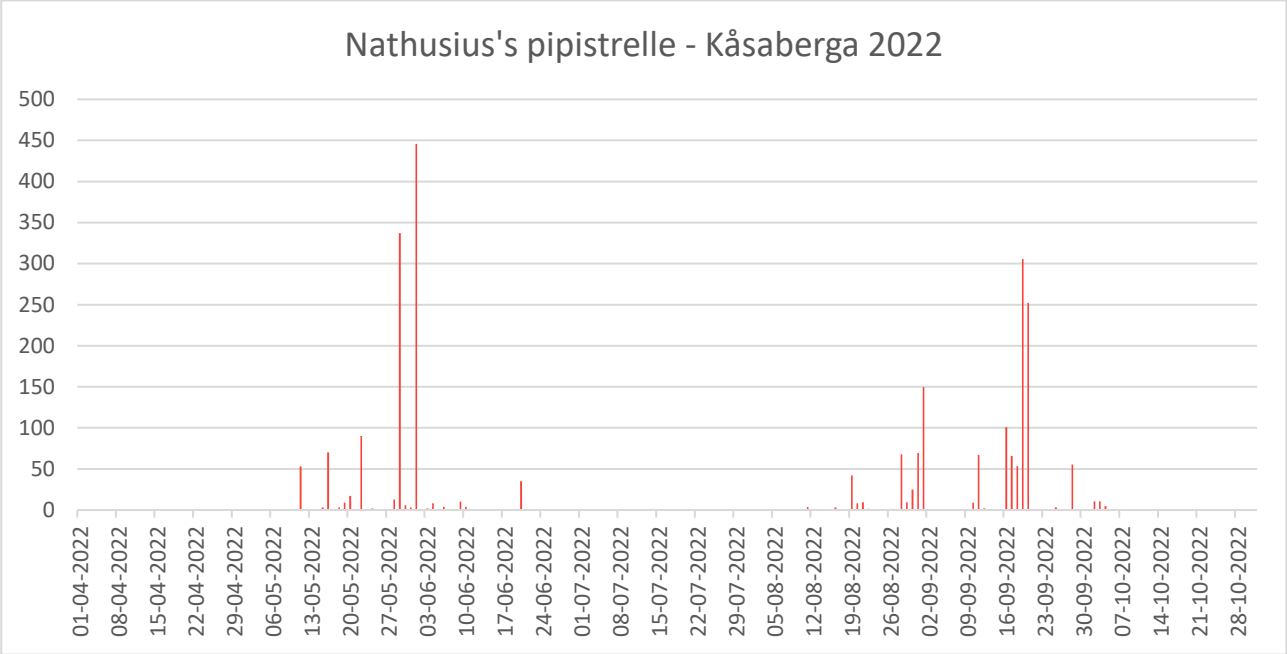
Nathusius's pipistrelle - Kåsaberga 2022
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450
400
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300
250
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100
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08-04-2022
15-04-2022
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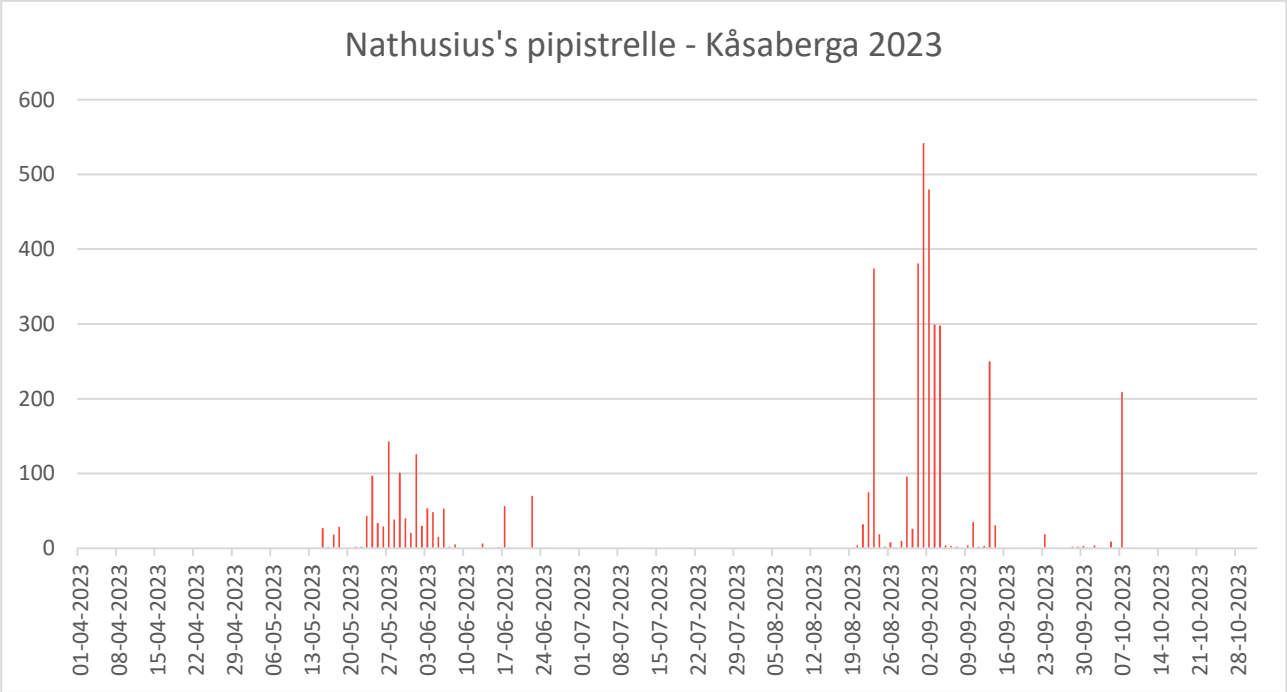
Nathusius's pipistrelle - Kåsaberga 2023
600
500
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01-04-2023
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22-04-2023
29-04-2023
06-05-2023
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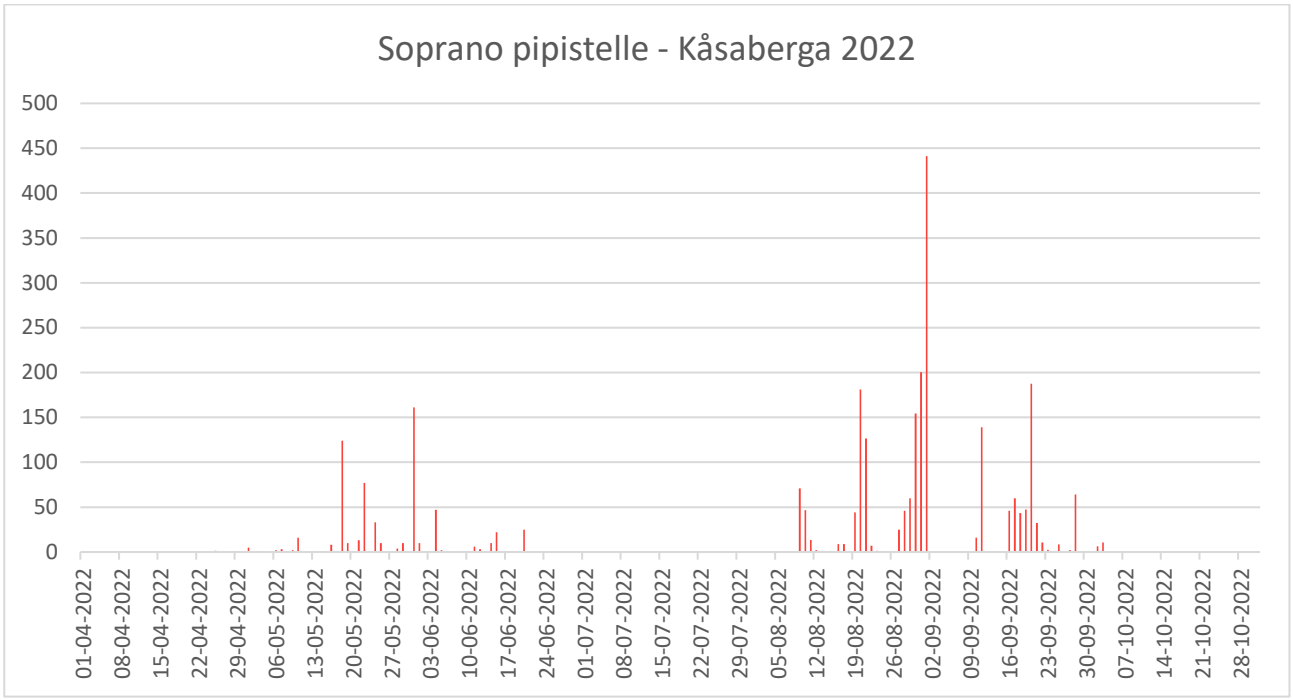
Soprano pipistelle - Kåsaberga 2022
500
450
400
350
300
250
200
150
100
50
0
01-04-2022
08-04-2022
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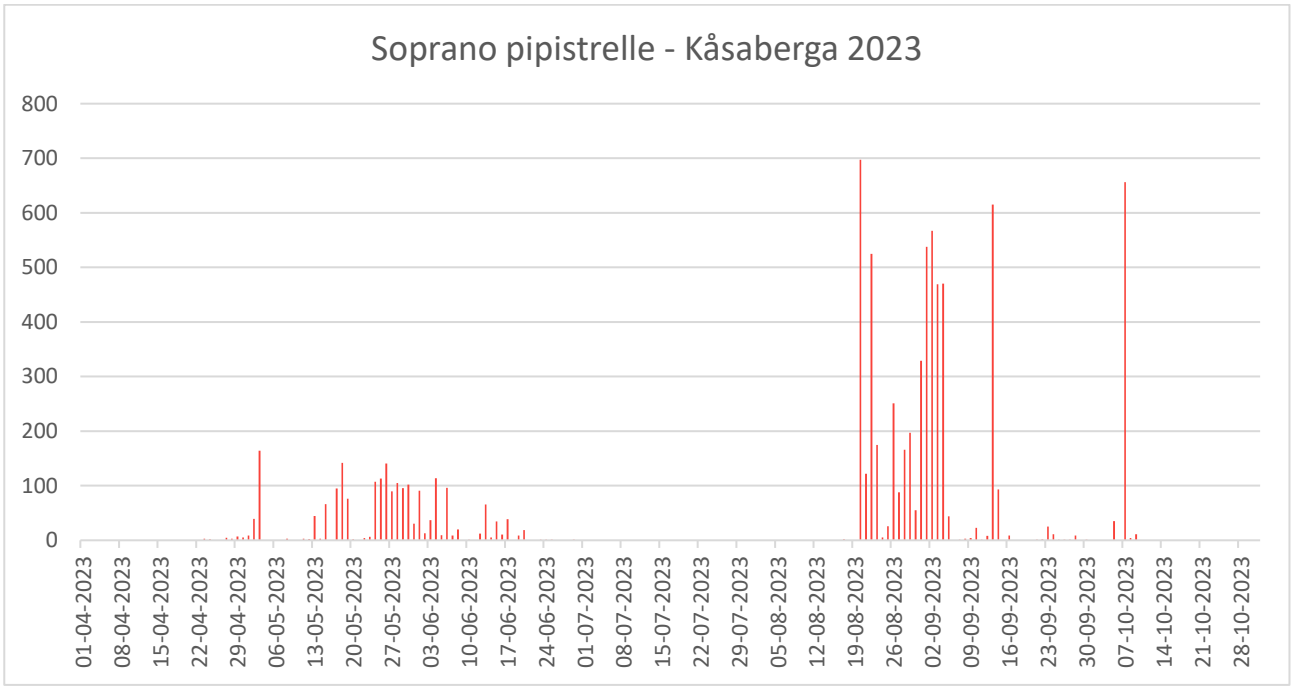
Soprano pipistrelle - Kåsaberga 2023
800
700
600
500
400
300
200
100
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22-04-2023
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06-05-2023
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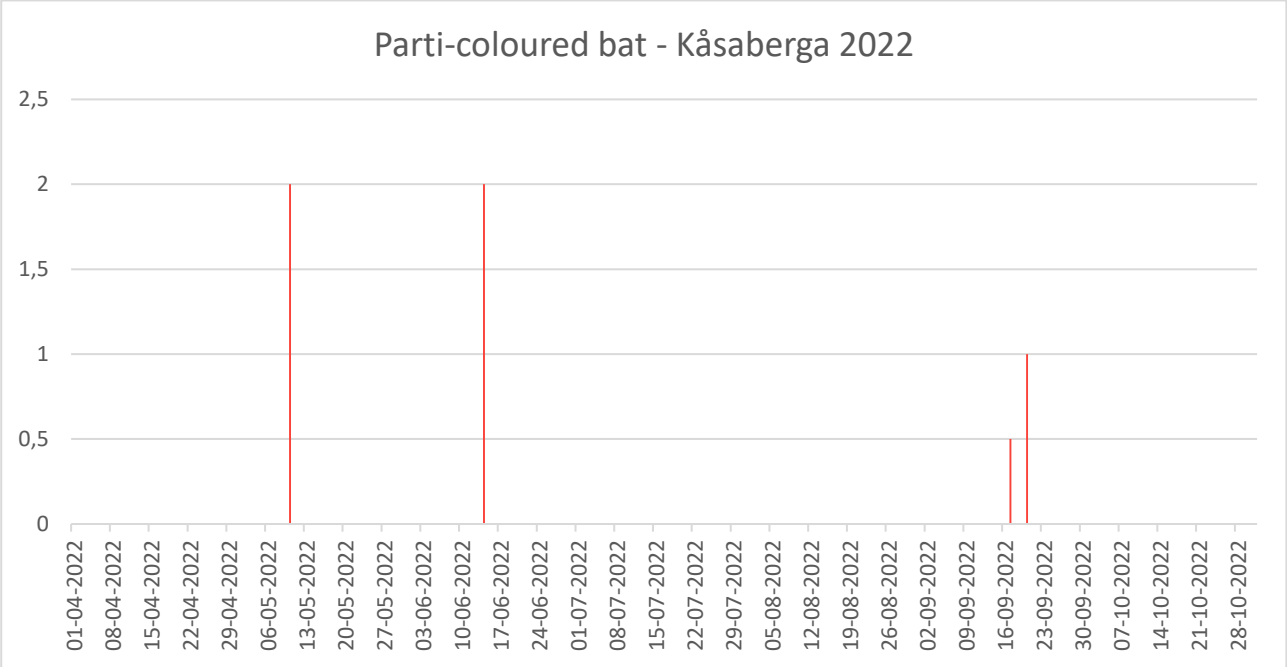
Parti-coloured bat - Kåsaberga 2022
2,5
2
1,5
1
0,5
0
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08-04-2022
15-04-2022
22-04-2022
29-04-2022
06-05-2022
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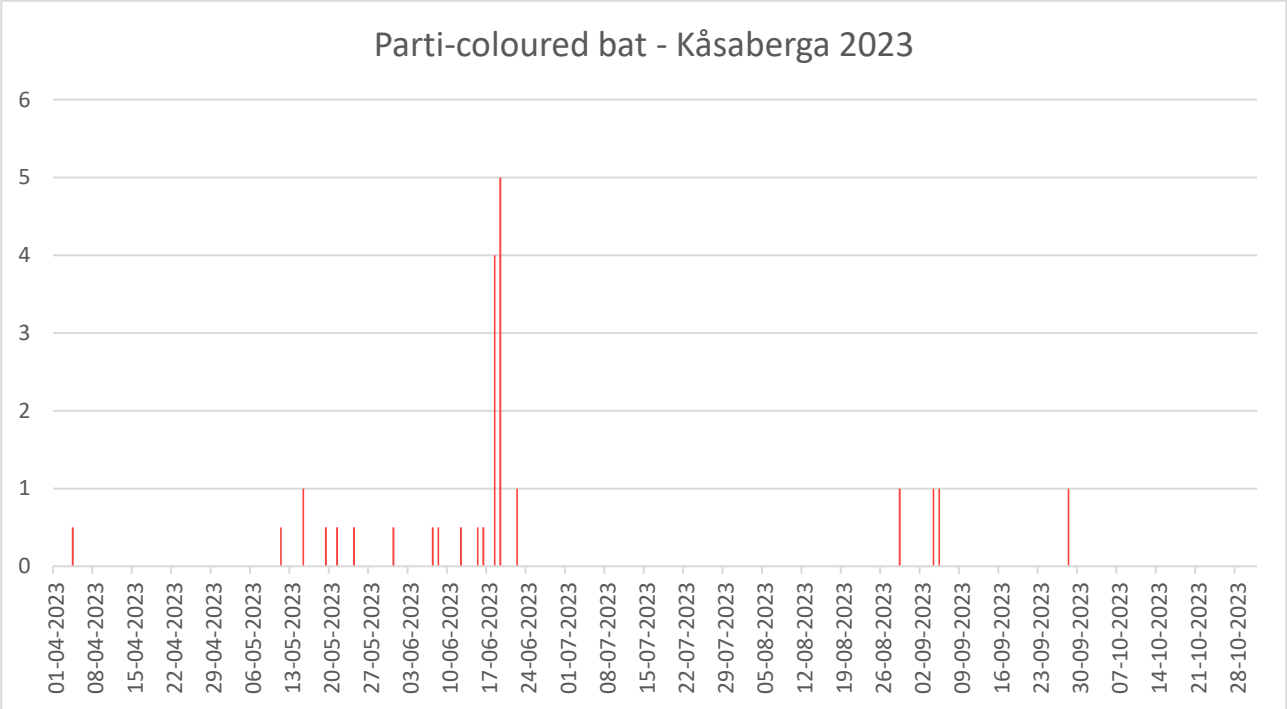
Parti-coloured bat - Kåsaberga 2023
6
5
4
3
2
1
0
01-04-2023
08-04-2023
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22-04-2023
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