ENERGINET ELTRANSMISSION A/S

KRIEGERS FLAK II (NORTH AND SOUTH)

OFFSHORE SURVEYS OF BIRDS, BATS AND MARINE MAMMALS FOR OFFSHORE WIND FARMS IN DANISH WATERS.

TECHNICAL REPORT BIRDS

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INDHOLD

Abbreviation	Explanation
AEWA	Agreement on the Conservation of African-Eurasian Migratory Waterbirds
BSH	Bundesamt für Seeschifffahrt und Hydrographie (Federal Maritime and Hydrographic Agency of Germany)
CSR	Conservation status report
DHI	Dansk Hydraulisk Institut (Danish Hydraulic Institute)
EEA	European Environment Agency
GLS	Global location sensor
GPS	Global positioning system
GW	gigawatts
HELCOM	Baltic Marine Environment Protection Commission (Helsinki Commission)
HIDEF	Hidef Aerial Survey Ltd.
IUCN	International Union for Conservation of Nature
MTR	Mean traffic rate
OWF	Offshore wind farm
SPA	Special Protected Area

1 SUMMARY

1.1 INTRODUCTION

In order to accelerate the expansion of Danish offshore wind production, it was decided with the agreement on the Finance Act for 2022 to offer an additional 2 GW of offshore wind for establishment before the end of 2030. In addition, the parties behind the Climate Agreement on Green Power and Heat 2022 of 25 June 2022 (hereinafter Climate Agreement 2022) decided), that areas that can accommodate an additional 4 GW of offshore wind must be offered for establishment before the end of 2030. Most recently, a political agreement was concluded on 30 May 2023, which establishes the framework for the Climate Agreement 2022 with the development of 9 GW of offshore wind, which potentially can be increased to 14 GW or more if the concession winners – i.e. the tenderers who will set up the offshore wind turbines – use the freedom included in the agreement to establish capacity in addition to the tendered minimum capacity of 1 GW per tendered area.

In order to enable the realization of the political agreements on significantly more energy production from offshore wind before the end of 2030, the Danish Energy Agency has drawn up a plan for the establishment of offshore wind farms in three areas in the North Sea, the Kattegat and the Baltic Sea respectively.

The area for Kriegers Flak II Offshore Wind Farm (KF II OWF) consists of two sub-areas: North and South. The areas are located 25-50 km off the coast of South Zealand and Møn. KF II North is located approximately 15 km from the east coast of Møn, while KF II South is located approximately 30 km southeast of Møn. The area for the KF II OWF is approximately 175 km^2, divided into 99km^2 for North and 76km^2 for South. The KF II OWF will be connected to land via subsea cables making landfall close to Rødvig on the south-east coast Zealand.

This report presents the results for the proposed areas KF II OWF (North and South) from the first year between February 2023 and January 2024.

1.2 OBJECTIVES AND METHODOLOGIES

Resting birds:

We define resting birds in this report as all birds regularly staying the pre-investigation area for the planned KFII OWF either for resting, feeding or regular stop-over during their movements between breeding and winter areas or between different feeding areas. To determine the abundances, densities, and spatial distribution of resting birds in the pre-investigation area it is important to use a method, which is able to cover huge areas within a short time period with a high spatial resolution. For this aim digital aerial surveys are the best available method so far. We undertook four digital aerial surveys specifically planned to record resting birds, in the 1st survey-year of this project. Additionally, two digital aerial surveys were conducted to specifically determine the presence of marine mammals. Since the transect lines and the methodology to record birds and marine mammals are the same, data from all six surveys could be used for both, birds and marine mammals. Results of all aerial surveys for marine mammals are presented in the technical report for marine mammals.“. The present report contains data from all six surveys from the first study year. The digital aerial surveys were conducted in February, April, June, August, October and December 2023 using digital video technology developed by the company HiDef (https://www.hidefsurveying.co.uk/). A plane equipped with four digital video cameras flew over 13 transects that covered a total area of 3,739 km² while taking video footage (10 pictures/minute) that was later processed and analysed to detect and identify any resting bird (and marine mammals) present in the images.

Migrating birds:

Migrating birds are all birds which fly across the pre-investigation area regularly on their movements between wintering and breeding grounds. Bird migration was investigated by means of vessel-based investigations in the two separated areas of the planned KF II OWF by visual observations during daylight, acoustic observations during nights, and standardised simultaneously recordings of bird echoes by vertical and horizontal radar devices. We expected for the areas of the KF II OWF project some differences especially between spring and autumn migration between the two sub-areas, since the northern area is located directly between the well-known bird watching site Falsterbo in southern Sweden and the Danish island of Møn. Therefore, it can be assumed that especially during autumn, diurnal migrants like cranes or raptors try to cross the area with shortest distance between the coastlines and thus occur in higher numbers in the northern area, whereas in spring no differences are expected since birds leaving the island of Rügen and possibly occur in both areas. We have therefore adjusted the number of observation days according to these expectations and collected data for 35 observation days for the northern proposed wind farm sub-area and for 22 observation days with special focus on crane and raptor migration in the southern windfarm sub-area. Accordingly, data in the southern area was collected during the proposed peak periods of crane and raptor migration in March/April and September/October.

The vessels used for bird investigations were centrally anchored within the proposed areas of KF II OWF for 35 24-hour days in the northern sub-area and 22 24-hour days in the southern sub-area divided into one to two surveys per month (March-May and August-November).

Through the analysis of all the collected data, information on migration intensity, flight altitude and distribution, temporal patterns and species composition during day and nocturnal migration could be investigated.

1.3 RESULTS

Resting birds:

A total of 25,621 resting birds belonging to 22 species were registered during the six digital aerial surveys in the pre-investigation area KF II OWF (both areas). Sea ducks dominated the resting bird community and represented 81% of all resting birds during all the survey period, of which the following three species were the most common ones: common eiders (35.4%), common scoters (34.7%) and long-tailed ducks (7%). After sea ducks, gulls were the second most common group of resting birds seen in the area, representing 7.5% of all resting birds and herring gulls was the most common species (2.9% of all resting birds). Auks, represented by similar numbers of common guillemots and razorbills accounted for the third most common group of resting birds encountered in the area (~4%).

Sea ducks occurred in high densities especially in the season-specific spring and winter and where mostly spatially distributed towards the western part of the survey area (shallower waters). Nonetheless, common eiders were very widespread spatially throughout the survey area, especially in spring when they were commonly found also within the areas of KF II N and S.

Gulls were distributed sparsely but all over the survey area at offshore locations and at coastal regions and also throughout the year. Auks were more abundant in winter and in spring and occurred in offshore regions, at high densities especially in the middle of the survey area. Cormorants were mostly concentrated close to the island of Møn and the peninsula Falsterbo but were also able to conquer the transformer stations within the existing OWF as new resting places.

Migrating birds:
A total of 15,841 diurnally migrating birds were observed in the KF II OWF northern area with similar numbers of migrating birds were registered for both seasons in 2023 (7,854 in spring and 7,987 in autumn). However, more species were identified in autumn than in spring (94 vs 62 species, respectively). Geese and ducks were the most abundant groups. Geese, of which barnacle goose was by far the most common species represented 50.6% and 36.9% of all migrating birds while ducks represented roughly 30% in each season, with two species being very common (common scoters and common eiders). Songbirds were the third most common group of migrating birds in autumn (12.4%), but in spring were less abundant than other groups such as gulls and cormorants.

In the southern area, three times as many diurnally migrating birds were registered: 45,637 migrating birds with many more occurring in spring than in autumn (27,355 vs. 18,282), with geese and ducks making up for even a larger proportion of all migrating birds so that other groups were in comparison much less abundant. Geese, mainly barnacle geese, made up for 83% and 59% of all migrating birds in spring and autumn, respectively whereas ducks represented 13% and 25% of all migrating birds in the same seasons respectively. Songbirds were the third most important group overall and represented again 12.4% of all migrating birds in autumn, but only 1.5% of all migrating birds in spring.

Migration intensity in the northern area was lower than in the southern area and similar for both seasons. Mean values were 72.7 and 82.8 ind./h in spring and autumn, respectively, with a maximal value of 340 ind./h on the 14th of May (spring) and 201 ind./h on the 13th of November (autumn). In the southern area, higher mean migration intensities were registered: 281 ind./h in spring and 357 ind./h in autumn. Also, much higher peak values were observed than in the northern area but at similar levels for spring and autumn: 1663 ind./h and 1645 ind./h were registered on the 17th of May (spring) and the 18th of October (autumn) respectively.

In general, most migrating birds were observed flying at low altitudes in the northern area, with 71% and 49% of all birds in spring and autumn, respectively flying up to 5 m above sea level. Less than 20% and about 25% of all migrating birds flew above 20 m above sea level in spring and autumn respectively in this area. In the southern area, in spring, most birds flew at an altitude between 20 and 50 m (mainly geese) and only 38% of all birds flew below 20 m, whereas in autumn, most birds (65%) flew below 20 m.

The flying direction of all birds in spring (both areas) was mainly and clearly the NE. In autumn, birds flew towards the SW but a large proportion flew also to the west, especially in the northern area.

In general, there were more calls heard in autumn than in spring in both areas and songbirds were by far the most abundant species group with the group of thrushes (*Turdus spp*.) being often more abundant than other songbirds (except during autumn migration in the southern area). Other groups that were relatively common were gulls (spring in the northern area) and waders, and to a lesser extent ducks. Common species were redwings, song thrushes and European robins.

Flying directions obtained from the horizontal radar agree with the directions obtained from visual observations and were also concordant between day and night for each season, with birds flying more towards the NE in the northern area and more towards the east in the southern area during spring, and towards the SW in autumn (closer to the west in the northern area, and SWW in the southern area).

Vertical radar data showed that nocturnal migration was

1.4 CONCLUSIONS

The results from the first year of a two-year baseline study reveals first valuable information on the presence and distribution of resting and migrating birds in the pre-investigation area for the proposed areas of KF II OWF. Results for the resting birds show that, in line with existing data sea ducks, especially eider, common scoter and long-tailed ducks are the most abundant species in the pre-investigation area with highest concentrations close to the coast and along a stripe between the northwest tip of Rügen and the island Møn. Only few sightings occurred within the proposed areas for KF II OWF. Long-tailed ducks were regularly observed within the existing OWF at Kriegers Flak.

Gulls, the second most common species group were distributed clearly along the coastline. Auks occurred widely distributed over the whole pre-investigation area and also within the proposed OWF areas. Divers (primarily red-throated diver) were observed mainly less offshore in shallower water depths close to the coast.
Comorants have been observed in high concentrations close to coast and very locally within the existing OWF at Kriegers Flak using the platforms of the turbines for resting.

Data from the second year will provide information if seasonal and spatial patterns observed for the studied resting bird species will be consistent over time.

For migrating birds results show that the pre-investigation area is crossed by migrating birds in quite high numbers compared to areas in the North Sea and other areas in the western Baltic Sea (e.g., the Pomeranian Bay). Overall migration intensity during night and day was contrary to what was expected, higher at the southern anchor position compared to the northern position. Both areas are part of the coastal diurnal migration with geese (barnacle goose) and ducks (common scoter and common eider) as the most dominant species occurring in high numbers on certain days with good migration conditions. Whereas ducks mostly fly below 20 m geese were frequently observed at altitudes above 50 m.

Birds of prey were frequently observed as expected but compared to the most abundant species like geese and ducks in much smaller numbers (6-105 individuals each season). Cranes were also observed in spring (47 -64 individuals) but in lower numbers compared to the other abundant groups. Songbirds as part of the diurnal migration crossed the area regularly but also at night. Results from both, the vertical radar and the bird calls suggest that the pre-investigation area is part of the broadband nocturnal migration route for passerines. Flight height distribution between 0 and 1,000 m shows that during day the lower level below 100 m is the level with highest bird migration intensity. At night birds were more evenly distributed and highest intensity occurred between 900-1000 m (KF II N) and between 300-400 m (KF II S), which suggests that a large proportion of the bird migration took place outside our survey, i.e. above 1,000 metres. The distribution of birds during a 24h day show, that the nocturnal migrants arrived at the positions inside the proposed OWF areas one hour after sunset and highest Migration Traffic Rates (MTR) occurred in the first half of the night before the migration intensity gradually decreased until sunrise. During the day light phase migration was significantly reduced compared with nights and highest MTR was measured in the first hours after sunrise. The hour with lowest migration was always the hour before sunset. This pattern reflects the typical migration pattern from offshore areas with a high flux of nocturnal migrants. A second year will give information about whether the results showing common pattern or only the result of the specific year.

2 INTRODUCTION

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P

This report presents the results of a baseline investigation of birds, including resting and migrating birds for the proposed area KF II OWF (North and South) from the first year between February 2023 and January 2024. The

proposed OWF area is divided into two parts, KF II OWF-N in the north and KF II OWF-S in the south (

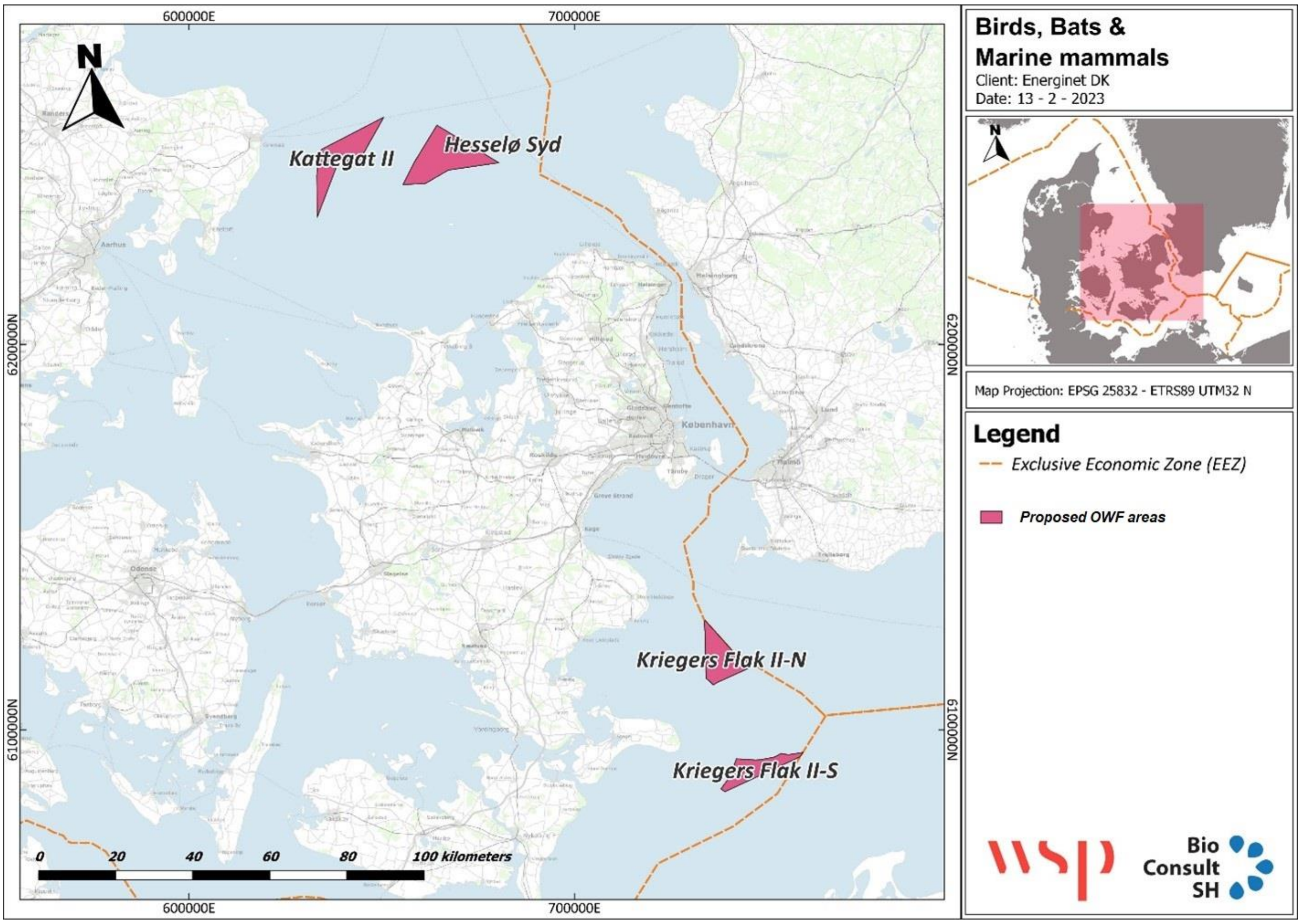


Figure 2-1

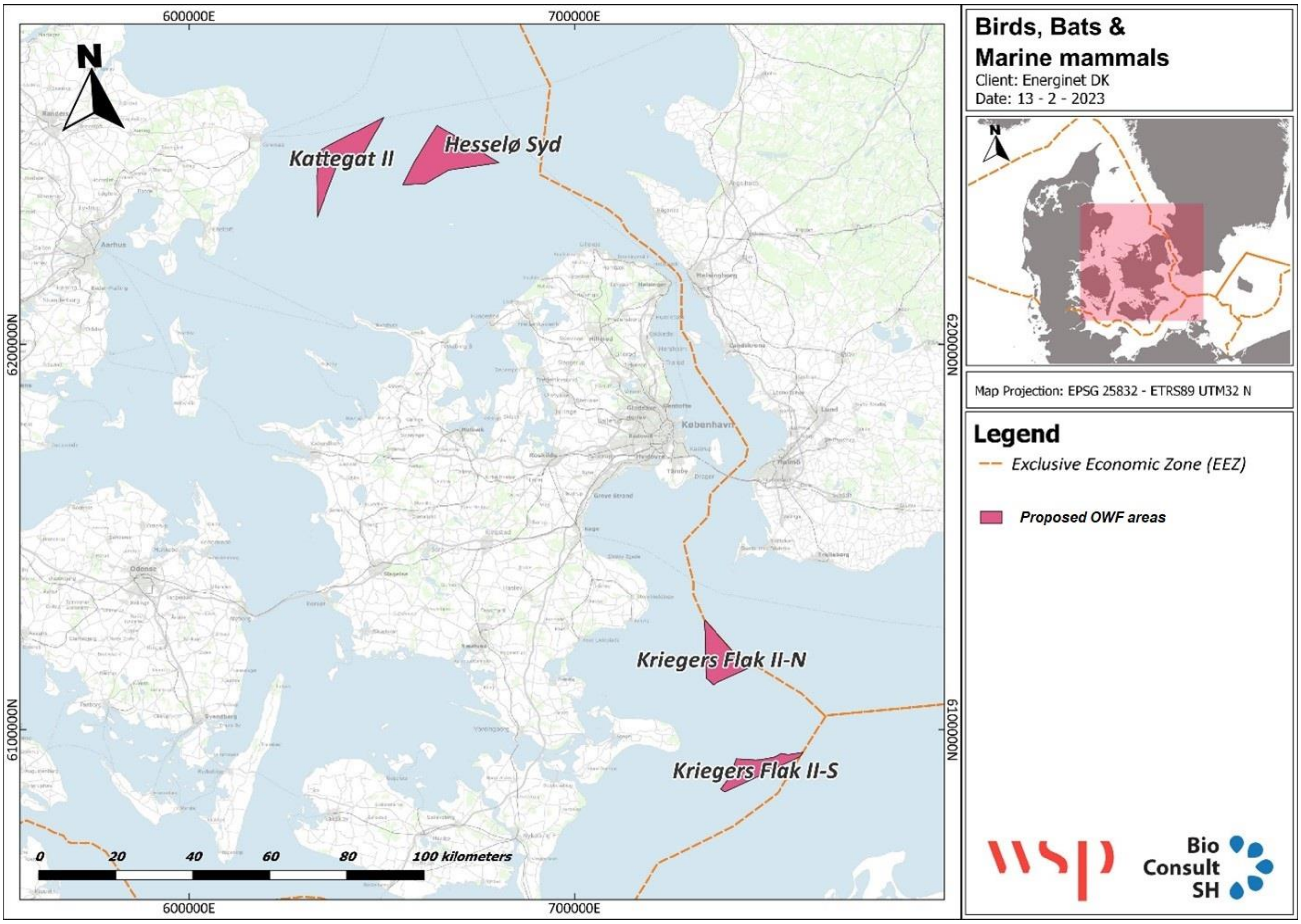


Figure 2-1). The pre-investigation area for birds and marine mammals covers both sites in one.

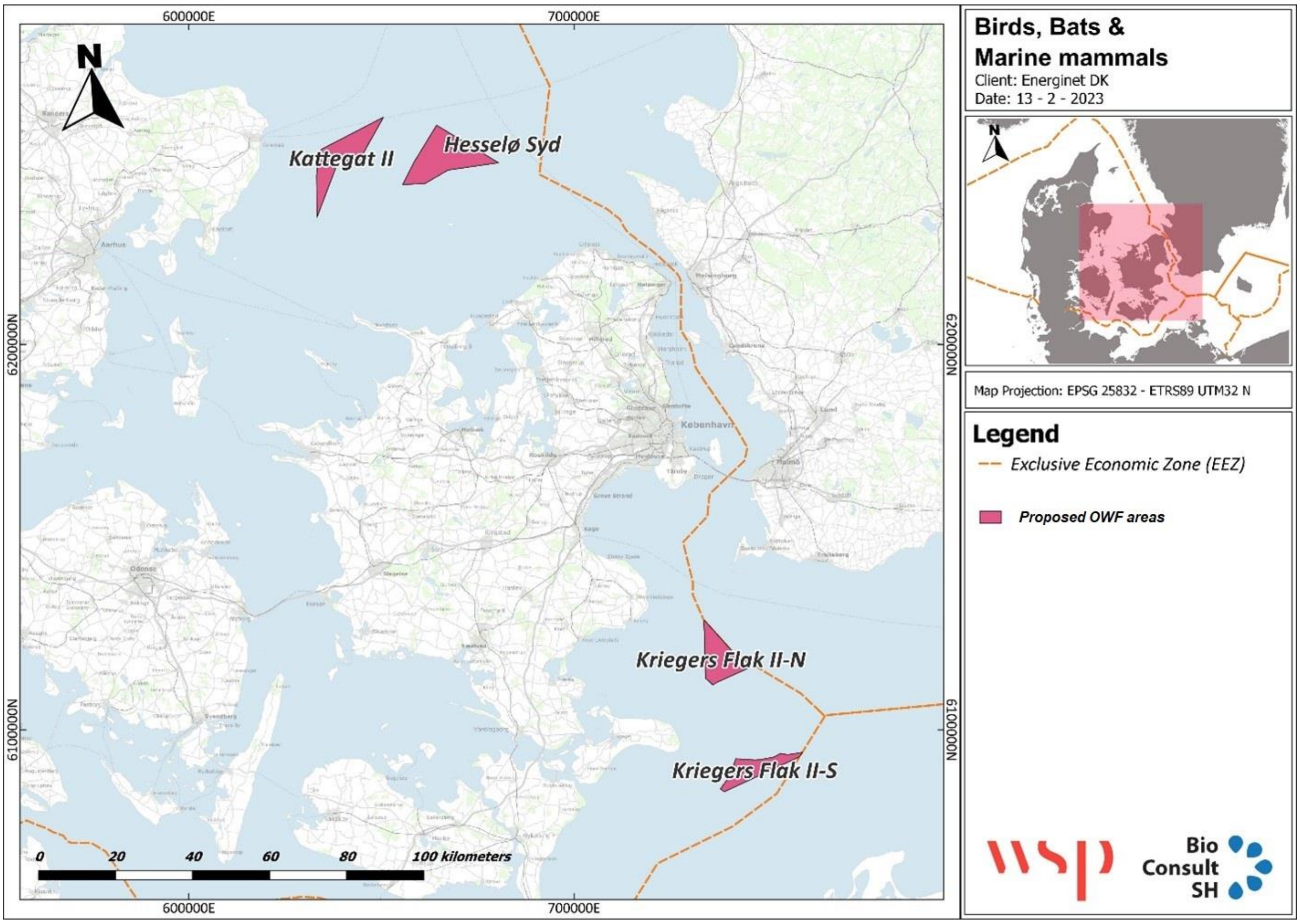


Figure 2-1. Map showing the location of the investigated wind farm areas Kattegat, Hesselø and KF II OWF. The present report focuses on KF II OWF.

The present report analyses the occurrence of birds in the pre-investigation area for KII OWF and is divided into one part focussing on resting birds and a second part focussing on migrating birds. Resting birds include seabirds resting and foraging in the pre-investigation area as well as assessing the suitability of the habitat at least during periods throughout the year. Migrating birds are bird species migrating through the pre-investigation area often twice a year on their seasonal movements between breeding and wintering grounds. For many of the terrestrial species, the sea is a biologically hostile habitat that needs to be crossed as quickly as possible in order to reach their breeding or wintering grounds. However, since many seabirds and other waterfowl are also migratory birds, the grouping is fluid and some of these species staying in the area but also crossing the pre investigation area will occur in both parts (resting and migrating) of this report.

The report is structured in such a way, that for both parts (resting and migrating birds), a compilation of data based on already available publications is given firstly, followed by a description of the methodological approach applied in order to attain the new data. Finally, the new data are brought into context based on the existing knowledge.

3 EXISTING DATA

A desktop study has been conducted by reviewing relevant literature including both peer-reviewed journals as well as publicly available “grey literature”. The considered publications included information on the general distribution and biology, as well as the abundance in the pre-investigation area of resting and migratory bird species. Species were selected as relevant, because they either commonly occur in and around the pre-investigation area or have a special conservation status. A detailed description of available information for the most relevant species groups of resting and migratory birds potentially present in the pre-investigation area is given.

Birds potentially utilising the pre-investigation area can be roughly divided into two groups: (i) resting birds, which are typically found within an area for long time periods, and (ii) migrating birds, which alternate between different distant regions such as breeding and wintering grounds and may therefore only cross an area temporarily. Migrating birds can be found among many different orders, such as songbirds, birds of prey or seabirds. Seabirds include a variety of species specifically adapted to marine environments. They generally breed in coastal regions or on islands and forage at sea (DIERSCHKE & GARTHE 2006). Nevertheless, this grouping is fluid as several resting bird species are also migratory. The chapter on resting birds therefore considers all seabird species, which use the pre-investigation area over longer periods of time for foraging, moulting, wintering, or stopping over during migration. The chapter on migrating birds partly considers the same seabird species which are already described in the resting bird chapter, when the species (or species group) also occurs during migration. Besides, all other species, which were regularly observed are presented in the migratory bird chapter. Since radars cannot distinguish between different species, results of this methodology present migration intensity (Mean traffic Rate, MTR), flight height distribution (vertical radar) and flight direction (horizontal radar) for all birds crossing the area within a few hundred metres around the anchoring vessel.

3.1 RESTING BIRDS

Resting birds include seabirds and other waterfowl species that remain in a non-breeding area during certain periods of the year. They are dependent on the local resources in these areas for moulting, overwintering, foraging etc. They typically tend to be very long-lived and have several adaptations allowing them to exploit resources even during harsh weather conditions.

The northern pre-investigation area KF II OWF-N borders the Swedish Natura 2000 site “Sydvästskånes utsjövatten” (SE0430187) to the North. The site is designated due to the presence of grey seal, common seal, and harbour porpoise, while no bird species are listed for this site.

In the following paragraphs, those resting bird species or species groups, which were identified as most relevant for the investigation area, will be described in more detail.

3.1.1 DIVERS (RED-THROATED DIVER AND BLACK-THROATED DIVER)

Divers, also called loons, include four species of fish-eating birds strongly linked to aquatic environments that inhabit the taiga and tundra regions of the Holarctic. All divers are migratory, breeding in freshwater lakes mainly in Scandinavia and in Russia and spending the winter season at sea (Durinck et al. 1994; BioConsult SH et al. 2019; Hemmer 2020). Two diver species are commonly found in the Baltic Sea, the red-throated diver (*Gavia stellata*) and the black-throated diver (*Gavia arctica*).

Both species use the Baltic Sea almost exclusively as wintering and staging grounds and as a migration corridor to wintering areas further south and west, such as the North Sea or Atlantic coastal waters. These are predominantly divers breeding in northern Russia (Mendel et al. 2008; BioConsult SH et al. 2019) which will arrive in or cross the area from October to January, and leave until June. Bellebaum and colleagues (2010a) report higher numbers of migrating red-throated divers near the coast as opposed to areas further offshore, assuming a more southward concentration of spring migration along the German coast and an autumn migration further north, with counts of 4,000 individuals in total passing between the Swedish Skåne coast and Bornholm. GPS tracks of about 20 tagged red-throated divers (BioConsult SH et al. 2019) suggest that individuals are rather evenly spread across the area and did not confirm these patterns.

Flight heights of both diver species are generally estimated to be low (Johnston et al. 2014a) . Especially during headwind situations divers tend to fly closely above the water surface. They will usually not be observed flying higher than 50 m and often just up to 10 metres (Krüger & Garthe 2001; Bellebaum et al. 2010b; BioConsult SH et al. 2020).

During wintering, divers forage on a broad range of fish species (Kleinschmidt et al. 2019). For the Baltic Sea, the diet of red-throated divers has been investigated in the Pomeranian Bay, which is one of their main wintering areas probably due to the suitability of the area as spawning, nursery and feeding ground for many fish species. In this area, zander (*Sander lucioperca*) and herring (*Clupea harengus*) constituted the majority of the consumed biomass of red-throated divers in winter and spring respectively (Guse et al. 2009).

Both species are widely distributed in the Baltic Sea. Most individuals occur in the Gulf of Riga at waters less than 30 m depth (Durinck et al. 1993). Other important areas are located off the coast of Lithuania and the Pomeranian Bay (Durinck et al. 1994). According to both studies, most divers winter offshore at waters with depth ranging between 5 and 30 m. They arrive in the Baltic Sea in September with increasing numbers during the winter peaking in February and March in the Kattegat (Skov et al. 2011). They start leaving the areas in April and May to migrate to their breeding grounds and are thus expeected to be present in the investigation area from September to June. During the rest of the year, they are expected to appear sporadically only. Skov et al. (2011) reported that the most important wintering area for black and red-throated divers in the Baltic Sea is located along the coast north of Rügen in Germany. For the pre-investigation area only very small numbers are expected with the closest key area being the Darss at the German coast.

Estimates conducted almost two decades ago suggested overall wintering numbers of 150,000 – 450,000 red-throated divers and 250,000 – 500,000 black-throated divers for the population inhabiting northwest Europe (MENDEL ET AL. 2008; SKOV ET AL. 2011). More recent evaluations estimate 210,000 – 340,000 wintering red-throated diver individuals (WETLANDS INTERNATIONAL 2022, AEWA CSR 8, accessed on 10.04.2024). It is still unclear whether populations of both species are in decline in the North Sea (VILELA ET AL. 2021; GARTHE ET AL. 2023). The population of black-throated divers inhabiting northern and western Europe and Siberia is estimated at 390,000 – 590,000 individuals (WETLANDS INTERNATIONAL 2022, AEWA CSR 8, accessed on 23.02.2022).

Since their populations may have decreased and since they are among the seabird species most vulnerable to many anthropogenic factors, they are included in the Annex I of European Union (EU) Birds Directive (Council

Directive 2009/147/EC on the conservation of wild birds, EUROPEAN UNION 2010) and in the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA, UNEP/AEWA SECRETARIAT 2019). Moreover, their wintering populations are considered critically endangered (CR) by HELCOM (2013). The IUCN categories but the recent Birdlife International Red List for Europe (BIRDLIFE INTERNATIONAL 2021) considered them as species of least concern.
Oil spills, habitat degradation and being bycaught in fishing nets are the most common threats for divers (MENDEL ET AL. 2008). Additionally, contamination in lakes for example by mercury pollution may affect their reproduction (e.g., ERIKSSON 2015). Ship traffic and offshore wind farms have been shown to have detrimental effects on divers. They display strong avoidance behaviour towards OWFs (DIERSCHKE ET AL. 2016; WELCKER & NEHLS 2016; HEINÄNEN ET AL. 2020), which can be noticeable up to a distance of 16 km away from OWF (MENDEL ET AL. 2019; VILELA ET AL. 2021; GARTHE ET AL. 2023)

3.1.2 GREBES

Grebes occur in coastal areas with shallow waters. The most important species of grebes which may be found in the survey area are red-necked grebes (*Podiceps grisegana*), great-crested grebes (*Podiceps cristatus*), and slavonian grebes (*Podiceps auritus*). Durinck et al (1994) reported that the main wintering area for all three species was found in the Pommeranian Bay. In the Danish Baltic Sea, they found a small concentration of wintering great-crested grebes in the north-west Kattegat along the coast north east of Ålborg (mean density of 0.3 ind./km^2). For red-necked grebes, they reported high densities of up to 2.4 ind./km^2 particularily in the Ålborg Bight.
An estimated total of 3,500-4,000 pairs of great-crested grebes breed in Denmark. Many of these concentrate in lakes and coastal waters during July-September (MELTOFTE 1996). Based on the IUCN categories and the recent Birdlife International Red List for Europe, the European populations of slavonian grebes are considered near threatened, those of red-necked grebes are categorised as vulnerable and those of great-crested grebes are considered to be of least concern (BIRDLIFE INTERNATIONAL 2021).

3.1.3 GREAT CORMORANT

Two of the six subspecies of the great cormorant (*Phalacrocorax carbo*) may occur in north Europe: *P. carbo carbo* and *P. carbo sinensis*, the latter is the subspecies that may occur in the pre-investigation area. Cormorants are diving birds that mainly feed on herring, perch, eelpout, cyprinids and sprat among other species found in the Baltic Sea (e.g. BOSTRÖM ET AL. 2012a; b; LARSSON 2017).
According to population estimates by Birdlife, 828,000 – 1,030,000 great cormorant individuals are found across Europe (BIRDLIFE INTERNATIONAL 2021). In the Baltic Sea, they occur during the whole year but mainly associated to coastal habitats. Largest concentrations can be generally found in the Mecklenburg region of Germany, the southern part of Bohuslän and Gdanks Bay and the Sound, as well as in Danish waters (SKOV ET AL. 2011). In Danish wateras areas with high concentrations of wintering great cormorants were mainly fround along the coast of Sjælland and Fy, as well as in the Ålborg Bight with densities varying between 100 and 5000 ind./km^2.
During the 19th century, the species went almost extinct. After protection measures established in the mid-20th century, the population has increased in the Baltic with a total of 190,000 – 210,000 breeding pairs occurring in the entire region, and around 27,000 breeding pairs in Denmark in 2012 (HERRMANN ET AL. 2014). Recent IUCN assessments consider them as least concerned (BIRDLIFE INTERNATIONAL 2021). Besides the common threats affecting most sea birds like oil spills, habitat degradation and fishing nets, great cormorants may suffer from conflicts with the fishing industry. Since their diet includes fish also utilised by humans, they have been blamed

for potentially reducing fish stocks. Although a reduction of perch was associated to the colony size of cormorants, no significant results were observed for other species (Östman et al. 2012). Most probably, the relationship between cormorants and fish is more complex and further research is needed (Ovegård et al. 2021).

Great cormorants can be attracted to OWFs and other man-made structures, as these provide them with resting sites, thus allowing them to expand their foraging grounds further offshore (Dierschke et al. 2016).

3.1.4 SEA DUCKS

Sea ducks spend their non-breeding season in marine environments feeding mainly on bivalves (e.g. Madsen 1954; Nehls 1989, 2001; Meissner & Bräger 1990; Mendel et al. 2008). The Baltic Sea offers important moulting and wintering sites for sea ducks with individuals mainly located in coastal waters and shallow offshore banks, where they can easily dive to obtain their food (e.g., Bräger et al. 1995). Among the most common and abundant sea ducks that may occur in the survey area are long-tailed ducks, common eiders, common scoters and velvet scoters. In general, all sea duck populations have suffered from declines in recent years (e.g., Durinck et al. 1993; Mendel et al. 2008; Bellebaum et al. 2012; Nilsson & Haas 2016). They are subject to many anthropogenic threats including oil pollution, being bycaught in fishing nets and habitat degradation (Mendel et al. 2008; Bellebaum et al. 2012; Nilsson 2016). In addition, breeding populations may suffer predation from gulls and other raptor species (Bellebaum et al. 2012). Some sea duck species such as common scoters are strongly disturbed by ship traffic showing long escape distances, while others may be less disturbed (Fliessbach et al. 2019). The same applies to the disturbance caused by OWFs, as the reaction differs among species as well (Petersen & Fox 2007; Petersen et al. 2014; Dierschke et al. 2016).

LONG-TAILED DUCK

Long-tailed ducks (*Clangula hyemalis*) have a circumpolar distribution range and migrate between arctic breeding grounds and temperate wintering areas. They mainly breed in freshwater habitats located in the arctic tundra areas, or in areas that provide similar conditions – e.g., the alpine areas of the Norwegian west coast (Glutz von Blotzheim & Bauer 1992). During the breeding season long-tailed ducks forage on a variety of organisms including insect larvae, fish spawn, crustaceans, and molluscs (Glutz von Blotzheim & Bauer 1992). During the non-breeding season, long-tailed ducks are gregarious, and often seen in flocks at temperate marine coastal areas and offshore banks, where they mainly feed on bivalves supplemented by polychaeta worms, echinoderms, and fish spawn (Madsen 1954; Kirchhoff 1979; Stempniewicz 1995; Evert 2004; Žydelis & Ruskyte 2005).

Long-tailed ducks wintering in the pre-investigation area are part of the Fennoscandian-West Siberian population. They arrive from the breeding grounds from October to moult in the Baltic Sea, are most numerous during winter (January-February) and leave until April to migrate to their breeding grounds (Mendel et al. 2008). Observations of long-tailed ducks in the pre-investigation area during summer are thus unlikely except for sporadically appearing young non-breeding individuals. The most important areas in the Baltic Sea with highest observed densities are in the Pomeranian Bay, the Gulf of Riga, and the Midsjö banks south of Gotland (Skov et al. 2011). In Danish water, highest densities were mainly observed on Rønne Banke. The Danish Center for Environment and Energy (DCE) has regularly conducted aerial surveys of the region and has estimated a total of 18.000-30.000 wintering individuals at Rønne Banke (Petersen et al. 2016).Other areas such as Kriegers Flak, Køge Bugt, Præstø Bugt and the waters south of Falster, Lolland, Langeland and Ærø showed higher concentrations as well with up to 21.05 ind./km^2 (PETERSEN & NIELSEN 2011). Lower densities were found in the Ålborg Bight with up to 8.83 ind./km^2. (PETERSEN & NIELSEN 2011).

Based on a coordinated Baltic Sea survey from 2007 to 2009 roughly 1.5 million long-tailed ducks were estimated to winter in the Baltic Sea (SKOV ET AL. 2011). This is a decline of 65 % compared to the census in 1988-1993, where a number of 4.7 million individuals was estimated (WETLANDS INTERNATIONAL 2006).

Long-tailed duck populations have decreased in the last decades due to various anthropogenic factors, especially oil pollution (SKOV ET AL. 2011). Various anthropogenic factors are suspected to have influences this decline (e.g SKOV ET AL. 2011; NILSSON 2016; NILSSON & HAAS 2016). Due to this drastic population decline, they are considered as vulnerable under the IUCN and are listed in Appendix II B of the European Birds Directive (European Union 2010).

COMMON EIDER

The population of common eiders (*Somateria mollissima*) in Denmark has increased during the 20th century (LYNGS 2000). The performed censuses indicate a population of about 23,000 eiders between 1988 and 1993. The last censuses of 2000-2002 reported a similar number of eiders, indicating that the population in Denmark remained stable (LYNGS 2008). Based on Petersen and Nielsen (2011), estimates suggested 503,000 common eiders wintering in Danish waters during 2008. More recent eveluations between 2000 and 2008/09 estimated this population to be stable as well (EKROOS ET AL. 2012).
During summer, common eiders are mostly located in the coastal areas around Samsø and the north western coasts of Sjælland with up to 252.85 ind./km^2 (PETERSEN & NIELSEN 2011). High concentrations were also found around Læsø and Smålandsfarvandet with up to 66.61 ind./km^2. During winter, their main concentration areas are found in the southern Kattegat, especially around the south western coast of Fyn with up to 419.60 ind./km2 (PETERSEN & NIELSEN 2011). High densities were also observed south of Læsø (up 70 43.85 ind./km^2) and in the coastal regions of Ålborg Bight (up to 27.46 ind./km^2) (PETERSEN & NIELSEN 2011).

Common eiders are considered as near threatened under the IUCN. In Europe, they are generally considered endangered (BIRDLIFE INTERNATIONAL 2021). Like other sea duck species, they are also listed in the Annex IIB of the European Birds Directive (EUROPEAN UNION 2010). Recent evaluations estimate 560,000 – 920,000 wintering common eider individuals (WETLANDS INTERNATIONAL 2022, AEWA CSR 8, accessed on 10.04.2024) for the Baltic, North & Celtic Seas population, with a declining trend.

COMMON AND VELVET SCOTER

In winter, most common scoters (*Melanitta nigra*) occur in the western Baltic Sea (DURINCK ET AL. 1993). Besides, the Pomeranian Bight and the Kattegat are important moulting areas from June to September. In the German Baltic Sea, they may be found during the whole year, especially in the Pomeranian Bay and surrounding area (MENDEL ET AL. 2008). In the Baltic Sea, common scoters show a preference for areas with water depths between 5 and 15 m (SKOV ET AL. 2011). In the wintering areas their diet consists largely of marine bivalves, which are harvested on or up to three centimetres below the surface (MADSEN 1954; FOX 2003; KAISER ET AL. 2006). Thereby, common scoters are assumed to choose their diet according to abundance, availability and energetic content of prey items rather than being restricted to certain prey species.

The results of the Baltic coordinated survey in 2007 to 2009 indicate that the winter population of common scoters has declined markedly from 783,310 birds in 1988–1993 to 412,000 birds in 2007–2009, equivalent to a 47% decline over 16 years (HELCOM HELCOM 2019a). However, recent evaluations for the Northwest European population estimate 678,000 – 815,000 wintering common scoter individuals (WETLANDS INTERNATIONAL 2022, AEWA CSR 8, accessed on 10.04.2024), with an increasing trend. High densities of wintering common scoters have been found north of the pre-investigation area in Ålborg Bugt and the areas around Læsø and Anholt with up to 303 ind./km² (PETERSEN & NIELSEN 2011) and lower densities in the Sejrøbugten with up to 105 ind./km². In summer during their moulting period, high common scoter densities were mainly found around Læsø and in Ålburg Bight with up to 284.78 ind./km². Smaller concerntrations were also located in the southern parts of Sejrøbugten and Bredergrund with up to 23.17 ind./km² (PETERSEN & NIELSEN 2011). Therefore, common scoters are expected to be present in the area year-round.

Velvet scoters (*Melanitta fusca*) breed along the Baltic Sea coast of Sweden, Finland, Russia and Estonia. The species is a regular and common winter and migration visitor in the Baltic Sea area from September to May. An important moulting area is located in the Pomeranian Bay around the Odra Bank (SKOV ET AL. 2011). Thus, velvet scoters can be found in the western Baltic Sea throughout the year (DURINCK ET AL. 1994; SONNTAG ET AL. 2006). A study of velvet scoters wintering along the Lithuanian coast demonstrated a preference for marine areas with sandy substrates at depths between 2 and 30 m (ZYDELIS 2000). In the Pomeranian Bay the species occurred in waters with sandy sediments up to 30 m depth but was most frequently found up to 15 m depth (SONNTAG ET AL. 2009). The closest identified key area relativ to the pre-investigation area is the Sejerø Bay (SKOV ET AL. 2011). However, bird densities were rather low as compared to other key sites (e.g. Pomeranian Bay).

While the common scoter are listed as a species of least concern by the IUCN, the velvet scoter is considered vulnerable (BIRDLIFE INTERNATIONAL 2021). Recent evaluations for the Northwest European population estimate 220,000 – 410,000 wintering velvet scoter individuals (WETLANDS INTERNATIONAL 2022, AEWA CSR 8, accessed on 10.04.2024), with a probably increasing trend.

3.1.5 GULLS

The general term ‘gulls’ groups different species of small-bodied and larger gulls (genus *Larus*). The first include two species that may occur frequently in the pre-investigation area: the black-headed gull (*Chroicocephalus ridibundus)* and little gull (*Hydrocoloeus minutus*). All gull species are opportunistic and omnivore feeders. Little and black-headed gulls feed mainly on insects and crustaceans whereas large gulls feed mainly on small or medium-sized fish (MENDEL ET AL. 2008). Except for the great black-backed gull (*Larus marinus*) they tend to be gregarious. While little gulls may be slightly affected by offshore wind farms avoiding these areas, other species are known to be attracted by OWF structures (DIERSCHKE ET AL. 2016).

COMMON GULL

In the Baltic Sea, common gulls (*Larus canus*) breed along the coast mainly in Sweden and Finland. These gulls are mainly migratory, some birds winter in the northeast and southern Baltic Sea, but most overwinter in the North Sea (DURINCK ET AL. 1994). They feed on terrestrial and aquatic invertebrates as well as fish, but also on fish discards and garbage dumps (DURINCK ET AL. 1994). In fact, they are typical ship followers (WALTER & BECKER 1997; KUBETZKI 2002). They are observed in large flocks of up to 100 birds (DURINCK ET AL. 1994).

Common gulls may occur in the area throughout all year but might be more numerous in winter. During winter, low densities are expected in the Kattage region in general with only a mean density of 0.3 ind./km², whereas highest densities were observed west of Bornholm (1-5 ind./km², DURINCK ET AL. 1994). Previous surveys indicated they were distributed over most of the Baltic Sea (DURINCK ET AL. 1993). Recent evaluations for the Northwest European population estimate 1,400,000– 2,000,000 common gull individuals (WETLANDS INTERNATIONAL 2022, AEWA CSR 8, accessed on 10.04.2024). They are considered as a species of least concern based on the recent IUCN Red List (BIRDLIFE INTERNATIONAL 2021).

LESSER BLACK-BACKED GULL

Lesser black-backed gulls are distributed throughout Europe. Three subspecies exist: the eastern variation *Larus fuscus fuscus,* which breeds from Sweden to northern Norway and eastwards to Russia. The western variation *L. f. graelssii* breeding from SW Greenland to Iceland and to Spain and the intermediate form *L. f. intermedius* mainly occurring in the Netherlands and Denmark (MENDEL ET AL. 2008). In Denmark, two of these subspecies may occur (*L. f. fuscus* and *L. f. intermedius*). The lesser black-backed gull is a common breeding bird in Denmark with an estimated population of 4,000-6,000 breeding pairs (https://dk.birdmigrationatlas.dk, accessed 23.04.2024). In the western areas of the Danish Baltic Sea breeding pairs are reported for Saltholm and Anholt, but the exact number is unknown (HELCOM 2013a). The lesser black-backed gull is also a common passage migrant in April-May and August-September. In autumn, birds usually leave the area towards the European west coast (wintering areas are e.g. in Iberia and West Africa).

Almost two decades ago, estimates suggested a population of 300,000 to 350,000 breeding pairs of lesser black-backed gulls (MENDEL ET AL. 2008). Recent evaluations for the 'intermedius' population estimate 560,000 – 610,000 lesser black-backed gulls individuals with a stable trend. (WETLANDS INTERNATIONAL 2022, AEWA CSR 8, accessed on 09.04.2024). They are considered as a species of least concern based on the recent IUCN Red List (BIRDLIFE INTERNATIONAL 2021), but are listed as vulnerable by HELCOM (2013a).

GREAT BLACK-BACKED GULL

The great black-backed gull *(Larus marinus*) occurs in small numbers in the Baltic Sea throughout the year. The highest populations are observed in winter when birds migrate southward from northern breeding sites. In the Kattegat, an important key area has been identified by Durinck et al. (1994), stretching along the Swedish coast. Great black-backed gulls feed mainly on fish and are solitary or observed in small loose flocks (DURINCK ET AL. 1994). They also gather near fishing ships to forage on discard (DURINCK ET AL. 1994; GARTHE & SCHERP 2003; MENDEL ET AL. 2008). Recent evaluations for the Northwest European population estimate 240,000 – 310,000 great black-backed gull individuals (WETLANDS INTERNATIONAL 2022, AEWA CSR 8, accessed on 10.04.2024). They are considered as a species of least concern based on the recent IUCN Red List (BIRDLIFE INTERNATIONAL 2021).

HERRING GULL

The numbers of herring gulls (*Larus argentatus*) have increased in Denmark during the last decades. While the first censuses of 1920 estimated a population of around 3000 pairs, more recent counts in 2010 estimated roughly 87,000 pairs. Currently, declining population trends of partially significant magnitude in the Baltic region for example in Finland have been reported (HARIO & RINTALA 2016; WETLANDS INTERNATIONAL 2022, retrieved on 03.03.2022). Most of the growth of the population occurred after the 1960s and parallels the growth observed in north-western Europe, apparently linked to an increase due to protection measures and the availability of additional food resources for example by garbage dumps and fisheries discards (BREGNBALLE & LYNGS 2014).

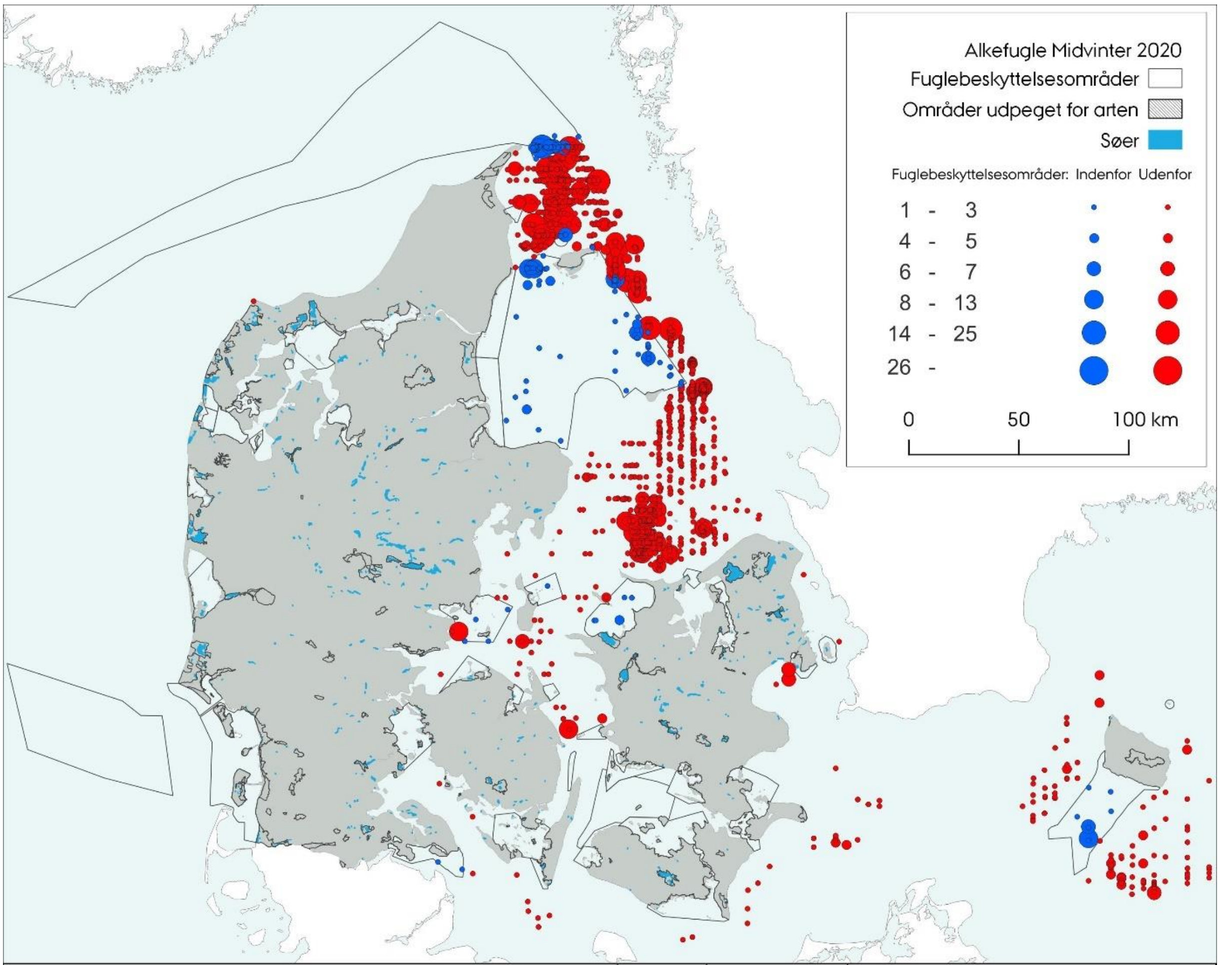
The development of the population of herring gulls differed between eastern and western Denmark. Before the mid-seventies, most herring gulls (61%) bred in the eastern part of Denmark (BREGNBALLE & LYNGS 2014), with the colony of Ertholmene being the second largest colony in Denmark (LYNGS 1992). Around 1974, the government installed culling programs in the largest colony, which resulted in a decline of the entire breeding population and shifted their centre of distribution towards the western part of the country (BREGNBALLE & LYNGS 2014). Although herring gulls breeding at Ertholmene have reduced from about 20,000 pairs in 1970s (LYNGS 1992) to about 9,000 pairs (BREGNBALLE & LYNGS 2014), the breeding colony is still important. During winter, medium densities have been identified stretching across the pre-investigation area (Durinck et al. 1994). Recent evaluations for the Northwest European population estimate 860,000 – 1,000,000 herring gull individuals (WETLANDS INTERNATIONAL 2022, AEWA CSR 8, accessed on 10.04.2024). Herring gulls are considered as a species of least concern based on the recent IUCN Red List (BIRDLIFE INTERNATIONAL 2021), but listed as vulnerable in the HELCOM Red List (2013b).
Herring gulls are regarded as the most common gull species in the offshore sites of the German Baltic Sea. Thus, their occurrence is expected in the pre-investigation area.

3.1.6 AUKS

Auk species typically found in the Baltic Sea are common guillemots (*Uria aalge*) and razorbills (*Alca torda*). Occasionally, other auks such as the atlantic puffin (*Fratercula arctica*) and the black guillemot (*Cepphus grylle*) may appear as well. The black guillemot is one of the species for which Rønne Bank is considered an important bird area (HEATH & EVANS 2000). Over two thirds of the population of common guillemots and 30% of the populations of razorbills breed on Störa Karlso (and Lilla Karlsö), two small islands located west of the island of Gotland, which are famous for hosting the largest fish-eating seabird colonies of the Baltic Sea (OLSSON & HENTATI-SUNDBERG 2017). Other colonies are located in different areas of the Baltic Sea, but most are relatively small. The archipelago of Ertholmene is one of the Danish important bird areas and the only site in Denmark known to have breeding colonies of both auk species (HEATH & EVANS 2000).

During winter, high densities of razorbills/guillemots were found in the central Kattegat, between Nordsjælland, Anholt and Læsø. These guillemots probably mainly originate from the Atlantic breeding population. Most birds were found on water depths of 20-40 m (Petersen&Nilsen 2011). In the pre-investigation area, however, wintering guillemots probably originate from the Baltic Sea breeding population. In terms of densities, no major concentrations were identified for the pre-investigation area (Durinck et al. 1994), with birds being present across a large area stretching towards the Northeast (Baltic proper). Recent surveys from winter 2020 also showed only small numbers for the pre-investigation area (Figure 3-1; https://novana.au.dk, accessed 22.04.2024). Of black guillemots, some birds are expected in the pre-investigation area, but no high densities (DURINCK ET AL.

1994). Higher densities of this species may occur in the Pomeranian Bay and south of Rønne Bank (Ode Bank, Adlergrund bank; Durinck et al. 1994; Mendel et al. 2008). Compared to the other two auk species, black guillemots prefer shallower waters (depths < 25 m, DURINCK ET AL. 1994).



Fugle talt i alt:	3.144	Procentandel:	
Heraf talt i fuglebeskyttelsesområder:	360	11,5%	
Heraf talt i fuglebeskyttelsesområder udpeget for arten:	0	0,0%	
Fugle talt i fuglebeskyttelses- og habitatområder (Natura 2000)	530	16,9%	

Figure 3-1. Spatial distribution of auks in the winter 2020. From https://novana.au.dk

While the two most common auk species have relatively stable populations or are increasing, other auk species are threatened (HELCOM HELCOM 2019b). In general, auks are long-lived, but start reproducing only after several years of life. Moreover, these species were heavily hunted by humans, and their populations almost got extinct. Both the Common Guillemot and the Razorbill are listed a species of least concern on the IUCN Red List (BIRDLIFE INTERNATIONAL 2021). Recent evaluations for the Northwest European population estimate 500,000 common guillemot and 830,000 – 2,000,000 Razorbill individuals (WETLANDS INTERNATIONAL 2022, AEWA CSR 8, accessed on 09.04.2024), with an increasing trend. Among the two other species that may rarely occur in the area, the black guillemot is listed as a species of least concern as well, whereas the Atlantic puffin is considered endangered (BIRDLIFE INTERNATIONAL 2021).

3.2 MIGRATING BIRDS

Migrating birds alternate between breeding and non-breeding regions. They can travel over long distances twice a year. Although this is a regular, annually recurring phenomenon, the magnitude of migration can vary strongly from year to year and is subject to great variability. The distance covered during migration varies among species as well, some migrate over long distances of several 100 or 1000 km, others travel short distances with only a few km. Among some species, only parts of the population migrate while the rest resides in their area of distribution (BAIRLEIN ET AL. 2014; CORDES & MAY 2023).

Estimates for the western Baltic Sea (including Belt Sea and Kattegat) suggest that about half a billion birds belonging to approximately 200 different species cross the western Baltic Sea during autumn and roughly ~ 250 million birds cross the area during spring (BSH 2021; NUSSBAUMER ET AL. 2021). The majority of these are songbirds (> 95%). The rest is composed of seabirds and other waterfowl such as divers, grebes, ducks, geese, waders, gulls, terns and auks. Thermal gliders such as birds of prey and cranes cross these areas during their migration as well (BSH 2021). Especially daily migrants like thermal gliders such as birds of prey and cranes tend to avoid crossing open sea when migrating (ALERSTAM 1978) and thus are frequent migrants in the Belt Sea/Kattegat area with shorter distances across sea areas compared to the western Baltic Sea. Instead, they follow land areas until a crossing is unavoidable and therefore concentrate at peninsulas or other narrow stretches of land in order to reduce the risks and energy expenditures associated with active flight over water (ALERSTAM 1990).

As previously mentioned, bird migration is very variable and thus hard to predict. However, the timing of migration is influenced by weather conditions such as temperature, precipitation, fog, wind speed and direction, as energetic costs necessary for flying itself are related to the presence and magnitude of these parameters (LIECHTI & BRUDERER 1998; LIECHTI 2006; SHAMOUN-BARANES ET AL. 2010; NILSSON ET AL. 2019). Thus, migration mostly takes place during only a few days of the migration period with the most favourable weather conditions (BSH 2021).

For many Scandinavian and Siberian breeding bird species, the Baltic Sea is part of their annual migration routes (Figure 3-2(WELCKER & VILELA 2020)). Numerous night-migrating songbirds are thought to cross the Baltic offshore area in a broad front mainly with a south-western orientation, but local aggregations and deviating directions are also possible. Most day-migrating birds follow landmarks from Falsterbo in Sweden over Danish islands such as Zealand and Lolland and German Fehmarn to the mainland of Europe, but fractions of those populations also directly cross the open water. Waterfowl like geese, ducks or divers mainly move through the area in an east-west direction (BELLEBAUM ET AL. 2010a).

Concerning especially KF II OWF, the area between the Falsterbo peninsula and the island of Møn is considered to be one of the most important sites after Skagen for landbirds migrating between Sweden and Denmark in autumn (KJELLÉN 2019). Raptors and cranes are considered the most important species groups in this area. Important are also diurnally migrating passerines (e.g. chaffinch/brambling, wagtails, pipits, larks and swallows) as well as swifts and pigeons (wood pigeons *Columba palumbus*). Extensive observation data from Falsterbo further shows that also migrating geese and ducks (e.g. barnacle and brent goose, Eurasian wigeon, teal, northern pintail and red-breasted merganser), and, to a lesser extent, divers (read and black-throated) and terns (common/artic) are frequently migratory species in this area. Waterbird counts revealed the importance of the area for sea ducks such as common scoters and eiders as well as gulls.

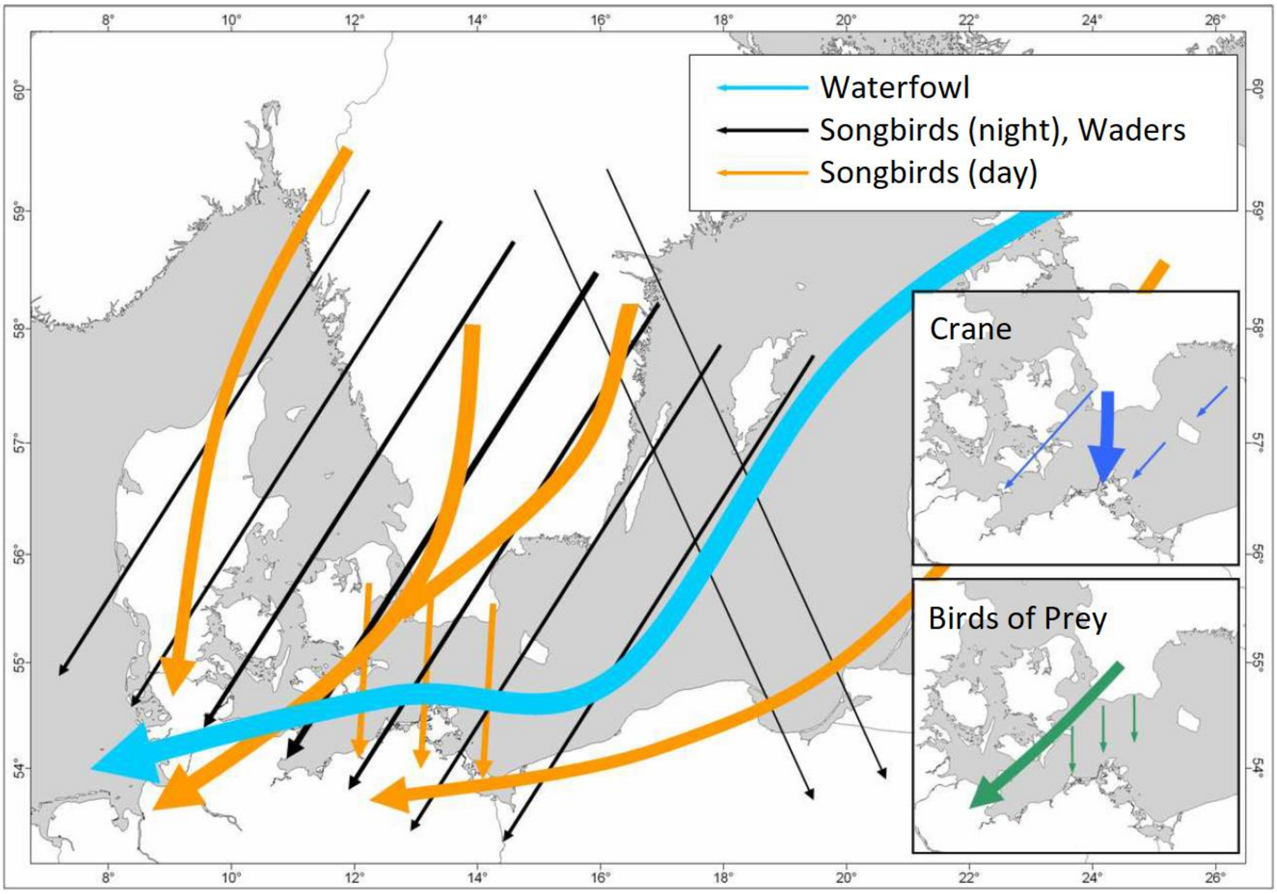


Figure 3-2. Most important migration routes in the Baltic Sea during autumn. From Bellebaum et al. (2010a).

In the following paragraphs, those migratory bird species or species groups, which were identified as most relevant for the investigation area, will be described in more detail.

3.2.1 GEESE AND SWANS

At least three goose species of the *Anser* genus, two "black" *Branta* species of barnacle and brent goose, and three species of swans migrate annually through the Southern Baltic region. In general, these species are either polytypic (except for *Branta leucopsis* and two of the swan species), or if monotypic, have populations that rarely exchange genetic material. Most geese breed on lakes, pools, rivers and in a variety of wetland habitats and winter on farmland in open country or in swamps, lakes, saltmarshes and coastal lagoons further south than their breeding areas (SCOTT & ROSE 1996). Moreover, the subspecies or populations of geese and swans that may be encountered in the southwestern Baltic Sea have all increased in size in the last decades partly because of protection of their main wintering and staging sites in northwestern Europe, and also a reduction of hunting pressure on some of these species (for example *Branta leucopsis*).

Whereas the specific biology and requirements of each of the species mentioned here varies, mostly all of them follow the same migration pattern. They start their migration towards the wintering areas (e.g., close to the Pomeranian Bay, or further southwest in Denmark, the Netherlands) by September, reaching peak numbers in January and February in their winter quarters and migrate back to their breeding areas from March onwards (SCOTT & ROSE 1996).

Only the greylag goose (*Anser anser*) breeds relatively close to the pre-investigation area (Southern Sweden, Northern Germany) and migrates further south in winter, whereas some of the populations of the brent goose (*Branta leucopsis)* have recently established new breeding sites in these regions (FEIGE ET AL. 2008).

Geese generally have a certain flexibility in terms of migration routes and migration timing. Tagging different goose species revealed that their migration corridors can be quite broad. Populations of barnacle brent geese, as well as greylag and greater white-fronted geese (*Anser albifrons*) all migrate through the southwestern Baltic Sea to reach their breeding grounds, thus passing the areas of Kriegers Flak (e.g., ANDERSSON ET AL. 2001; EICHHORN ET AL. 2009; LAMERIS ET AL. 2018; KÖLZSCH ET AL. 2019; KRUCKENBERG ET AL. 2022; MADSEN ET AL. 2023). Regarding observed migration altitudes, geese often fly at high altitudes. The barnacle goose for example is known to fly at faster speeds and higher altitudes in spring than in autumn (341 m vs 215 m, GREEN & ALERSTAM 2000).

As already mentioned, the populations of these species have increased in recent years. However, this increase has also resulted in some conflict with humans. *B. b. bernicla* has increasingly turned to new food sources grazing on cultivated crops near the coast, causing a conflict with farmers, for example in Britain (SALMON & FOX 1991). As a result, and a possible solution, studies have been conducted to evaluate whether an increase of the hunting bag for some of these geese species could help to control their populations without representing a threat. Similar conflicts arise with many of the other species, and with the exception of the barnacle goose no other species of these waterbirds is listed under the Annex I of the Birds Directive.

Similarly due to their relative large sizes and heavy bodies, their large numbers during migration and their socially interactive nature makes them largely susceptible to collision risk with wind turbines (REES 2012). Nevertheless, there is relatively little information of the collision risk for these birds and much of it is neither available nor reported (REES 2012). Geese and swans are known to show avoidance behaviour to wind farms. Almost 95% of pink-footed geese (*Anser brachyrhynchus*), a species which is more often encountered in the North Sea, showed strong vertical and horizontal avoidance behaviour as a response to offshore windfarms (PLONCZKIER & SIMMS 2012). Moreover, these authors also showed that during periods of reduced visibility geese tended to fly at lower altitudes (100-150 m) compared to periods of good weather conditions when they flew higher (250-300 m). Nevertheless, they said that in their study most of the migration took place early in the afternoon under favourable conditions, thus possibly reducing the risk of collision (PLONCZKIER & SIMMS 2012).

3.2.2 BIRDS OF PREY

Birds of prey, also known as raptors, are all top predators. About 39 species of breeding diurnal birds of prey are inhabiting Europe (STROUD 2003). More than half of the species known worldwide (at least 62% or 183 species) undertake seasonal migrations with many of them being long-distance migrants undertaking sometimes intercontinental flights (BILDSTEIN 2006). Most birds of prey can soar, meaning they are able to maintain flight without flapping their wings by making use of the rising air currents and thereby reducing energetic costs. Soaring is an efficient form of transport, both during and outside of long-distance migration (BILDSTEIN 2017). Especially long-distant migrants are strongly dependent on soaring flight. However, when crossing large waterbodies such as the Baltic Sea, which usually lack upwinds, soaring provides quite a challenge. Other species such as ospreys, harriers and most accipiters and falcons migrate with powered flight by flapping their wings. Most raptors are day migrants, but few species such as peregrine falcons, ospreys, and merlins also migrate during nights.

The migration corridors of raptors, which often travel in flocks, are well-known (BILDSTEIN 2006). Their most important flyway in Europe is the western European-western Africa flyway (BILDSTEIN 2017). A comparative study of satellite tracking and ring recoveries for four common raptor species gathered detailed information on the taken routes (STRANDBERG ET AL. 2009).

Close to the pre-investigation area at Falsterbo in South Sweden, raptor autumn migration has been studied since the early 1940s (KJELLÉN & ROOS 2000), whereas standardized counts of raptors and other migratory birds have been conducted since 1973 (KJELLÉN 2019). An average of 46,000 migrating raptors and falcons are observed annually. The most common species there are the Eurasian sparrowhawk (*Accipiter nisus)*, the common buzzard (*Buteo buteo)* and the red kite (*Milvus milvus)* (KJELLÉN 2019). Species with more southerly distribution breeding close to Falsterbo are more commonly observed compared to species with northerly distributions (KJELLÉN 2019). Similarly, thermal migrants tend to be more concentrated than active flyers at Falsterbo. Since raptors tend to fly at lower altitudes in these regions, the censuses at Falsterbo have been particularly important for raptor studies (e.g., KJELLÉN 1997).

The numbers of the most common birds of prey have either increased or remained stable within the last decades (cf. KJELLÉN 2019). Three species show negative trends at Falsterbo: the European honey buzzard (*Pernis apivorus),* the rough-legged buzzard (*Buteo lagopus)* and the northern gowshawk (*Accipiter gentilis)* (KJELLÉN 2019). In comparison to a previous study on the trends of raptors from 1940s to the late 1990s in the same area, there seems to be a slight recovery of raptors currently migrating through Falsterbo (KJELLÉN & ROOS 2000; KJELLÉN 2019).

There is, however, a large variation in the number of raptors being observed during the autumn migration every year. This may not only be linked to more birds being counted under favourable weather conditions. When birds fly against the wind, they tend to fly at lower altitudes and may be more easily observed and thus counted. It could also be caused by changes in population numbers due to changes in reproduction. Species like the Eurasian honey buzzard and the rough-legged buzzard are known to produce varying numbers of juveniles depending on the availability of prey such as wasps or rodents during the breeding season (Kjellén 2019).

As top predators, most birds of prey are k-selected species with relatively little annual reproduction and their young require many years to mature before breeding (DWYER ET AL. 2018). Thus, they have naturally low densities. The population sizes of raptor species are relatively small compared to other breeding birds. Their life-history traits and their high trophic level make them extremely susceptible to anthropogenic threats such as land use change, direct killing, poisoning and environmental contaminants, electrical injuries causing death.and climate change. They are among the most threatened group of birds in the world (MCCLURE ET AL. 2018). In Europe, the most influential impacts affecting the populations of the most vulnerable diurnal raptor species include habitat loss/change, intensification of agricultural habitats, direct persecution (e.g. shooting), pesticide contamination, disturbance of nest sites and many others (STROUD 2003; SERRATOSA ET AL. 2024).

Due to the particular vulnerability of birds of prey and the reduction of their population sizes caused by numerous threats they have already faced by the first half of the last century (BIJLEVELD 1974; BILDSTEIN 2017), they are among the rarest birds in Europe: 46% of European birds with less than 1,000 breeding pairs are birds of prey (STROUD 2003). Thus, many of the species are protected by European legislation and have also been included in other conventions (see **Fehler! Verweisquelle konnte nicht gefunden werden.** for the most common species likely crossing through the Baltic Sea).

Since no collision victim search underneath offshore wind turbines is possible all studies measuring direct mortality are based on onshore studies. Direct mortality from collisions with onshore wind turbines are relatively common in birds of prey (Thaxter et al., 2017). The collision of individuals by wind turbines were already observed with the first large onshore wind farms placed in Altamont Pass in California and have been documented in many other onshore places ever since. In Germany, in March 2013 at least 37% of all reported bird collisions corresponded to birds of prey confirming that they made up a disproportionately large amount of all collisions (HÖTKER 2017). Some species were especially susceptible. Among them were red kites, whose breeding populations in Germany have been rapidly declining since 1991 (MAMMEN ET AL. 2017), which is why they are a focal species in relation to potential risks of wind turbines.

Despite the estimates of collision rates being very variable and the difficulty of obtaining reliable data, some overall findings and conclusions have been achieved from a German database (RASRAN & DÜRR 2017). According to this study, most frequently killed birds at onshore wind farms were red kite and common buzzards, but other species such as white-tailed eagles, common kestrels and black kites were also often reported as victims. Most collision victims were adult birds mainly occurring in spring and late summer (RASRAN & DÜRR 2017). The collision risk directly depends on the rotor swept area. Red kites often flew at heights within the rotor swept area of onshore wind turbines. Up to 50% of all recorded red kite flights are at a collision risk height (MAMMEN ET AL. 2017).

Whereas collisions with onshore turbines have been documented for at least 34 species of birds of prey, the effect this may have on population level has been explored for comparatively fewer species (e.g. Duriez et al. 2022). For example, a study modelling the population of red kites in Germany has predicted a further decline due to additional mortality from collisions with wind turbines (BELLEBAUM ET AL. 2013). Indirect effects such as modifying flight altitudes to avoid wind farm collision and displacement and effective habitat loss have also been studied for different species. Golden eagles for example are apparently able to detect and avoid turbines during migration after the construction of wind farms (JOHNSTON ET AL. 2014b). Black kites have been found to reduce the use of areas up to 674 m away from turbines with an estimated loss of 3-14 % of the suitable areas at the migratory bottleneck of the Strait of Gibraltar (MARQUES ET AL. 2019). After the construction of Anholt Offshore Wind Farm in Kattegat specific investigations were conducted to assess the weather dependent collision risk for raptors passing the OWF during spring migration (JACOBSEN ET AL. 2019). The study shows, that 73 % of the observed raptors showed avoidance behaviour to the OWF with three quarters of all reacting birds returning to mainland indicating that an OWF could potentially act as a barrier by forcing some birds to use alternative routes. Accordingly, the authors recommend that important raptor migration routes should be taken into consideration when planning OWF sites. Further examples of study cases of the effects of wind turbines on different birds of prey are reviewed by WATSON and colleagues (2018).

However, since reliable methods for the monitoring of bird collisions with offshore turbines are still under development, all numbers on potential collision victims in offshore areas are based on models with the BAND model the most famous one (Band 2012).

3.2.3 CRANES

The population of common cranes breeding in Northwest Europe and Scandinavia increased and is estimated to support 350,000 individuals (WETLANDS INTERNATIONAL 2022, AEWA CSR 8, retrieved on 25.02.2022). Especially for cranes inhabiting Finland and Sweden, the Southwestern Baltic Sea is an integral part of their migration route to and from wintering quarters in Southwestern Europe. The Rügen-Bock region in Germany is an important resting area, hosting temporarily up to 40,000 individuals (BSH 2021). Between 500.00 and 60.000 individuals migrate from southern Sweden crossing the Arkona basin in a 1–2-hour flight (Figure 3-3). Especially in autumn, a proportion of cranes will also move in a southwestern direction over the area of Bornholm. A study by Skov et al. (2015) reported that telemetry data obtained from cranes showed that individuals used a broader corridor crossing the area anywhere between Borhnholm and the coast of Zealand, Møn and Falster.

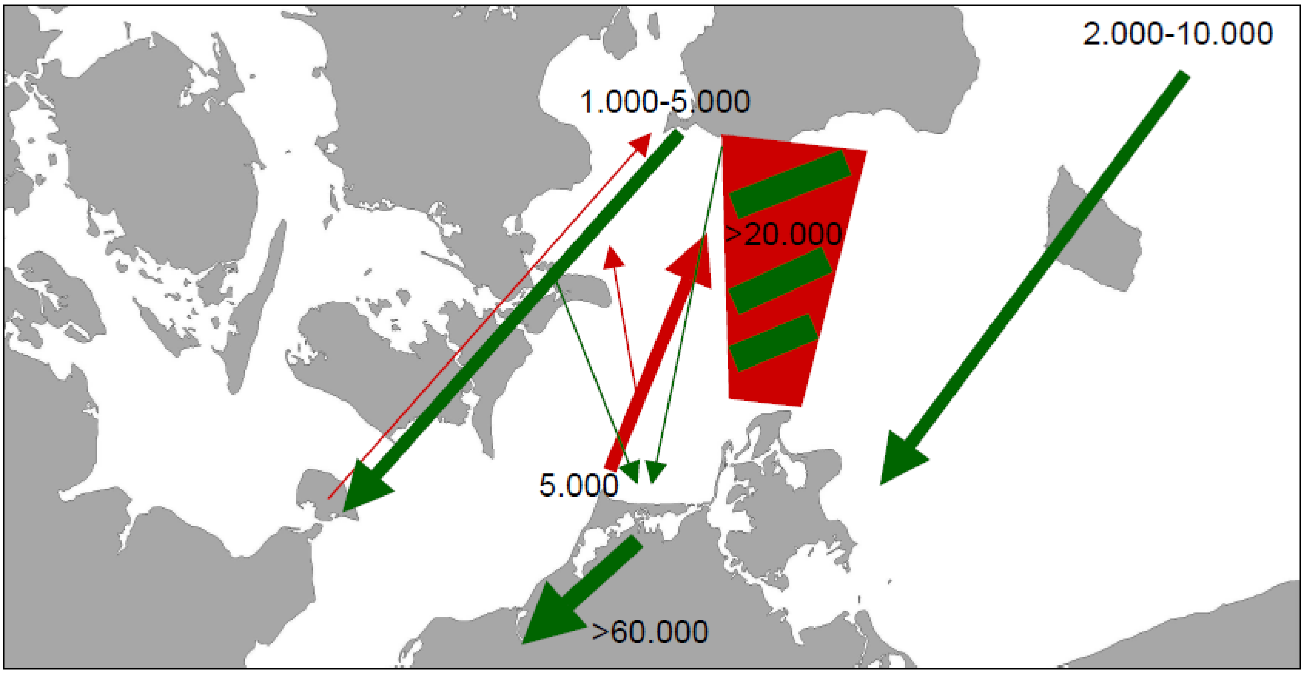


Figure 3-3: Migration routes of common cranes in the southern Baltic area (BSH 2021 based on Falsterbo, Bornholm and other observation data). Estimated numbers may be higher today due to an increasing population trend.

Due to the increasing population, the common crane currently is listed as a species of least concern (BIRDLIFE INTERNATIONAL 2021). However, its susceptibility to increasing offshore wind power generation remains unclear. One important behavioural trait in this regard might be the flight height of cranes crossing the Baltic Sea. They tend to use soaring flight over land, but due to the lack of thermal updrafts over the open water, they have to gain or hold their altitude in powered flight after leaving the coasts (ALERSTAM 1990). Studies of flight altitudes of cranes in the Baltic offshore region so far revealed a certain variety, with cranes observed flying clearly below 200 m height as well as far above (SCHULZ ET AL. 2013; SKOV ET AL. 2015). Even though a study from an onshore wind farm determined avoidance rates for Cranes of 99.93-100% (Drachmann et al. 2022), their flight behaviour and flight height during the crossing of the Baltic Sea leads to the fact that a theoretical risk of collision in the offshore area cannot be ruled out and therefore this species is a significant factor in the discussion about shutdowns in the western Baltic Sea.

3.2.4 TERNS

Terns are in general not common in the Baltic Sea and thus around the pre-investigation area. Most common species are the sandwich tern (*Thalasseus sandvicensis*), the arctic tern (*Sterna paradisea*) and the common tern (*Sterna hirundo*). Sandwich Terns were not breeding in the Baltic Sea region at the beginning of the 20th century (HERRMANN ET AL. 2008). The Danish population of sandwich terns was estimated at 4,700 breeding pairs in 2006, but the majority bred in the North Sea region (HERRMANN ET AL. 2008). The population breeding in the Baltic Sea (mainly Kattegat area) varied from 500 to 2,000 breeding pairs between 1993-2007 (see HERRMANN ET AL. 2008).

In an extensive study investigating the migration patterns of European sandwich terns, Møller (1981) described that this species typically migrates close to the coast flying a few meters above water level. Sandwich terns are diurnal migrations with migration peeking during the morning and evening (MØLLER 1981). Arctic and common terns both migrate along the west coast of continental Europe following the East Atlantic Flyway (e.g. (ALERSTAM ET AL. 2019).

The arctic and the common tern may also be observed close to the pre-investigation area, but mainly close to the coast and in the summer months. None of the tern species are expected to occur abundantly, they are seabirds requiring protection (all species are listed in Annex I of the European Birds Directive and under the AEWA), and at least the sandwich tern seems to react negatively towards OWF (DIERSCHKE ET AL. 2016).

3.2.5 SONGBIRDS

Passerines include more than half of all described bird species in the world and are also referred to as songbirds or perching birds, due to the arrangements of their toes, which facilitates perching.

Since passerines include a very large number of species, it is not surprising that they also comprise most of the bulk of migrating birds. One of the best studied bird migration systems is the one involving the Palearctic-African flyway. The first evaluation of the number of passerine birds migrating between Europe and Africa birds by Moreau in 1972 estimated 4.3 billion (HAHN ET AL. 2009). Newer estimations suggest only half of this number (~ 2.1 billion birds) migrating from Europe to Africa every autumn with almost three quarters of those birds corresponding to the migration of 16 passerine bird species (HAHN ET AL. 2009). This estimation corresponds to numbers of birds migrating from largest parts of Europe not only crossing the Western Baltic Sea, but it gives an impression of the importance of passerine birds during migration. European passerines show a variety of migration patterns and strategies of which a lot is still unknown (BUSSE 2001). European migrating passerine birds typically travel from their breeding sites often located in the north of Europe to their wintering quarters located in warmer regions in southern Europe or northern Africa. Passerine migration is often occurring in broad fronts instead of corridors (see Figure 3-4 for an example).

Passerine birds can be long-distance migrants with their breeding wintering sites geographically separated by an area which the species is only crossing or using as a stopover site during migration. Other species are short-distance migrants with their wintering grounds being close to or overlapping with their breeding sites. For several species it is known that their populations only partially migrate. For example, there may be different migration patterns between sexes or ages or even populations (e.g., only northern populations of European robins are migratory, southern populations are resident and populations at intermediate distributions are partially migratory). According to the review by Busse (2001), at least 63 species of European passerines are long-distance migrants, whereas 69 species can be classified as short-distance migrants (BUSSE 2001).

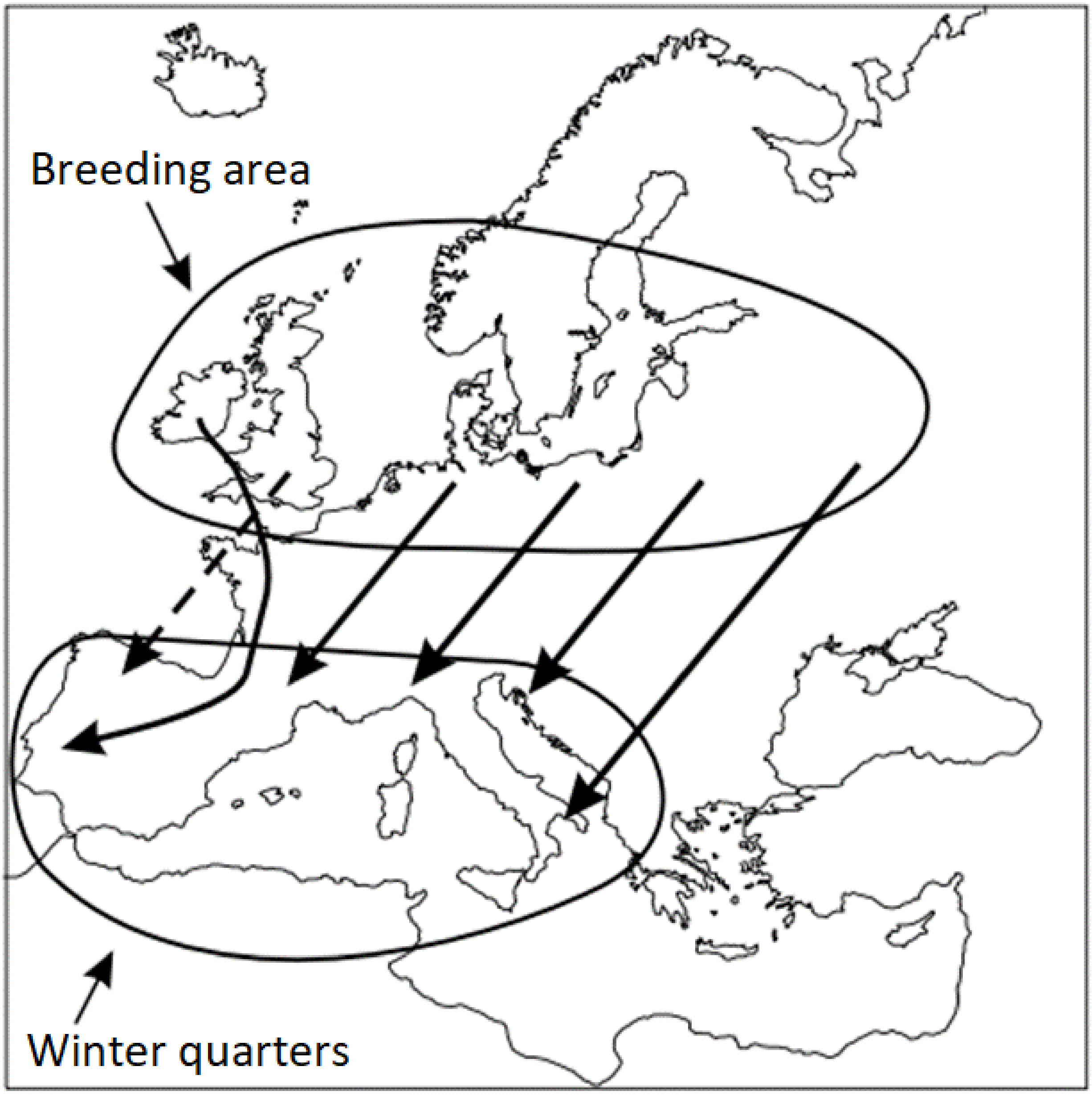


Figure 3-4: Example of broad front migration from the breeding region to the wintering quarter. Taken from Busse (2001, who modified it from Zink, 1973).

Most recent interpretations of migration studies and routes suggest that there might be four main passerine flyways in the Western Palearctic: 1) the Western/Atlantic flyway, 2) the Central/ Apennine flyway, 3) the South-Eastern (Balkan-SE) flyway and 4) the Eastern (Indian) flyway, which are shown in Figure 3-5 (BUSSE ET AL. 2014). The different lines shown in Figure 3-5 connect breeding sites with wintering quarters (as summarized from ringing recovery studies). Most (passerine) birds fly on these routes across broad fronts, but there are some passages with bottlenecks.

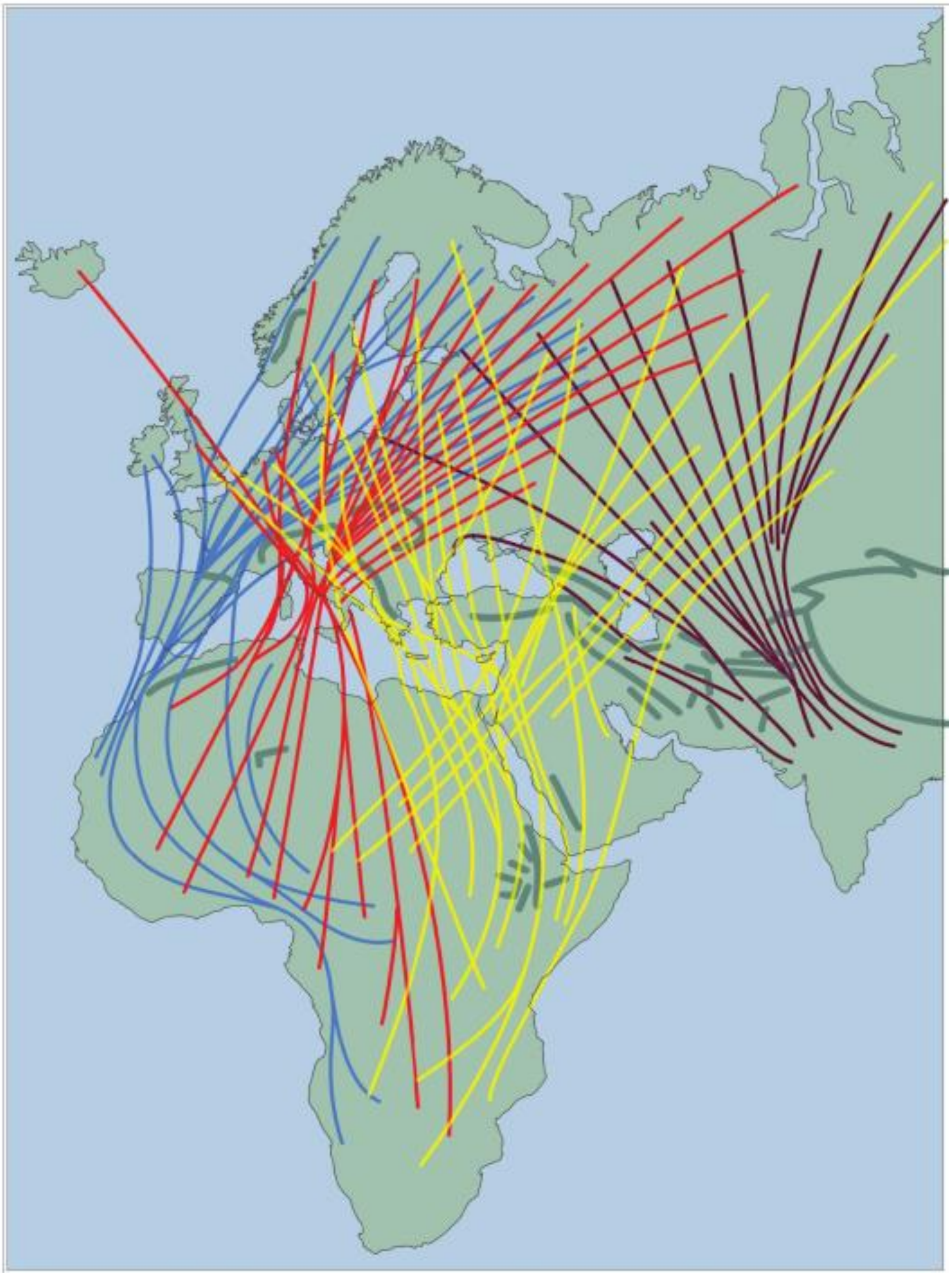


Figure 3-5: The four main fly way routes occurring in the Palearctic: 1) the western/Atlantic (blue), 2) the Central (Apennine, red), 3) South-Eastern (Balkan, yellow) and 4) Eastern (Indian, brown). Taken from Busse et al., 2014.

Migration of passerine birds occurs during day and night with species having adapted to migrate at a particular time of day. Most diurnal migrating species include low and mid-distance migrants, such as finches and wagtails, which are more dependent on visual orientation cues. Birds migrating during night are mid-distance migrants, such as thrushes and robins, as well as long-distance migrants such as warblers.

As seen in Figure 3-2 and

Figure 3-5 most common migrating passerine birds cross the Western Baltic Sea fly in a SW direction in autumn (the flyway 1). Nevertheless there are some migrating in a SE direction (BELLEBAUM ET AL. 2010a).

Given the large number of passerine birds potentially crossing the Baltic Sea includingthe pre-investigation area especially during the autumn migration, they are potentially affected by wind turbines, especially during (mass) migration. Some studies have shown that many species and a large proportion of birds killed by turbines correspond to passerines birds. For example in South Africa, a fourth of all species and all individuals killed by wind turbines corresponded to Passeriformes. They fell second only in terms of collisions kills only after raptors (PEROLD ET AL. 2020).

In temperate waters and during migration, the proportion of migrating passerines that may be affected by direct collisions with wind turbines may be much larger. Hüppop and colleagues (2006) found that over 98% of all carcasses recovered at FINO1, an offshore research platform in the North Sea, belonged to passerine birds. Despite the study by Hüppop and colleagues covering the German North Sea, some of the overall findings may also be expected for the Baltic Sea. Migration intensity concentrates on certain days of the whole migration period (75% of all passerines were observed during 17-33% of the migration days in the study). These results obtained from visual observations were also confirmed from the study of radar echoes. With regards to flight altitudes during migration, it was observed that almost half of the radar echo signals (registered up to an altitude of 1,500 m) corresponded to the first 200 m of altitude (within the range at which wind turbines may be in operation).

4 METHODOLOGY

4.1 RESTING BIRDS

The recording of resting birds was performed using the digital video technology developed by the company HiDef (HiDef Aerial Surveying Ltd 2024, Weiss et al. 2016). This method has already been used for several years in various studies also in the western Baltic Sea and Skagerrak area (e.g., Zydelis et al. 2019; BioConsult SH et al. 2020). The HiDef system, specifically designed for this type of work, follows a methodology that is widely accepted by the industry and relevant authorities. Since 2014, BioConsult SH has conducted more than 1,000 survey missions in the North Sea and the Baltic Sea, most of them in relation to offshore wind farms, gaining images of several hundred thousand birds and some thousand marine mammals. Digital aerial surveys have been developed and established in the UK and became in 2014 the standard method for offshore wind farm studies in Germany (BSH 2013). The method has proven to be highly suitable for offshore surveys and to consolidate the basis for consenting offshore wind farms.

4.1.1 DESCRIPTION OF THE SURVEY TRANSECTS

To determine abundances, densities, and distribution patterns of resting birds in the pre-investigation area, six digital aerial surveys were conducted. They were performed about every two months during the entire study period which took place between February 2023 and January 2024.. Since both areas are less than 30 km away from each other the survey design is adopted to cover both proposed OWF areas in one pre-investigation area of KF II OWF (North and South, see

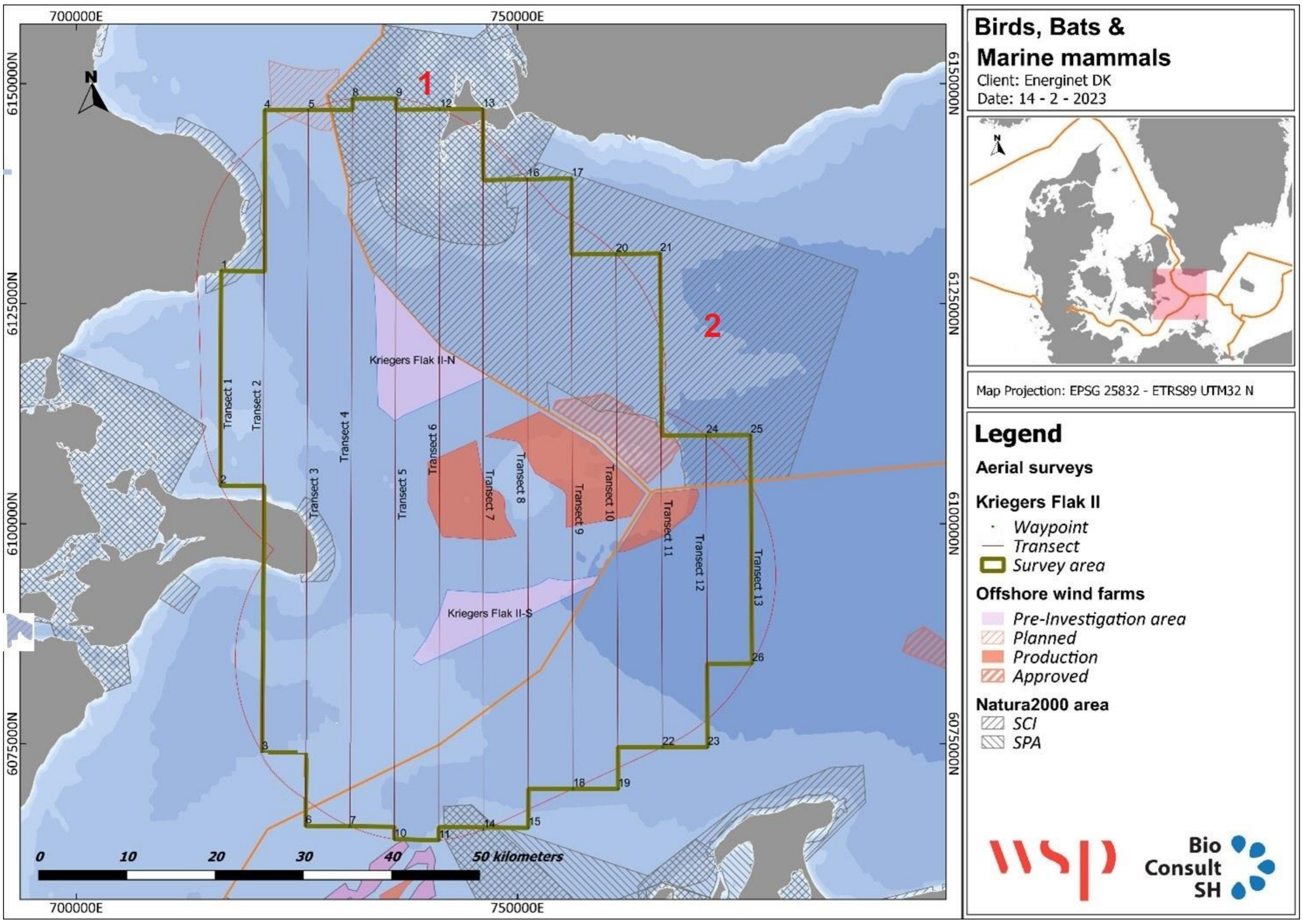


Figure 4-1). A total of 13 transects with varying lengths between 24.4 and 84.1 km in length were covered during the study period, resulting in a total of 831.3 surveyed km (see

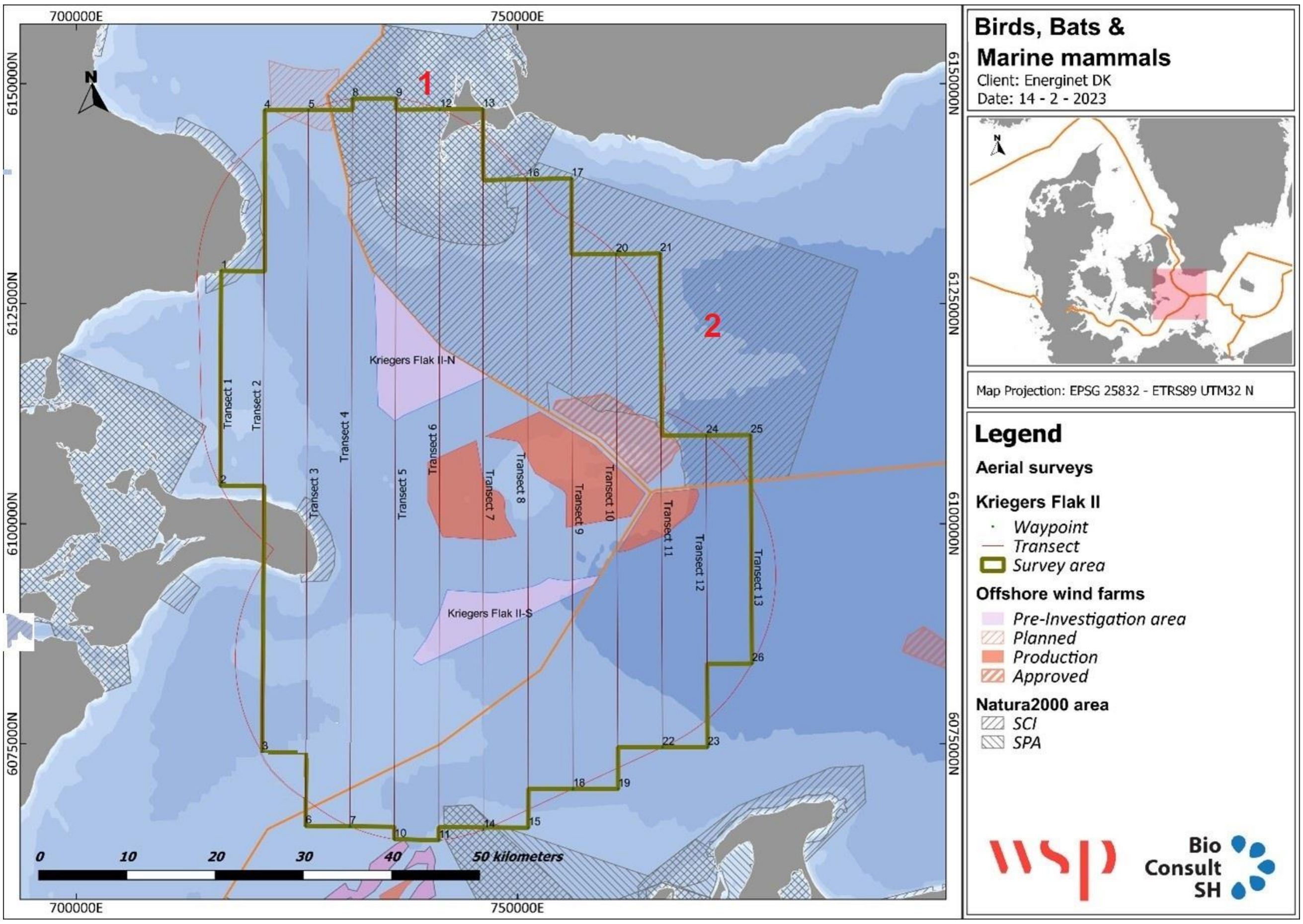


Figure 4-1, Table 4-1 and Table 4.2 for information regarding single surveys). The transects ran parallel to each other in a north-south direction and were 5 km apart. In total, 3,739.1 km² were covered during the surveys.

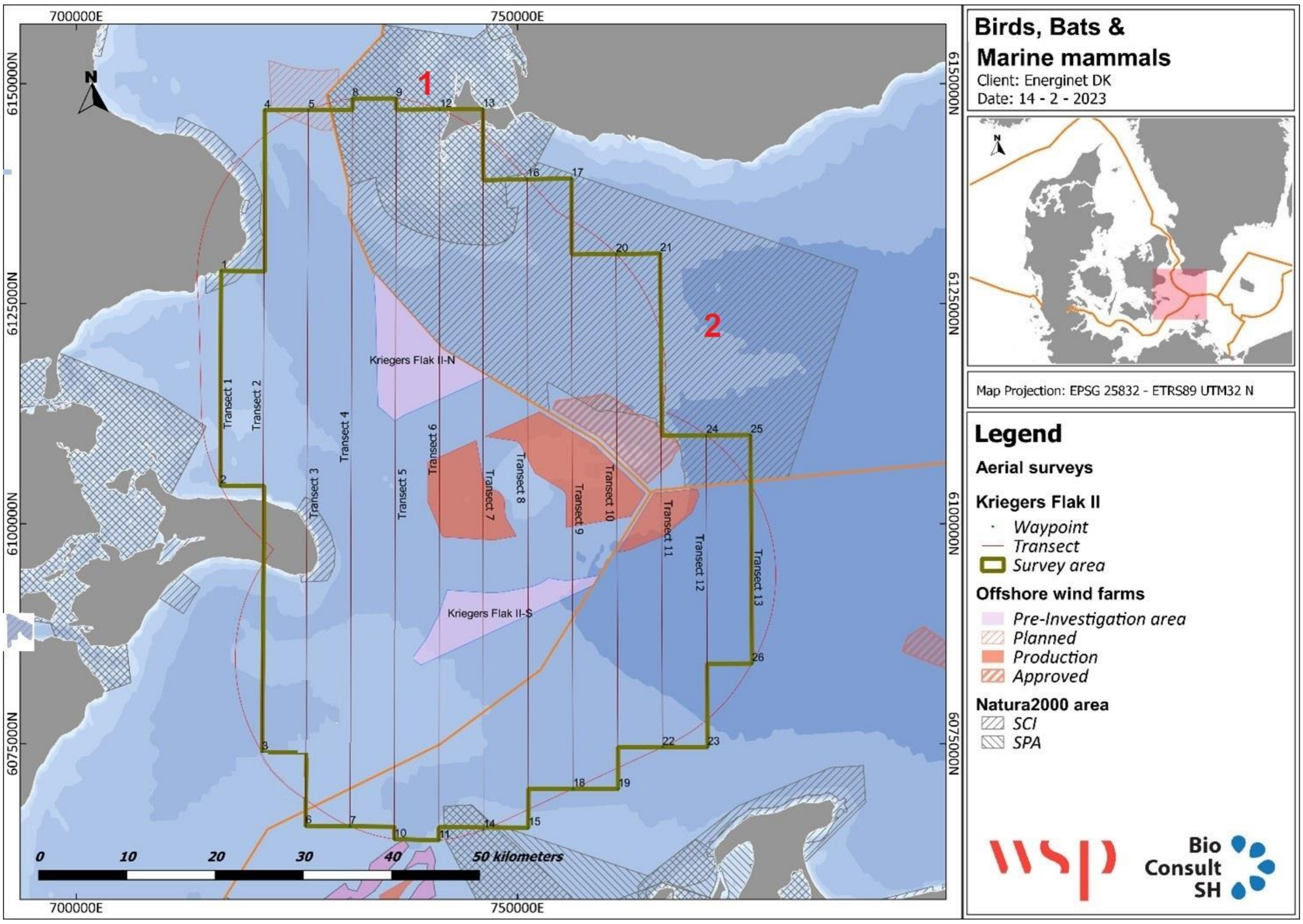


Figure 4-1. Aerial survey transect design for the survey area used during all flights. The figure includes the proposed areas of KF II OWF (pink) and the Natura 2000 areas (diagonals, crosshatched), 1: SCI SE0430095 Falsterbohalvön and SPA SE0430002 Falsterbo-Foteviken, 2: SCI SE0430187 Sydvästskånes utsjövatten. The red polygons are existing offshore windfarms.

Table 4-1. Overview of the six digital aerial surveys carried out in the survey area between February 2023 and January 2024. Survey dates, distance and survey effort as well as the covered area are given for every single flight (except for the last flight, which was not yet processed by the time of writing).

Survey no.	Date	Distance (km)	Effort (km²)	Coverage (%)
1	27.02.2023	833	431.13	11.5
2	04.04.2023	787	416.78	11.1
3	22.06.2023	790	420.53	11.2
4	16.08.2023	834	339.61	9.1
5	18.10.2023	796	415.06	11.1
6	23.12.2023	834	444.98	13.2
		Total: 4,873	**Total: 2,468**	**Average: 11.2**

Table 4.2. Waypoints (WP) showing the start and end transect coordinates and transect lengths during the digital aerial surveys in the pre-investigation areas KF II OWF N and S.

Transect	Start Transect	End Transect	Length [km]
1	WP1: 55.25736°N; 12.40568°E	WP2: 55.03848°N; 12.38576°E	20.5
2	WP3: 54.76499°N; 12.43648°E	WP4: 55.41892°N; 12.49748°E	30.9

3	WP5: 55.41678°N; 12.57595°E	WP6: 54.68753°N; 12.50645°E	37.9
4	WP7: 54.68479°N; 12.58426°E	WP8: 55.42622°N; 12.65561°E	40.7
5	WP9: 55.42399°N; 12.73385°E	WP10: 54.66939°N; 12.6609°E	46.8
6	WP11: 54.66589°N; 12.73898°E	WP12: 55.41029°N; 12.81078°E	49.9
7	WP13: 55.40829°N; 12.88752°E	WP14: 54.67413°N; 12.81805°E	53.1
8	WP15: 54.67378°N; 12.8972°E	WP16: 55.33462°N; 12.95984°E	55.2
9	WP17: 55.33248°N; 13.03839°E	WP18: 54.71077°N; 12.97924°E	57.3
10	WP19: 54.70801°N; 13.05826°E	WP20: 55.25289°N; 13.10999°E	57.3
11	WP21: 55.25074°N; 13.18862°E	WP22: 54.74793°N; 13.14068°E	62.0
12	WP23: 54.74524°N; 13.21973°E	WP24: 55.06281°N; 13.2507°E	62.0
13	WP25: 55.06031°N; 13.32938°E	WP26: 54.82762°N; 13.30673°E	65.9

4.1.2 DATA COLLECTION

The recording of resting birds was performed using the digital video technology developed by the company HiDef (HIDEF AERIAL SURVEYING LTD 2024). A twin-engine, high-wing propeller-driven aircraft (Partenavia P 68) was used for the acquisition of digital videos, see Figure 4-2. This aircraft is equipped with four high-resolution video camera systems, which take approximately seven images per second and can achieve a resolution of two cm at sea surface. Since the camera system is not directed vertically downwards (depending on the sun position, it can be slightly inclined or even set against the flight direction), interferences arising from solar reflections (glare) can be effectively reduced. The external cameras (indicated by A and D, Figure 4-2) cover a strip of 143 m width while the internal ones cover a width of 129 m each, resulting in 544 m effectively covered. There is however about 20 m distance between each strip to avoid double counting of individuals detected by the cameras. Thus, the total recorded strip of 544 m is distributed over a width of 604 m.

The aircraft flew at an average speed of approx. 220 km/h (120 knots) at an altitude of 549 m. A GPS device (Garmin GPSMap 296) recorded the position every second, which permitted to geographically assign a location to the images and the individuals registered on them. The collected data was stored on mobile hard disks for subsequent review and analysis. For further details regarding the method see WEIß ET AL. (2016).

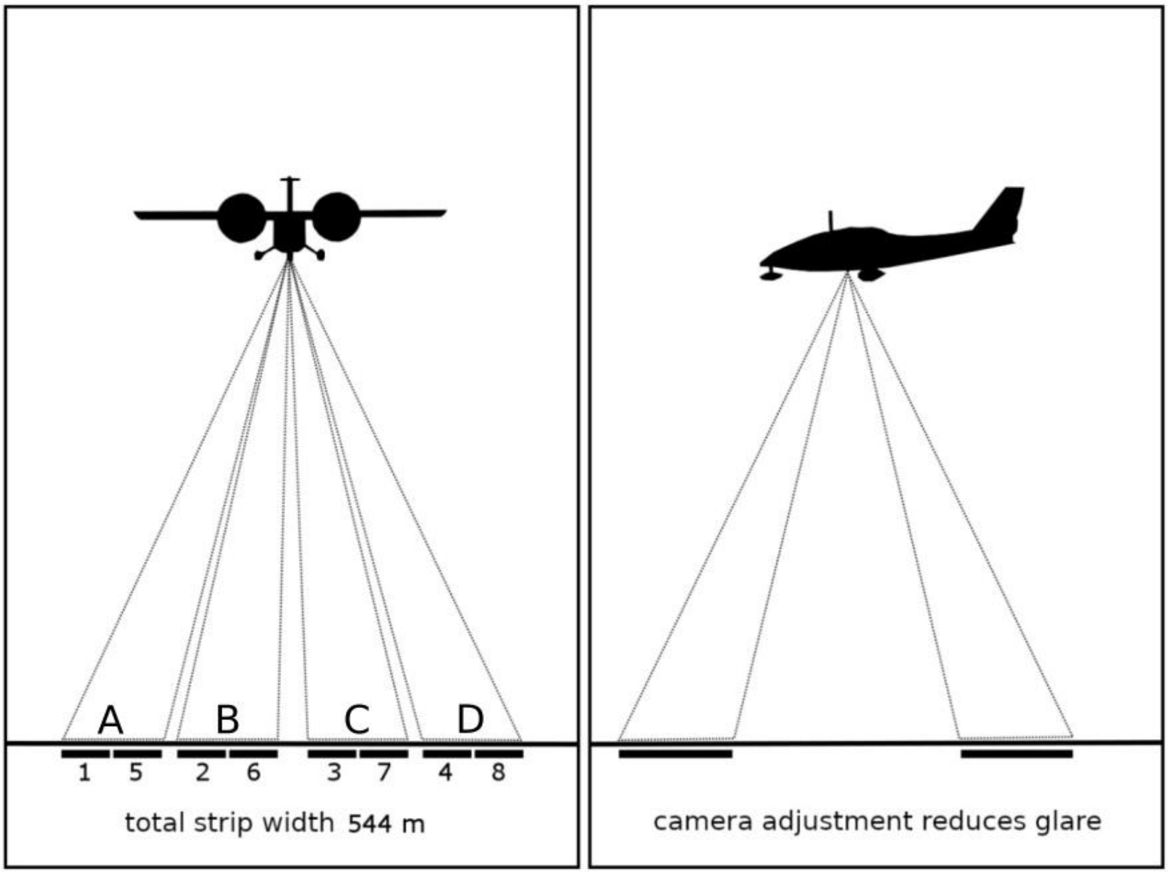


Figure 4-2. The HiDef Camera-System. The four cameras (A to D) cover an effective strip width of 544 m of the sea surface at a flight altitude of 549 m (left: frontal view; right: side view). The numbering indicates the camera images as they are used in the evaluation (the images from each camera are divided into two halves).

4.1.3 DATA PROCESSING

To facilitate the detection of objects, the video sequences taken from each camera were split into two halves, so that each half of the picture fitted the width of a large monitor. The video files were then processed using an image capture and management software (StreamPix). First, the images were examined and all the detected objects (birds, mammals, ships, etc.) were marked and pre-sorted for subsequent identification. To guarantee a consistent high quality, 20% of each film was randomly selected and processed again by another reviewer. If both reviewers reached a consensus of 90% regarding object identification, discrepancies were rechecked, and the film afterwards approved for further analysis. If the consensus was below 90%, the film was reanalysed entirely. Sections of the footage that could not be assessed due to backlight or the presence of clouds were not considered for further analysis.

The next step involved the identification of the previously marked objects (birds). This was done by experienced observers. Often birds can be identified on the images to species level. Due to strong similarities between some species (e.g. common guillemots and razorbills, common and Arctic terns, red-throated and black-throated Divers), an identification on species level is not always possible. However, it is usually possible to identify individuals as belonging to a species group formed by two (or few) closely related species. In addition to the identification, other information such as position, age, behaviour (swimming or flying) and flight direction were determined whenever possible. Environmental parameters (air turbidity, sea state, solar reflection, and water turbidity) were recorded every 500 images (approx. covering 4 km).

To assure quality control, 20% of the objects identified were re-assessed by a second reviewer. All discrepancies between the first and second identification process were checked again by a third expert. If there was a consensus of at least 90%, the data collected was released for further analysis. If the consensus was below 90%, systematic errors (e.g., problems in determining specific species groups) were corrected and all objects were re-identified.

4.1.4 DATA ANALYSIS

All detected resting birds were either identified to species level or assigned to a species group category (see below). Among these, relevant species/species groups were defined based on the frequency of occurrence in the survey area and the importance of the area as habitat for species according to reference literature.

The individuals not identified to species level in the aerial surveys were initially grouped into a larger taxonomic group of very similar species. Examples of these are common guillemot/razorbill and unidentified divers (red-throated and black-throated diver). These groups consisting of two species include a large proportion of the resting birds not identified to species level. Other resting birds that could not be assigned to any of the previously mentioned or other two-species group, are in most cases identified to family level.

4.1.5 CALCULATION OF DENSITIES

Based on the number of detected individuals for each species or species group, monthly mean densities given as ind./km² were calculated. As the survey effort differed among transects (see Table 4-1), densities were corrected by dividing them by the area covered for each transect. As the effect of the aircraft on birds is negligible, no correction factors are applied to the abundances of species (ZYDELIS ET AL. 2019). Therefore, it is assumed that all individuals present in the study are during the time of the survey are captured by the images.

The spatial distribution was determined for all surveys together or seasonally according to the species-specific classification by GARTHE et al. (2007) and displayed using grid density maps. A grid was laid over the survey area with its grid cells aligned with the EEA grid (EEA 2019).

4.2 MIGRATING BIRDS

Bird migration was studied from an anchored ship using four different methods, each looking at different aspects of bird migration. Observer-based observations (4.2.2) are divided into 1) visual observations during daylight for species composition, flight height distribution (up to a maximum of 200 m), phenology and migration intensity and 2) acoustic observations during night for adding information on migration intensity and species composition crossing the area during night (only possible for calling species when they are flying in the lower altitudes). Standardised (vertical and horizontal) radar surveys (4.2.3) were applied continuously when the ship was laying for anchor for migration intensity and flight height distribution as well as flight direction. Table 4-3 indicates the type of information that is possible to investigate by each method.

Table 4-3 Survey methods and data output

Data/Method	Species determination posible		No species determination	
	Visual observations	Acoustic observations	Horizontal radar	Vertical radar
Species composition	X	X		
Altitudinal distribution	X			X
Flight direction	X		X	
Migration intensity	X	X		X
Phenology	X			X

The surveys were conducted from vessels equipped with radar devices suitable for monitoring bird movements. The vessel was anchored centrally in both areas of the KF II OWF (N and S) proposed OWF areas (Figure 4-3). The anchoring position of the N area was 55° 12.68' N, 12° 41.75' E and that of the S area was 54° 54.84' N, 12° 57.52' E. The anchor position was verified upon the arrival of the vessel and controlled hourly during adverse weather conditions. A survey was only interrupted if adverse weather conditions (e.g. wind speeds above 17 m/s and >2.5 m waves) prevented the bird observations or prevented the vessel from maintaining the anchor position at the survey site. Weather conditions (precipitation, wind speed and direction, temperature, visibility, and wave height) were recorded every full hour. The alignment of the vertical radar antenna was checked every 30 minutes and realigned if necessary to keep the direction of the antenna perpendicular to the main migration direction.

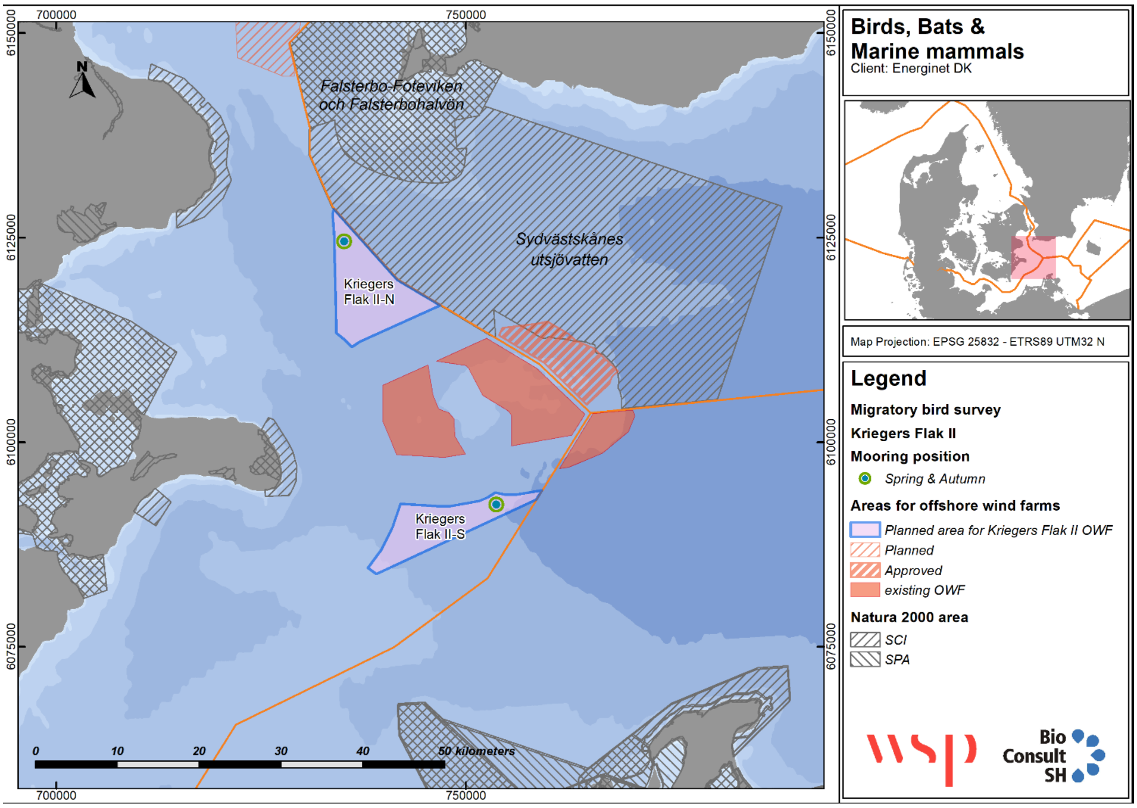


Figure 4-3 Overview of the KF II OWF pre-investigation area (pink), consisting of two areas (KF II OWF North and South), together with other approved, planned and in production offshore wind farms. The green point at the middle of each area indicates the anchoring point for the vessel during the observations and measurements of migrating birds (spring and autumn 2023).

4.2.1 SURVEY EFFORT

Surveys were conducted during spring and autumn 2023 using the ships Arne Tiselius and Fortuna Kingfisher. Table 4-4 and Table 4-5 show the survey dates for both areas, KF II OWF N and S. Observations usually began at dawn (at civil morning twilight) at the given date and then continued for two to five 24 h cycles (Table 4-4, Table 4-5). Civil twilight is defined as the moment when the sun is 6 degrees below the horizon or when the light is barely enough for reading. The total number of days/nights in which surveys took place is also given in those tables. Of all survey dates, some had to be discarded because they did not reach a minimum of 70% valuable data of the total daytime/nighttime due to weather (rain, fog strong wind) or sea state (see tables). Radar measurements were conducted simultaneously.

Table 4-4 Survey information. Starting and finishing periods of every survey and number of days/nights, dates for the collection of every type of data for the area KF II OWF N.

Survey	Survey periods		Number of 24 h cycles	Number of days/nights	
	Start: Date and time	End: Date and time		Visual observations	Nocturnal flight calls
1	17.03.2023, 02:00	19.03.2023, 02:00	2	2	2
2	26.03.2023, 07:30	29.03.2023, 04:30	3	3	3
3	08.04.2023, 07:30	11.04.2023, 03:00	3	3	3
4	17.04.2023, 18:30	19.04.2023, 18:30	2	2	2
5	12.05.2023, 07:00	15.05.2023, 02:30	2.5	3	3
6	19.05.2023, 04:30	21.05.2023, 01:30	2	2	2
7	10.08.2023, 03:30	12.08.2023, 01:30	2	2	2
8	19.08.2023, 03:30	22.08.2023, 03:30	3	2 (3)	3
9	07.09.2023, 04:00	10.09.2023, 03:00	3	2)(3)	3
10	21.09.2023, 19:00	23.09.2023, 04:30	1.5	1	2
11	22.10.2023, 15:30	25.10.2023, 15:00	3	3	3
12	28.10.2023, 17:20	29.10.2023, 16:00	1	1	1
13	12.11.2023, 06:00	15.11.2023, 15:30	3.5	4	3
14	17.11.2023, 06:30	20.11.2023, 06:30	3	3	3
Total [planned]			**34.5 [35]**	**33 [35]**	**35 [35]**

Due to bad weather the survey was interrupted on 19.08.2023 and 08.09.2023, not enough hours could be done on those day and were removed from further analysis.

Table 4-5 Survey information. Starting and finishing periods of every survey and number of days/nights, dates for the collection of every type of data for the area KF II OWF S.

Survey	Survey periods		Number of 24 h cycles	Number of days/nights	
	Start: Date and time	End: Date and time		Visual observations	Nocturnal flight calls
1	19.03.2023, 05:00	21.03.2023, 01:00	2	2	1 (2)
2	11.04.2023, 06:00	13.04.2023, 04:00	2	2	2
3	21.04.2023, 06:30	24.04.2023, 02:00	3	3	3
4	16.05.2023, 02:30	19.05.2023, 01:30	3	3	3
5	21.05.2023, 04:30	23.05.2023, 02:30	2	2	2

6	10.09.2023, 06:00	12.09.2023, 04:00	2	2	2
7	18.09.2023, 01:30	19.09.2023, 01:30	1	1	1
8	20.09.2023, 18:00	21.09.2023, 16:00	1	1	1
9	16.10.2023, 08:00	18.10.2023, 23:30	2.5	3	2 (3)
10	25.10.2023, 17:30	28.10.2023, 15:00	3	3	3
11	20.11.2023, 15:00	21.11.2023, 06:30	0.5	0	1
Total [planned]:			**22 [22]**	**22 [22]**	**21) [22]**

Due to bad weather, not enough hours of collection happened on the nights of 20.03. and on the night of 18.10.

4.2.2 OBSERVER-BASED DATA

VISUAL OBSERVATIONS (DAY MIGRATION)

Visual observations provide extensive information on diurnal bird migration. Migration intensities, flight altitudes and directions as well as species composition are derived from data collected by observers.

Visual observations were conducted during the daylight phase, starting with civil morning twilight until civil evening twilight. Every hour, two 15-minute intervals were recorded, during which two observers scanned the surrounding area for flying birds with bare eyes and binoculars. Each observer covered a 180°area. Species and number of individuals of flying birds or bird flocks were noted, as well as estimations of flight altitude and flight directions (subdivided in eight directions: N, NE, E, SE, S, SW, W, NW). Observers also annotated if birds were visibly associated with the observer vessel or other (especially fishing) vessels, as in those cases birds were assumed to be foraging instead of migrating. The observers entered the observation data directly via a tablet, and data was backed up daily to a database to prevent data loss.

DATA ANALYSIS

The evaluation only included observations of flying birds that were not associated with the own vessel. The most commonly occurring species and species groups (higher category taxons, e.g., gulls, auks, etc.) are shown in pie charts that represent their percentage based on the number of total registered individuals per season.

Migration intensity was calculated as birds per hour, extrapolating from 30 minutes of observations per hour. Based on this, both the annual and daily course of migration intensity was presented for all birds combined as well as for single species groups. Only data from days during which the observations spanned through at least 70 % of the daylight period were used. Of the 35 dates of analysis in 2023 for the area KF II OWF N, two dates in autumn were discarded because they included low effort (see Table 4-4).

To evaluate flight altitude distribution, the recorded migratory altitudes of all individuals of every species were grouped into altitude ranges (0-5 m, 5 - 10 m, 10 - 20 m, 20 - 50 m, 50 - 100 m, 100 – 200 m, > 200m) as proposed by German authorities (BSH 2013) and are shown according to their relative frequency. Observations are also combined for systematic groups. Migratory directions of flight were shown in 45° increments, also according to their relative frequency.

FLIGHT CALLS (NOCTURNAL MIGRATION)

Recording of flight calls provides information on the species composition and the intensity of nocturnal bird migration. The nocturnal flight call observations were carried out by one observer at a time with two observation units of 15 minutes per hour from civil evening twilight to civil morning twilight. Observations were, as for the visual observation during daytime, entered directly into a tablet.

For the recording of bird calls, the number of single calls were noted and not the number of (estimated) individuals. Calls which typically consist of a certain number of single elements, as for instance the call of common greenshank, were only counted as one call.

DATA ANALYSIS

The recorded calls were corrected for effort and converted into call rates (calls per hour). Similarly, to the case of visual observations, two dates were discarded for further analysis for the planned area Kriegers Flak S. To illustrate the temporal pattern of the migratory activity during a night, the call intensity was determined for each hour of the night, beginning with the onset of civil twilight. To determine seasonal patterns, the calling activity was determined for each recorded night. All analyses were carried out separately for all taxonomic groups and in summary for all species.

4.2.3 RADAR MEASUREMENTS

Horizontal and vertical radar devices (Figure 4-4) emit electromagnetic waves which are reflected by objects that can thus be spatially located. Detection depends on the wavelength emitted by the radars, the size of the objects, the distance to the radar and the direction of movement of the objects in relation to the radar. Compared to ships and other objects usually detected by radar, birds are very small and therefore best detected with lower wavelengths. For this reason, devices transmitting with a power of 25 kW in the X-band range (9,410 MHz) were used.

Figure 4-4 Horizontal and vertical radar mounted on a research vessel.

VERTICAL RADAR

Data from the vertical radar provided information on the intensity, temporal patterns and flight altitude distribution of bird migration during the day and night. The vertically rotating radar antennae were aligned perpendicular to the assumed main migratory direction by means of manual readjustment every 30 minutes.

DETECTION METHODOLOGY

The detection radius of the radar was set to 1,500 m and the sensitivity (gain) of the radar antenna was set to 70 %. Filters for rain and sea clutter were switched off, as these would also filter out an unknown number of bird signals. The afterglow duration of the radar signals was set to 45 seconds. For moving objects, the "radar shadow", i.e. signals of the same object detected during previous revolutions of the antenna, were displayed as a track in addition to the current signal (Figure 4-5). Every four minutes an image of the radar screen was captured and stored.

The recorded radar screenshots were visually scanned for bird signals, which were identified based on size and the trail caused by the time of afterglow. The bird signals were marked, and their image coordinates were converted into flight altitudes and distance to the radar unit. The number of individual birds that correspond to a bird signal cannot be determined. A bird signal thus represents at least one bird. Images were not evaluated if more than 25 % of the radar screen was obscured by rain clutter superimposing bird signals. The effort of the vertical radar for the pre-investigation areas KF II OWF N and S is shown in Figure 4-6 and Figure 4-7, respectively..

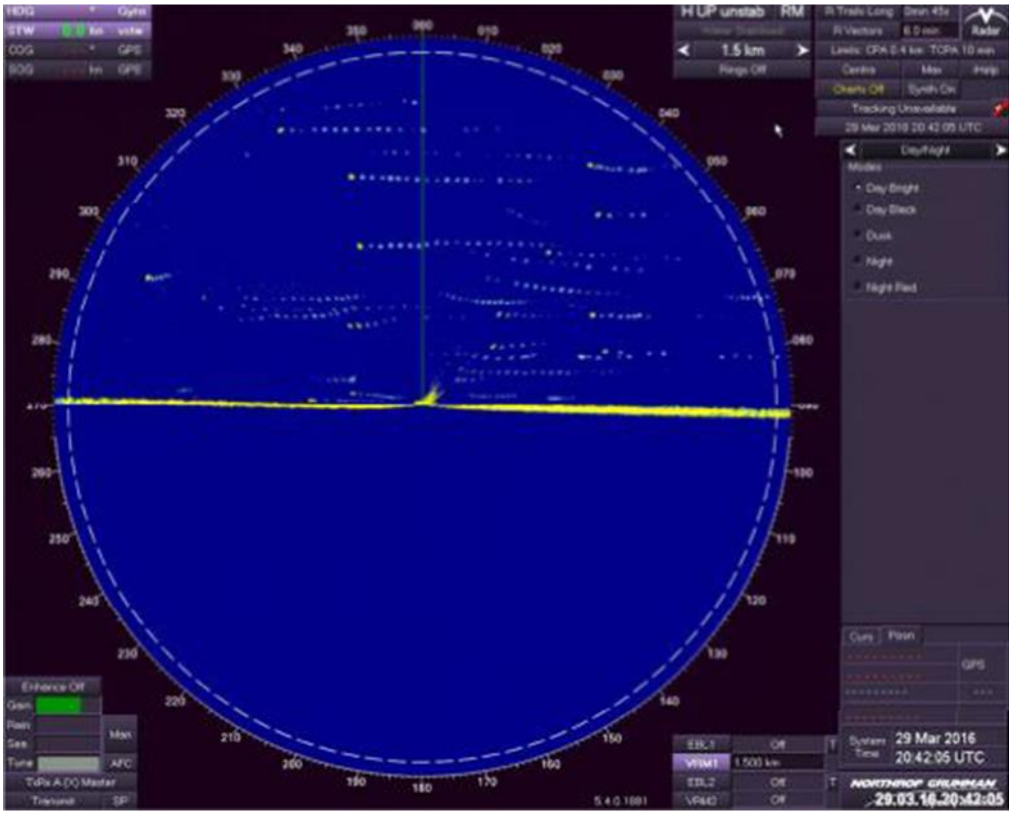


Figure 4-5 Example of a screenshot from vertical radar with characteristic bird signals (the yellow line represents the sea surface, the signals in the upper half of the radar area are bird echoes).

Since not all images obtained from vertical radar were available yet for analysis at the time of writing this report, results from vertical radar will be presented in the final report.

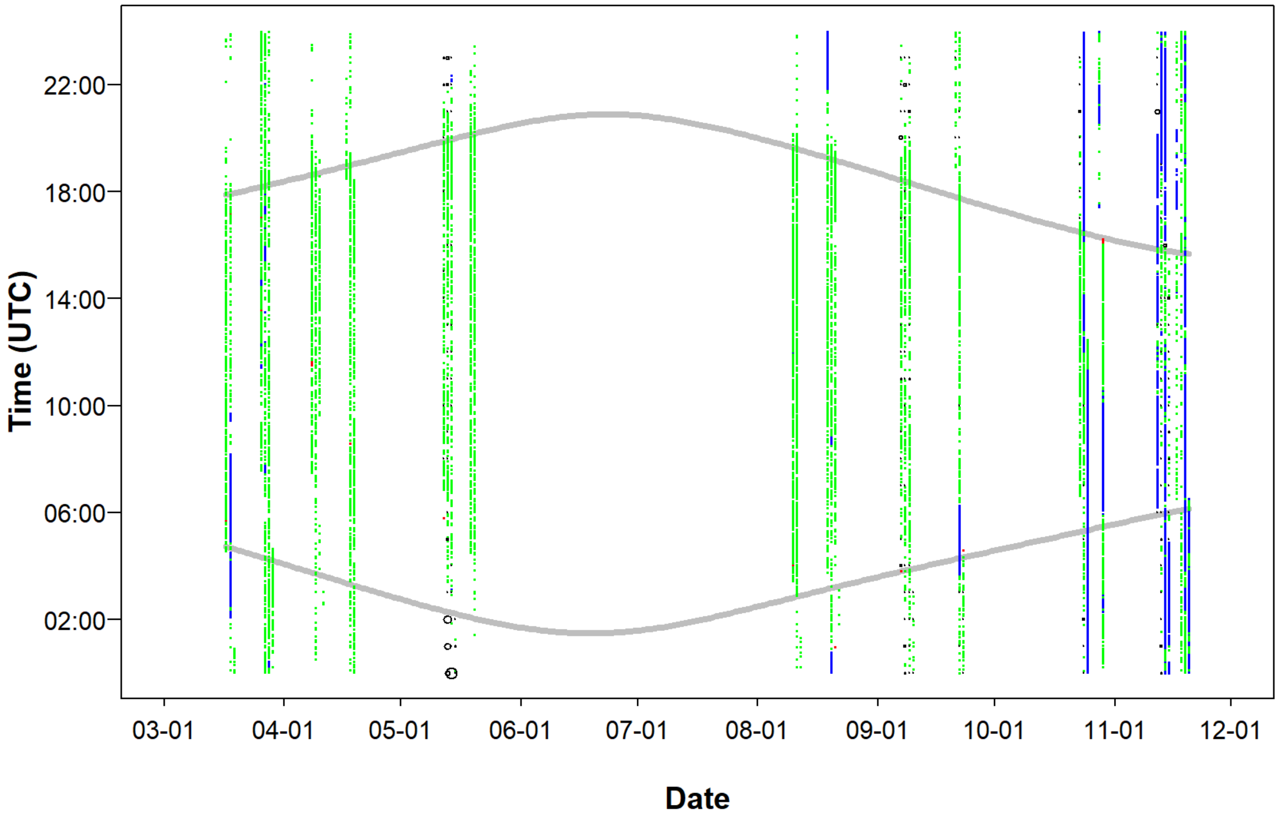


Figure 4-6 Effort of vertical radar (KF II OWF N). Colours during the time of recording indicate the possibility to analyse the data: green indicate periods with analysable data, blue are periods not evaluable due to precipitation, red are periods not analysable due to other disturbances. Black circles indicate the number of bird signals and grey lines mark the sunrise and sunset in spring and autumn 2023.

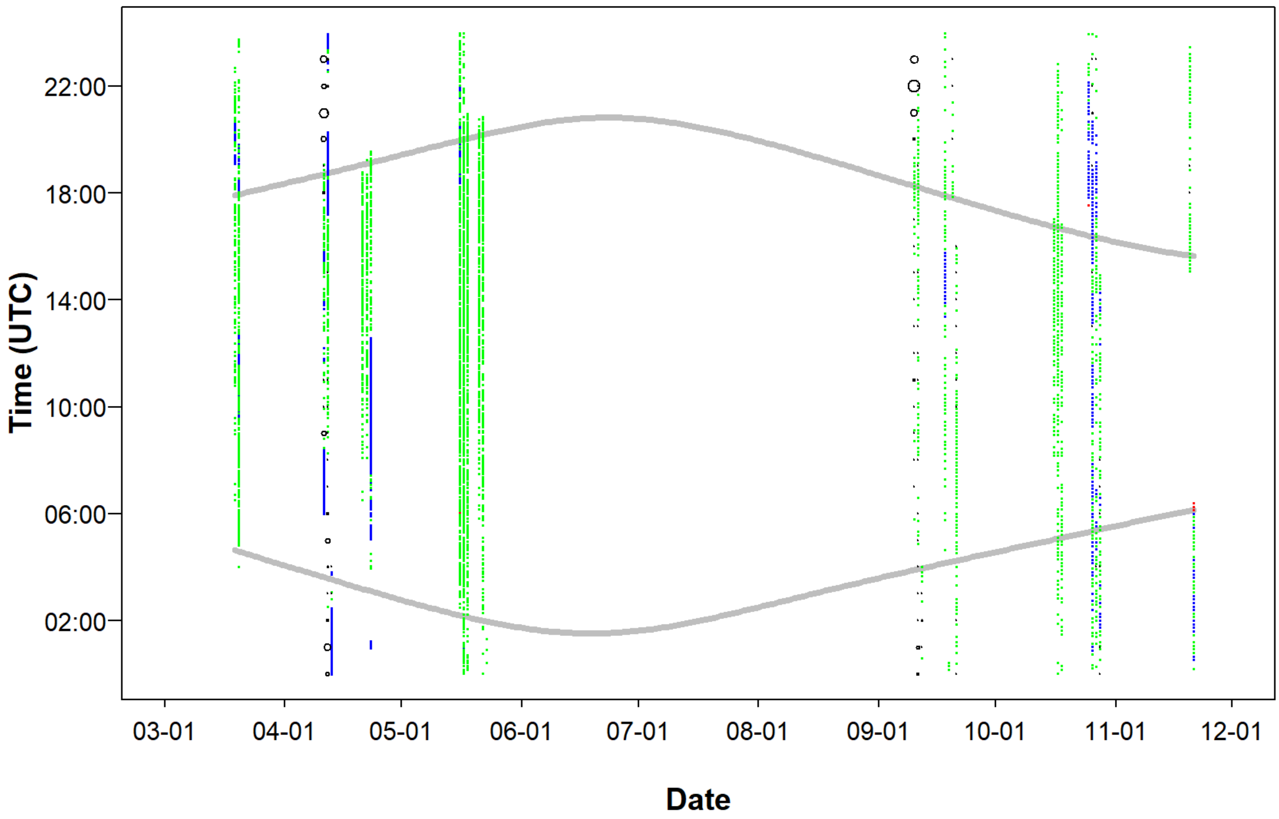


Figure 4-7 Effort of vertical radar (KF II OWF S). Colours during the time of recording indicate the possibility to analyse the data: green indicate periods with analysable data, blue are periods not evaluable due to precipitation, red are periods not analysable due to other disturbances. Black circles indicate the number of bird signals and grey lines mark the sunrise and sunset in autumn 2023.

As the detectability of bird signals is highly dependent on the distance to the radar, the raw data obtained as described above had to be distance-corrected before analysis. For this, empirical bird signal data of 50 to 150 m altitude were selected. The distance from the radar unit was determined for all signals in this altitude band and a distance-dependent detection probability was calculated according to BUCKLAND et al. (2001), using "Distance" package (MILLER ET AL. 2019) and the R software 4.2.2,. "Half normal" and "hazard rate" models up to 5th order were tested, choosing the best-fitting model per radar device based on Akaike information criterion. As in close vicinity of a radar the device generally does not record bird signals, an area of 100 m around the device was not considered for the determination of the correction functions.

Using the distance functions derived from the 50 - 150 m data, individual distance correction fac-tors were calculated for all recorded signals of the whole detection range up tom 1,5 km height, and the number of signals at each given altitude was corrected accordingly.

MIGRATION INTENSITY

The migration intensity was calculated as migration traffic rate (MTR). This is the number of signals that cross a virtual stretch of 1,000 m perpendicular to the migration direction every hour up to an altitude of 1000 m. Migration intensity was calculated for all hours of the recording periods for which at least three valid radar images were available.

For each day and night, the mean migration intensity was determined from the corresponding hourly results. Only days or nights for which hourly migration intensities were available for at least 70 % of the time, were taken into consideration. Like visual and acoustic observation data, results were depicted as an annual phenology as well as its distribution in the course of 24 hours.

FLIGHT ALTITUDE DISTRIBUTION

To represent the flight altitude distribution from vertical radar, the relative proportion of signals was determined for each 100 m height increment up to 1,000 m. The evaluation was carried out separately for diurnal and nocturnal migration and for spring and autumn migration, respectively. In order to show potential differences in altitude distribution between days/nights with high and low migration intensity, this evaluation was additionally conducted separately for the five days/nights with the highest migration intensities compared to the rest of days and nights sampled.

HORIZONTAL RADAR

Flight directions of birds were determined with the horizontal radar. A similar radar device with a transmission power of 25°KW and and 9,410 MHz wavelength was used, but the antenna was aligned horizontally instead of vertically.

DETECTION METHODOLOGY

Filters for rain and waves were turned off as they would also suppress an unknown number of bird signals. The detection radius of the radar was set to 3,000 m and the sensitivity (gain) of the radar antenna to 60 %. The afterglow duration was prolonged to 90 seconds in order to record flight paths of birds, which were used to determine the flight direction. The horizontal radar devices were operated in “north up” mode, the radar screen therefore always displayed north to the top independently of the ship’s orientation. Every four minutes, an image of the radar screen was captured and stored.

The recorded radar screenshots were visually scanned for bird signals, which were identified based on their size and the flight paths visible due to the afterglow period. Head (current position of a bird) and tail (end of the visible flight path) of each track were marked using the soft-ware “GSA Bird Counter 1.17” and stored as image coordinates, which were then converted into flight directions in relation to the north.

Horizontal radar screenshots are very often affected by sea clutter and therefore cannot be analysed. Since only relative information regarding flight directions is to be obtained from the data, quantification is not necessary. Only screenshots with less than 50 % of the image area covered by sea clutter were evaluated. The effort of horizontal radar surveys is shown in Figure 4-8 and Figure 4-9.

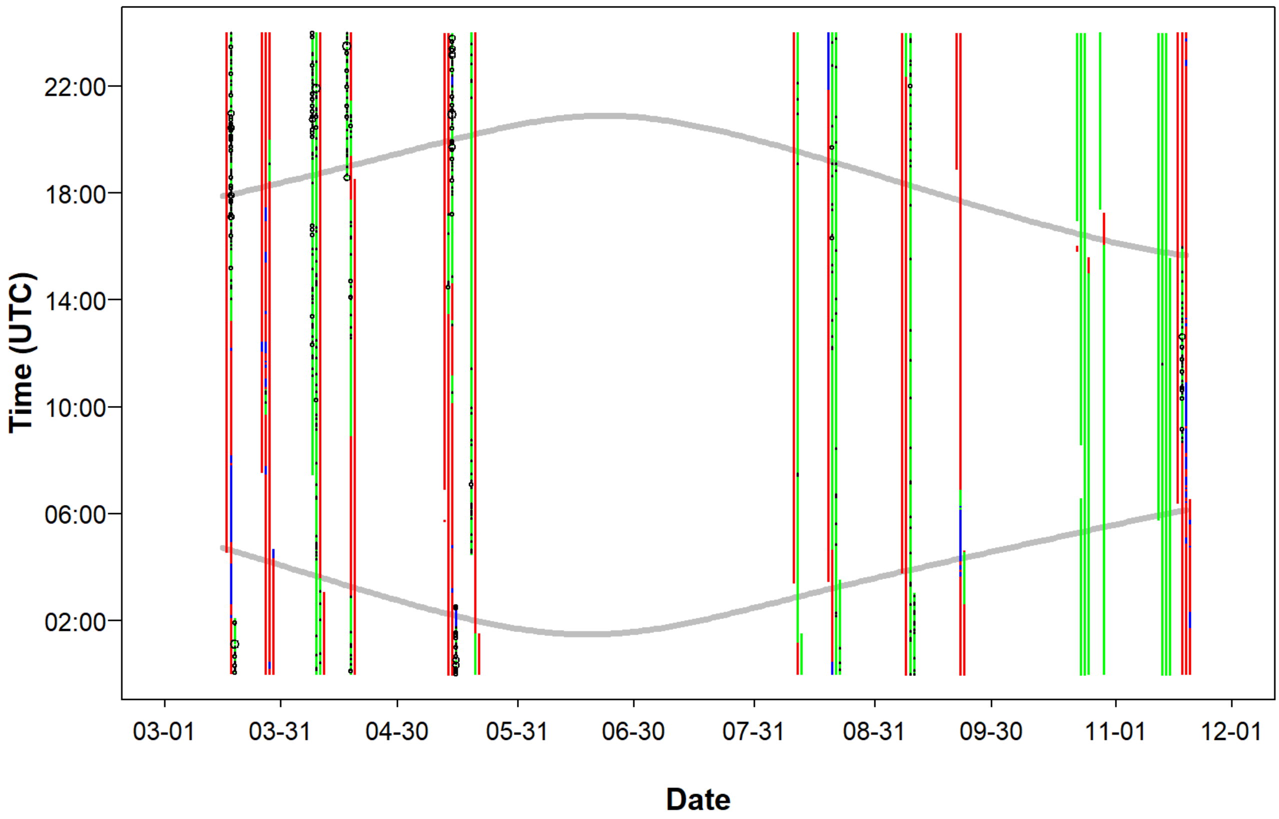


Figure 4-8 Effort of horizontal radar for the pre-investigation area KF II OWF N. Colours during the time of recording indicate the possibility to analyse the data: green indicate periods with analysable data, blue are periods not evaluable due to precipitation, red are periods not analysable due to other disturbances. Black circles indicate the number of bird signals and grey lines mark the sunrise and sunset in 2023.

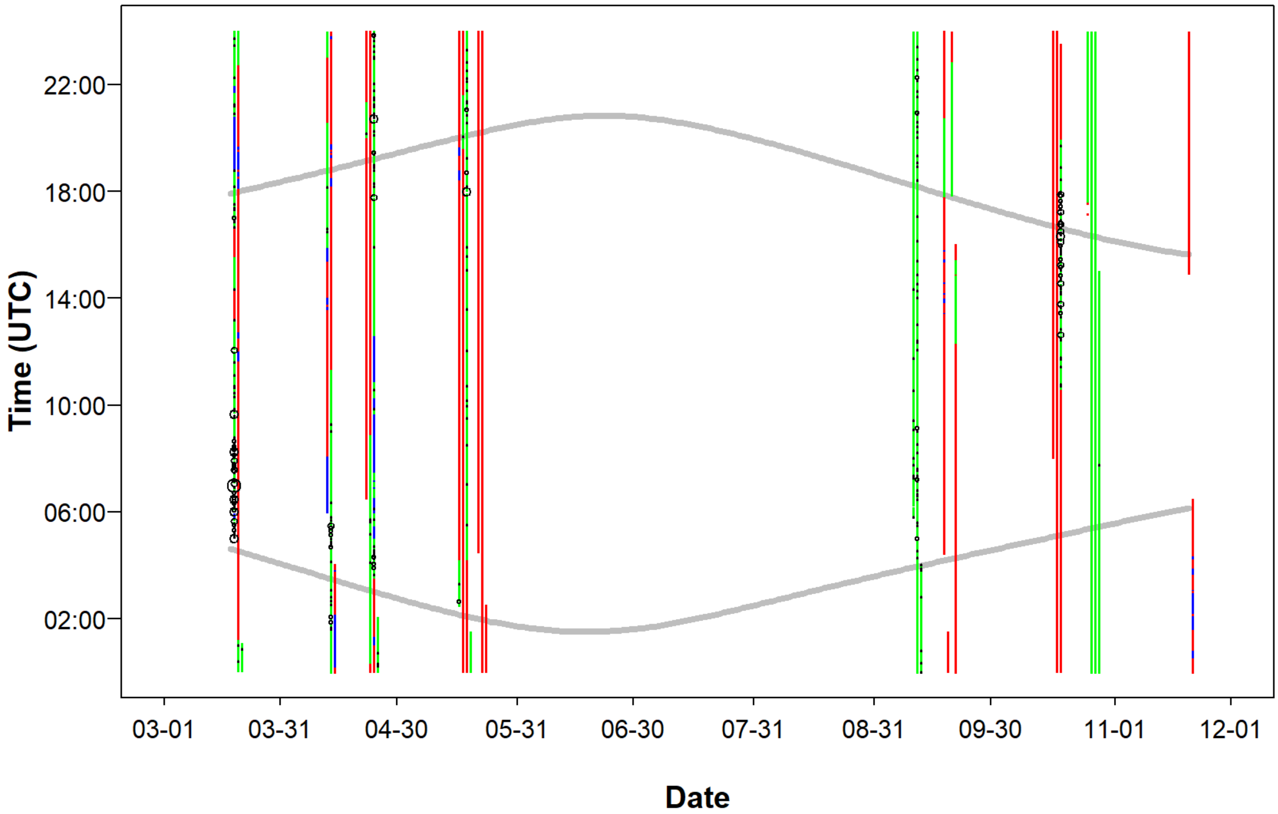


Figure 4-9 Effort of horizontal radar for the pre-investigation area KF II OWF S. Colours during the time of recording indicate the possibility to analyse the data: green indicate periods with analysable data, blue are periods not evaluable due to precipitation, red are periods not analyzable due to other disturbances. Black circles indicate the number of bird signals and grey lines mark the sunrise and sunset in 2023.

FLIGHT DIRECTION

The flight direction distribution was presented per season for both day and night migration. For plotting, flight directions were grouped into 20° increments. Using Rayleigh tests, it was tested whether directional migration could be assumed based on the respective directional distribution. When this was the case, the mean direction of flight was marked with an arrow in the diagrams.

All analysis described in this chapter were conducted using R 4.2.2.

5 DATA AND RESULTS

5.1 RESTING BIRDS

5.1.1 ALL SPECIES

Table 5-1 reports the total number of resting bird species observed during the six digital aerial surveys between February 2023 and January 2024. The phenology and spatial distribution of species which represented at least 0.5% of total abundance are described in more detail in the next pages.

Table 5-1 Bird counts and percentages of all resting bird species during the six digital aerial surveys between February 2023 and January 2024. Species representing at least 0.5% of total abundance are highlighted.

Species groups	English name	Scientific name	All digital surveys	
			N ind.	Percentage
Divers	Red-throated diver	*Gavia stellata*	163	0.73
Divers	Black-throated diver	*Gavia arctica*	88	0.39
Divers	unidentified diver	*Gavia sp.*	70	0.31
Grebes	Great crested grebe	*Podiceps cristatus*	48	0.21
Grebes	Red-necked grebe	*Podiceps grisegena*	18	0.08
Grebes	Slavonian grebe	*Podiceps auritus*	63	0.28
Grebes	Red-necked/great crested grebe	*Podiceps grisegena/Podiceps cristatus*	51	0.23
Grebes	Slavonian/Black-necked Grebe	*Podiceps auritus/Podiceps cristatus*	4	0.02
Grebes	unidentified grebe	Podicipedidae *sp.*	109	0.49
Gannets	Northern gannet	*Morus bassanus*	8	0.04
Cormorants	**Great cormorant**	***Phalacrocorax carbo***	**729**	**3.25**
Ducks	**Common eider**	***Somateria mollissima***	**7,933**	**35.39**
Ducks	**Long-tailed duck**	***Clangula hyemalis***	**1,570**	**7.00**
Ducks	**Common scoter**	***Melanitta nigra***	**7,777**	**34.70**

Ducks	**Common/velvet scoter**	***Melanitta sp.***	**333**	**1.48**
Ducks	**Velvet scoter**	***Melanitta fusca***	**631**	**2.82**
Gulls	Little gull	*Hydrocoloeus minutus*	44	0.20
Gulls	**Black-headed gull**	***Chroicocephalus ridibundus***	**217**	**0.97**
Gulls	**Common gull**	***Larus canus***	**456**	**2.03**
Gulls	unidentified small gull	*Larus small sp.*	39	0.17
Gulls	Lesser black-backed gull	*Larus fuscus*	19	0.08
Gulls	**Herring gull**	***Larus argentatus***	**652**	**2.91**
Gulls	Common/herring gull	*Larus canus / Larus argentatus*	61	0.27
Gulls	**Great black-backed gull**	***Larus marinus***	**136**	**0.61**
Gulls	unidentified large gull	*Larus (magnus) sp.*	52	0.23
Gulls	Great / lesser black-backed gull	*Larus fuscus/Larus marinus*	5	0.02
Gulls?	fulmar/gull	*Fulmarus/Larus*	1	0.00
Gulls	unidentified gull	Laridae *sp.*	20	0.09
Terns	Sandwich tern	*Thalasseus sandvicensis*	43	0.19
Terns	Common/Arctic tern	*Sterna hirundo/Sterna paradisaea*	67	0.30
Terns	Little tern	*Sternula albifrons*	5	0.02
Terns/Gulls	tern/small gull	*Sterna spp / Larus spp.*	8	0.04
Terns	unidentified tern	Sternidae *sp.*	5	0.02
Auks	**Common guillemot**	***Uria aalge***	**362**	**1.61**
Auks	Common guillemot/razorbill	*Uria aalge / Alca torda*	224	1.00
Auks	**Razorbill**	***Alca torda***	**362**	**1.61**
Auks	Black guillemot	*Cepphus grylle*	30	0.13
Auks	unidentified auk	Alcidae *sp.*	12	0.05

Total			**22,415**	**100**

Table 5-2 includes monthly densities for each of the months at which digital aerial surveys were available.

Table 5-2. Monthly mean densities (ind./km²) of selected species/species groups recorded in the survey area during digital aerial surveys from February 2023 and January 2024. The maximum value is also indicated. The number 0 means that no individual of this species/species group was found in that month.

Survey Method	**Digital aerial surveys**						
Species/Species-group	**February 2023**	**April 2023**	**June 2023**	**August 2023**	**October 2023**	**December 2023**	**Max**
Red-throated diver	0.093	0.072	0.005	0	0.027	**0.18**	**0.18**
Black-throated diver	0.032	0.046	0	0	**0.094**	0.036	**0.094**
Great crested grebe	0.039	0.005	0	0.003	0.022	**0.043**	**0.043**
Great cormorant	0.322	0.05	0.04	0.274	**0.877**	0.213	**0.877**
Common eider	4.078	6.109	0.055	0.059	**7.409**	1.148	**7.409**
Long-tailed duck	1.127	**1.713**	0.171	0	0	0.67	**1.713**
Common scoter	5.284	4.801	0.086	0	2.39	**5.551**	**5.551**
Velvet scoter	**0.624**	0.118	0	0	0.458	0.276	**0.624**
Little gull	0.005	0.005	0	0	**0.096**	0	**0.096**
Black-headed gull	0.063	0.127	0.102	**0.186**	0.039	0.034	**0.186**
Common gull	0.176	0.305	0.059	0.006	**0.352**	0.18	**0.352**
Lesser black-backed gull	0.007	**0.014**	0.007	0.006	0.012	0	**0.014**
Herring gull	0.218	0.362	0.05	0.032	**0.583**	0.299	**0.583**
Great black-backed gull	0.044	0.007	0	0.006	**0.202**	0.063	**0.202**
Arctic/common tern	0	0	0.014	**0.18**	0	0	**0.18**
Sandwich tern	0	0.01	0.007	**0.106**	0	0	**0.106**
Common guillemot	**0.58**	0.151	0.01	0.003	0.027	0.074	**0.58**
Razorbill	**0.459**	0.336	0	0	0.007	0.047	**0.459**
Black guillemot	**0.042**	0.007	0.002	0	0.005	0.013	**0.042**
Divers	0.204	0.146	0.007	0	0.13	**0.258**	**0.258**
Grebes	**0.315**	0.156	0	0.006	0.046	0.16	**0.315**
Ducks	11.586	**12.810**	0.312	0.059	10.333	7.645	**12.810**
Gulls	0.598	0.917	0.219	0.268	**1.429**	0.629	**1.429**
Terns	0.000	0.010	0.029	**0.306**	0.000	0.000	**0.306**
Auks	**1.308**	0.758	0.012	0.003	0.048	0.189	**1.308**
No. of surveys	**1**	**1**	**1**	**1**	**1**	**1**	

During the six digital aerial surveys conducted between February 2023 and January 2024 (see Table 4-1), a total of 25,621 birds were observed of which 22,415 were classified as resting birds. Of these, 1,061 birds could not be identified to species level (4.7% of the total number of resting birds). The total number of birds, together with their scientific names, Danish common names and conservation status are shown in Table A-1 in the appendix. The resting birds identified in this study belonged to 22 species (see Table 5-1).

Sea ducks dominated the resting bird community. Altogether, sea ducks represented 81.4% of all resting birds found in the area during all digital aerial surveys (Figure 5-1). Three sea duck species were the most common species: common eiders were the most common ones (35.4%), closely followed by common scoters (34.7%) and the third most common species during the whole period of surveys was the long-tailed duck (7.0%). An additional species of sea duck was seen in less numbers but still represented 2.8% of all resting birds (velvet scoters). Six species of gulls made up the second most common group, which in total represented just 7.6% of all resting birds. Of gulls, herring gulls were the most common ones, and its abundance made up for 2.9% of all resting birds seen in all surveys. Nonetheless, common gulls, black-headed gulls and great black-backed gulls represented more than 0.5% of all resting birds and are further described in the next section. The group of auks were the third most abundant group and altogether they represented 4.4% of all resting birds. Two species were recorded in similar proportions: razorbills (1.6%) and common guillemots (1.6%). An additional 1.0% of individuals could not be determined on species level and are grouped as common guillemots/razorbills. Lastly, with a total of 729 individuals, great cormorants were the fourth most abundant species representing 3.3% of all resting birds during the whole period. Divers, grebes and terns represented 1.4%, 1.3% and 0.5% of all resting birds and are presented in the following section as well.

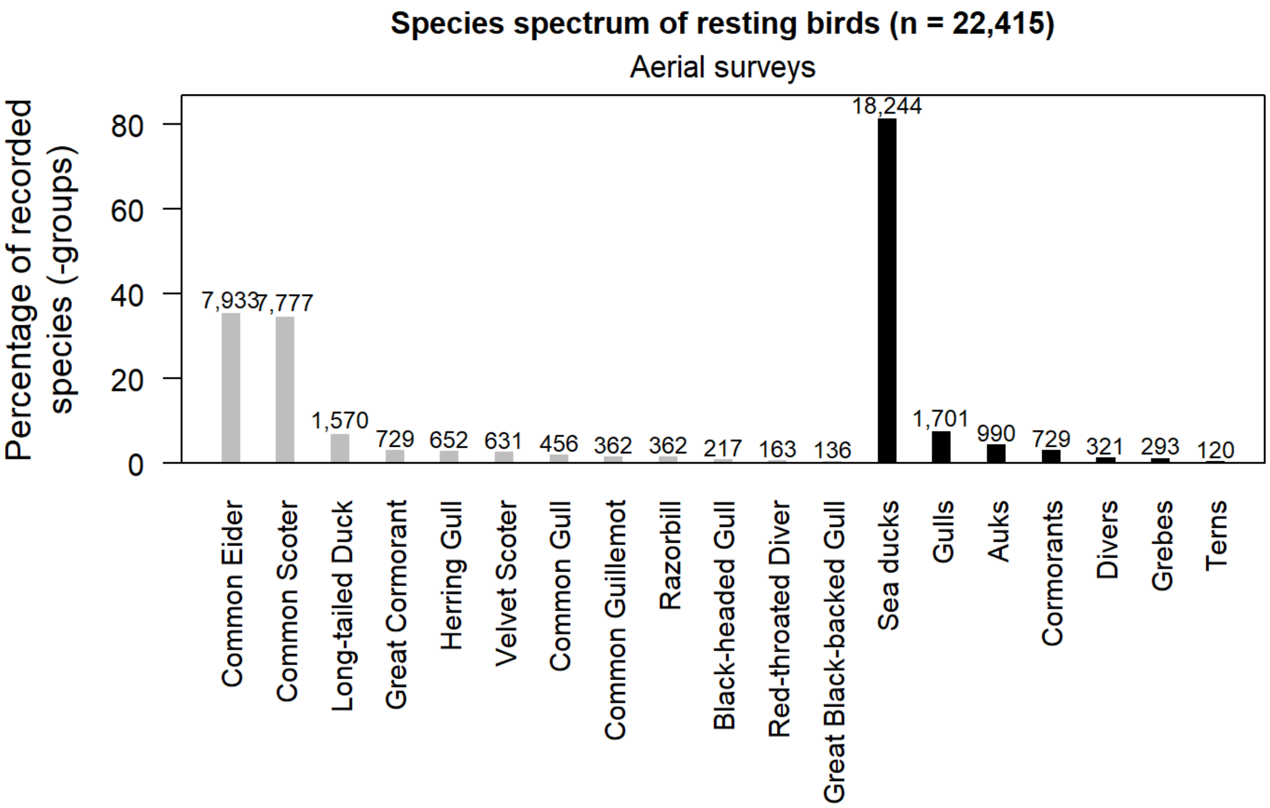


Figure 5-1 Percentage of the most common species or species groups representing at least 0.5% of the total number of resting birds recorded during aerial surveys in the survey area between February 2023 and January 2024 (number of individuals shown above each bar). Species are depicted in grey, species groups in black

5.1.2 ABUNDANCE AND DISTRIBUTION OF THE MOST COMMON SPECIES

DIVERS

Two species of divers were seen in the area: red-throated and black-throated divers. There were almost double as many individuals of the first species than of the second one (163 vs. 88 individuals, respectively). In addition, there were 70 individuals that could not be properly identified and were classified as unidentified divers. The maximum number of divers were spotted in December 2023 when their density reached 0.26 ind./km². They occurred at very low densities or were totally absent during summer. For instance, black-throated divers were not seen in the surveys of June or August. Diver densities appeared to increase again towards the start of the autumn/winter season. In October they reached a density of 0.13 ind./km² (Figure 5-2). In terms of seasonal densities for divers, the highest seasonal density was winter period (0.23 ind./km²) which included the flights of February and December and the lowest one in summer (0.04 ind./km², June and August flights).

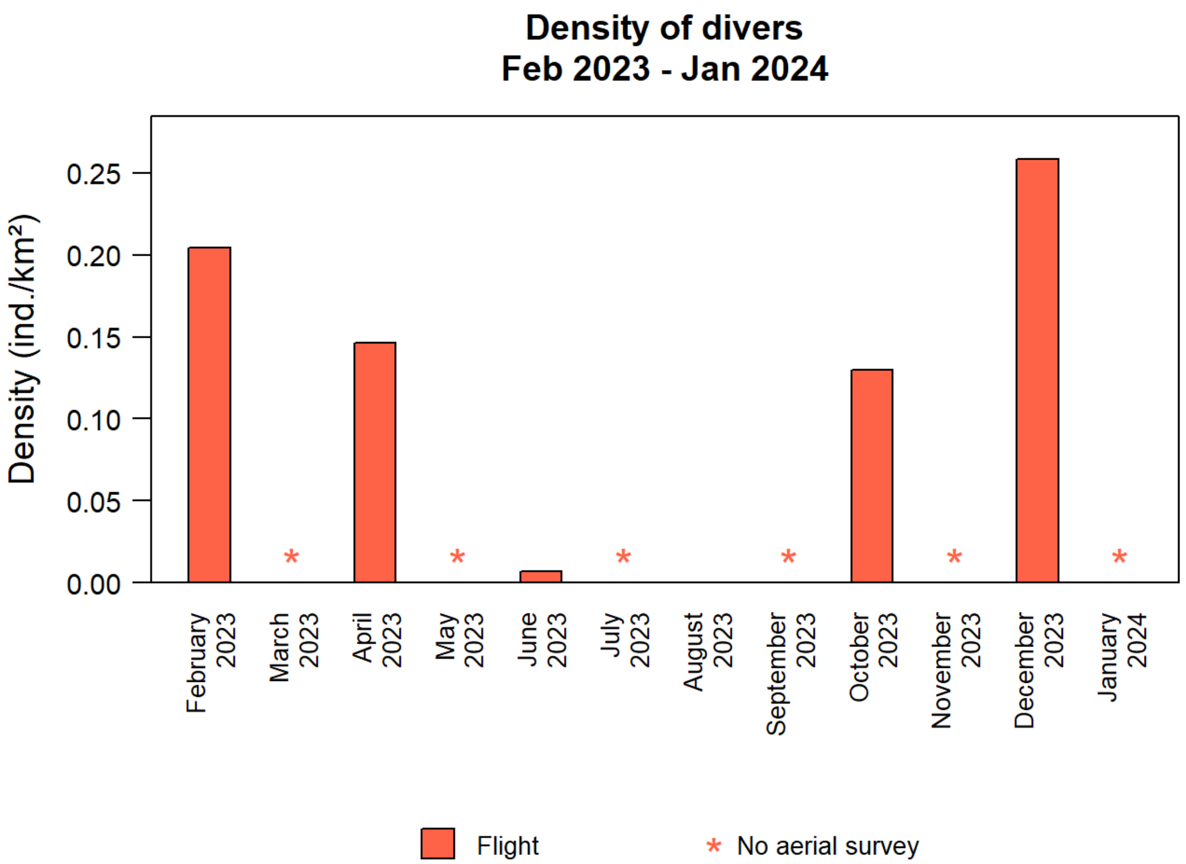


Figure 5-2 Monthly densities of divers during digital aerial surveys in the survey area between February 2023 and January 2024.

During spring, divers were located mainly along the Danish and Swedish coast southeast of Falsterbo, but few individuals were also present around the existing OWF Kriegers Flak, as well as north of Rügen (Figure 5-3). During summer, only very few individuals were found around Falsterbo and Møn. In autumn, divers were located north of Møn and south of Falsterbo. A few individuals were observed west of Kriegers Flak. During winter, individuals were generally present in the entire study area, but the majority of divers was located along the coastal waters of Denmark and Sweden. Several individuals were also observed in and around the operating OWF Kriegers Flak.

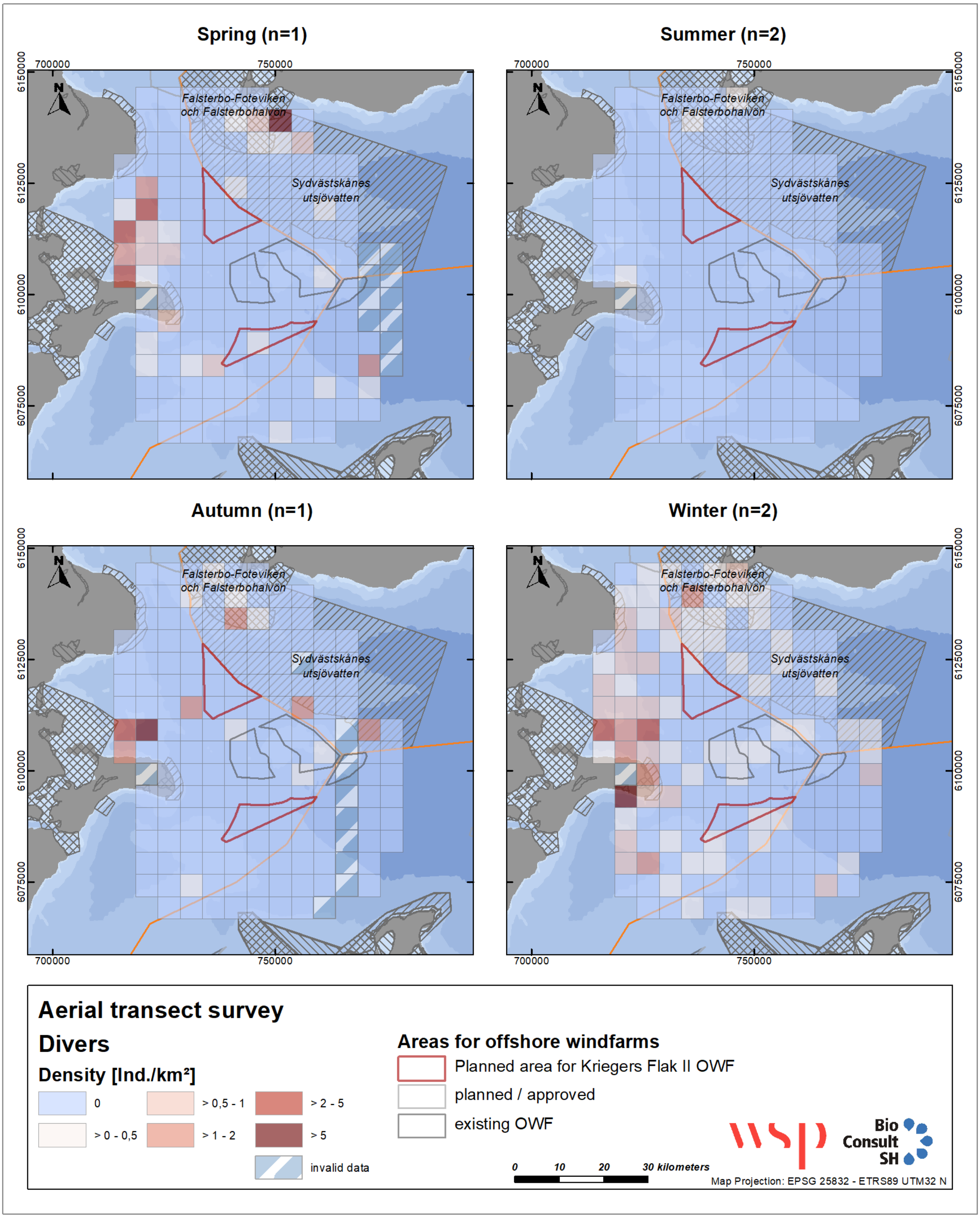


Figure 5-3 Distribution of divers in the survey area per season during the digital aerial surveys between February 2023 and October 2023. Seasonal classification species-specific according to GARTHE ET AL. (2007).

GREBES

Three species of grebes were found during the digital aerial surveys in the area. In terms of decreasing abundance these were: Slavonian grebe, great crested grebe and the red-necked grebe. In addition, there were 51 individuals of grebes that could not be told apart between red-necked and great crested grebes, and 4 individuals that could not be distinguished between Slavonian and black-neckd grebe and the majority of grebes occurring in the area (109 individuals) could not be identified to species level. In total, grebes made up for 1.3% of all resting birds observed in the survey area.
Their abundances were highest in February when they reached a density of 0.32 ind./km² and decreased in April and was lowest during summer, increasing again in survey of October and even more in December 2023 (Figure 5-4).

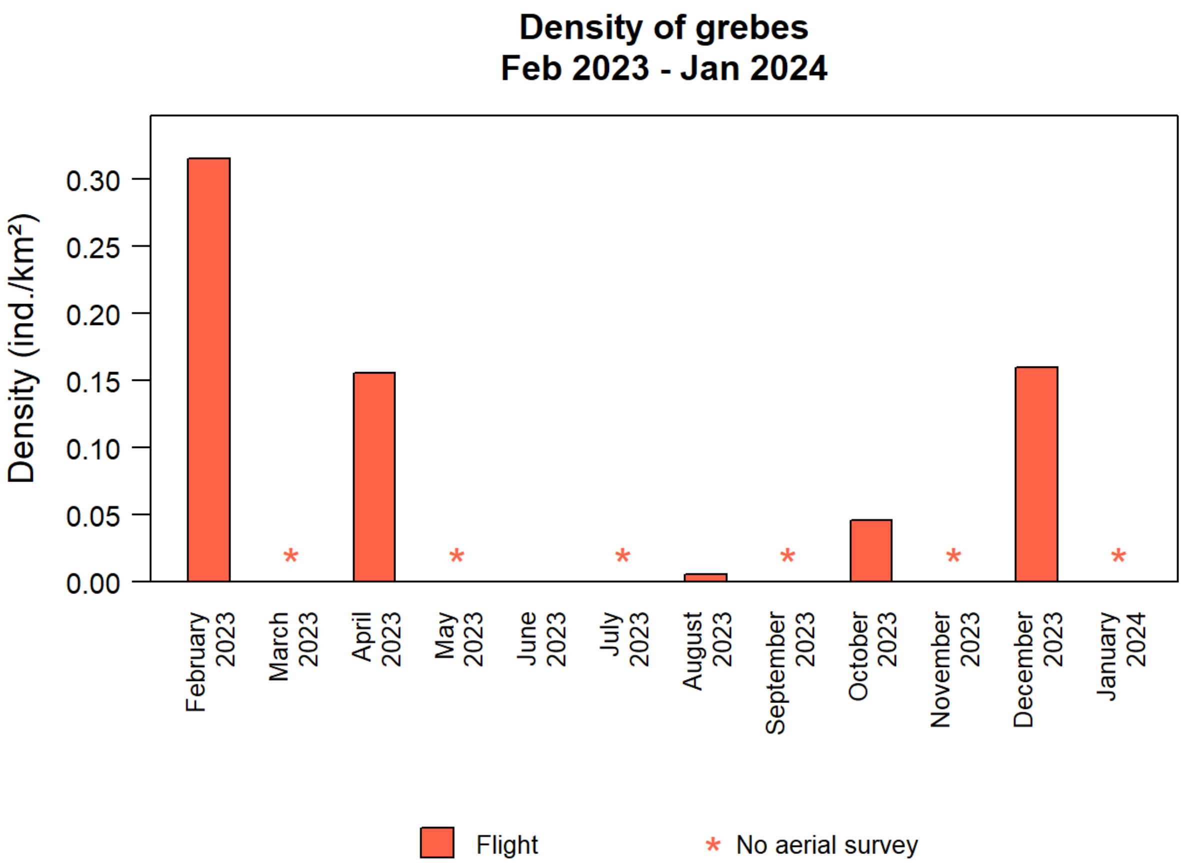


Figure 5-4 Monthly densities of grebes during digital aerial surveys in the survey area between February 2023 and January 2024.

GREAT CORMORANT

A total of 729 individuals of great cormorants were detected in all the surveys. The abundance of this species was the highest in the month of October (0.88 ind./km²) and lower in the months of April and June. These latter months coincide with the summer season of the species where the seasonal density was the lowest (0.041 ind./km²). Seasonal density was higher in the autumn season (0.61 ind./km², the average of the densities of

August and October). The maximum monthly density occurred in October 2023 and was 0.877 ind./km² (Figure 5-5).

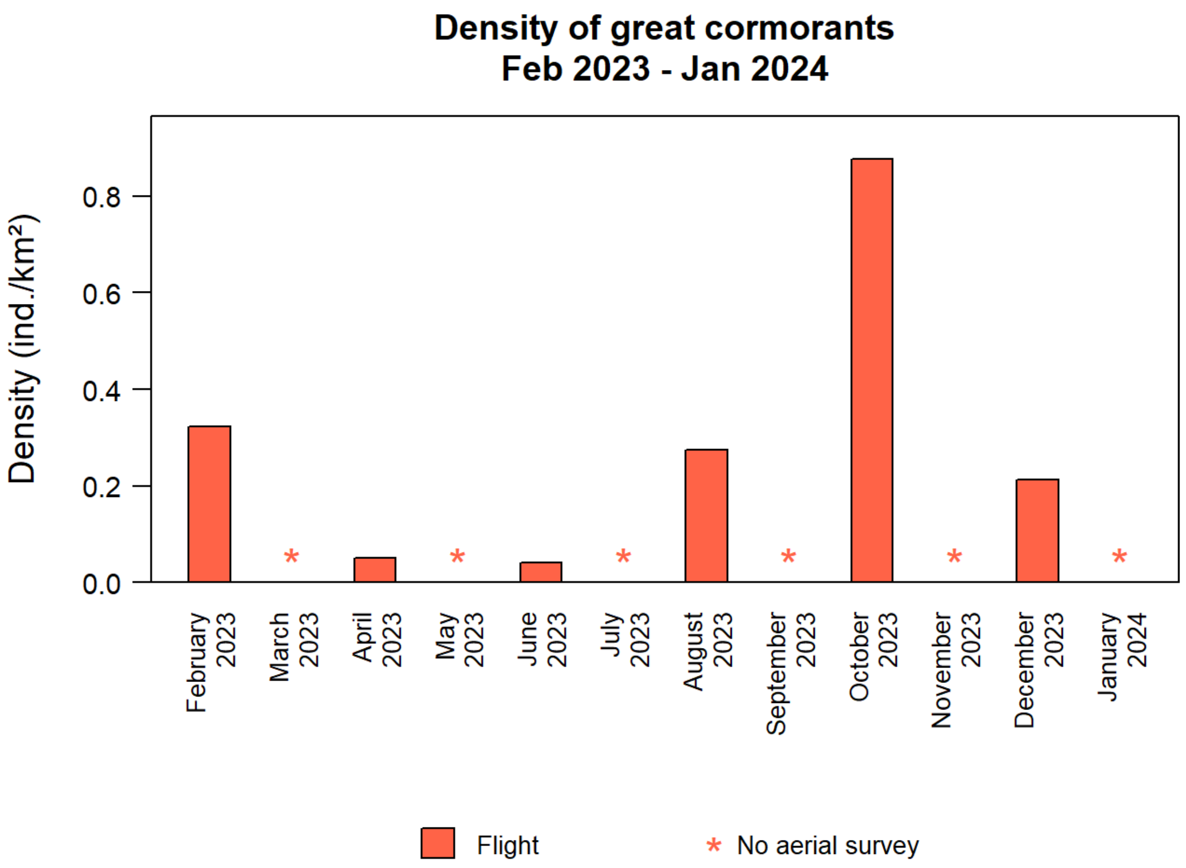


Figure 5-5 Monthly densities of great cormorants during digital aerial surveys in the survey area between February 2023 and January 2024.

Great cormorants were mainly encountered in the shallower areas of the pre-investigation area and close to the shore (close to the island of Møn and around the peninsula Falsterbo, Figure 5-6). Nonetheless, there were some grid cells that contained high densities of cormorants in spring, but also in other seasons within the offshore region in the middle of the pre-investigation area within the already existing wind farms in the area of Kriegers Flak. After rechecking the pictures from the birds observed within the existing OWF we could proof that these cormorants conquered the helicopter landing decks of the transformer platforms as a new resting habitat (

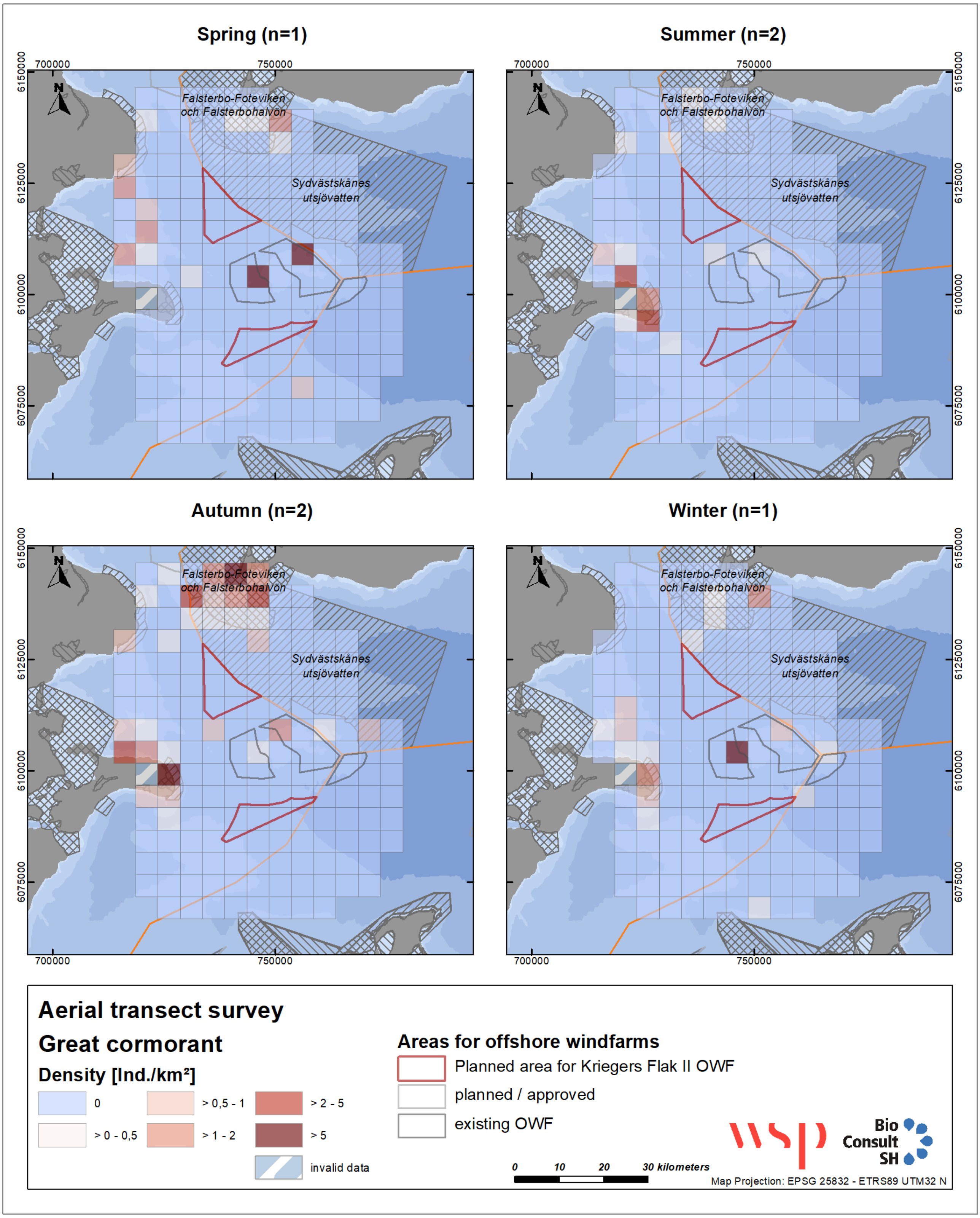

Spring (n=1)
Summer (n=2)
Autumn (n=2)
Winter (n=1)
700000
750000
6150000
6125000
6100000
6075000
N
Falsterbo-Foteviken
och Falsterbohalvön
Sydvästskånes
utsjövatten
Aerial transect survey
Great cormorant
Density [Ind./km²]
0
> 0 - 0,5
> 0,5 - 1
> 1 - 2
> 2 - 5
> 5
invalid data
Areas for offshore windfarms
Planned area for Kriegers Flak II OWF
planned / approved
existing OWF
0
10
20
30 kilometers
Map Projection: EPSG 25832 - ETRS89 UTM32 N
wsp
Bio
Consult
SH

Figure 5-6 Distribution of great cormorants in the survey area per season during the digital aerial surveys between February 2023 and October 2023. Seasonal classification species-specific according to GARTHE ET AL. (2007).

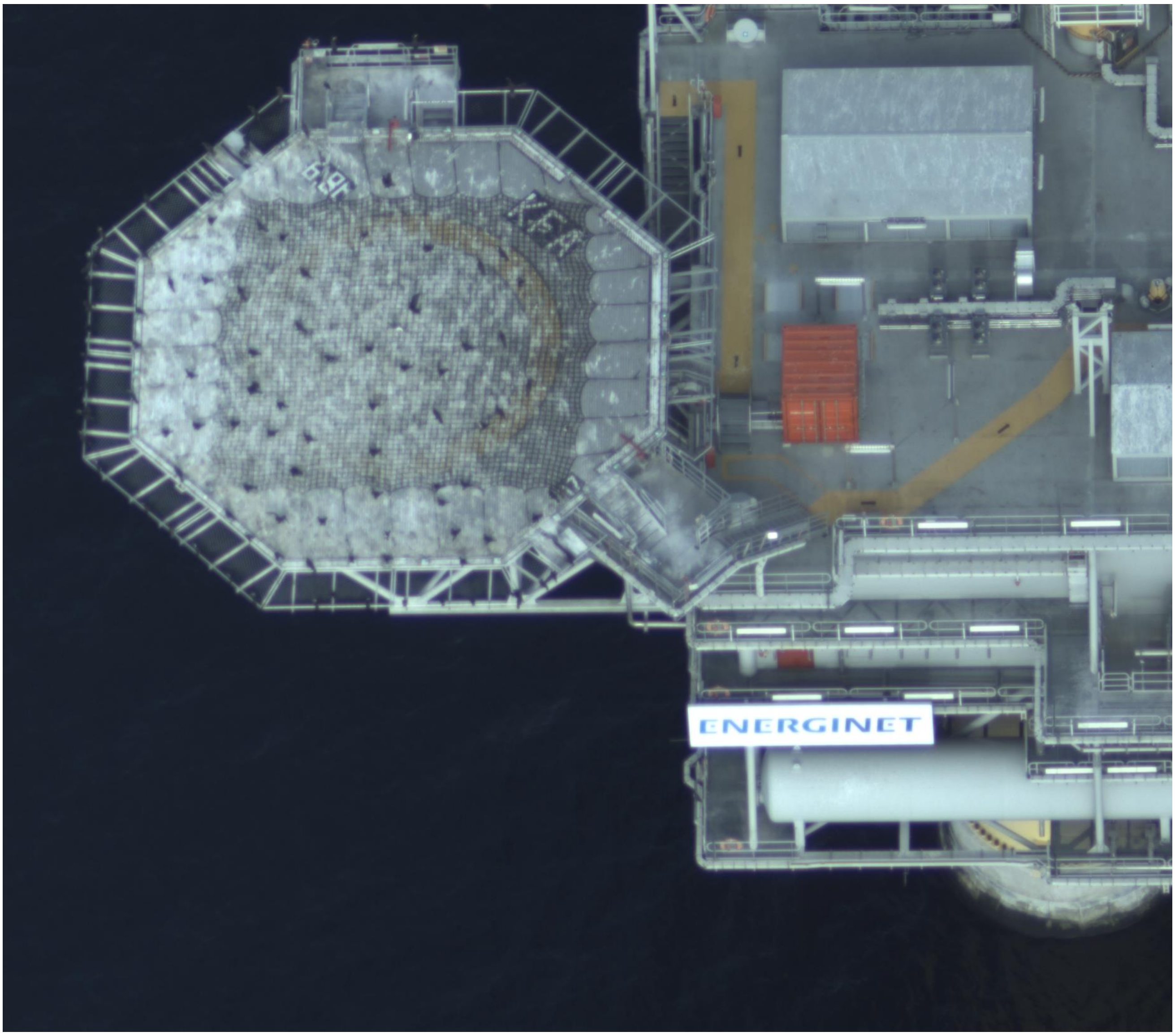


Figure 5-7 Cormorants resting on the helicopter deck of the transformer station in the OWF Kriegers Flak in February 2023.

DUCKS

Sea ducks were the most common species group and represented 81.4% of the total resting birds. Two species were dominant: common eiders (35.4%) and common scoters (34.7%), and still two other species occurred at relatively high abundances and are also presented here: long-tailed ducks (7%) and velvet scoters (2.8%).

COMMON EIDER

A total of 7,933 common eiders were registered in the survey area during the six digital surveys. The highest monthly density was observed in October with 7.4 ind./km² (Figure 5-8) and coincided with the autumn season. The lowest densities were observed in the surveys of June and August which correspond to the summer season of the species. The summer density was then 0.06 ind./km². The surveys of February and December corresponded to the winter season while the survey of April corresponded with spring (seasonal densities of winter and spring were 2.6 and 6.1 ind./km², respectively).

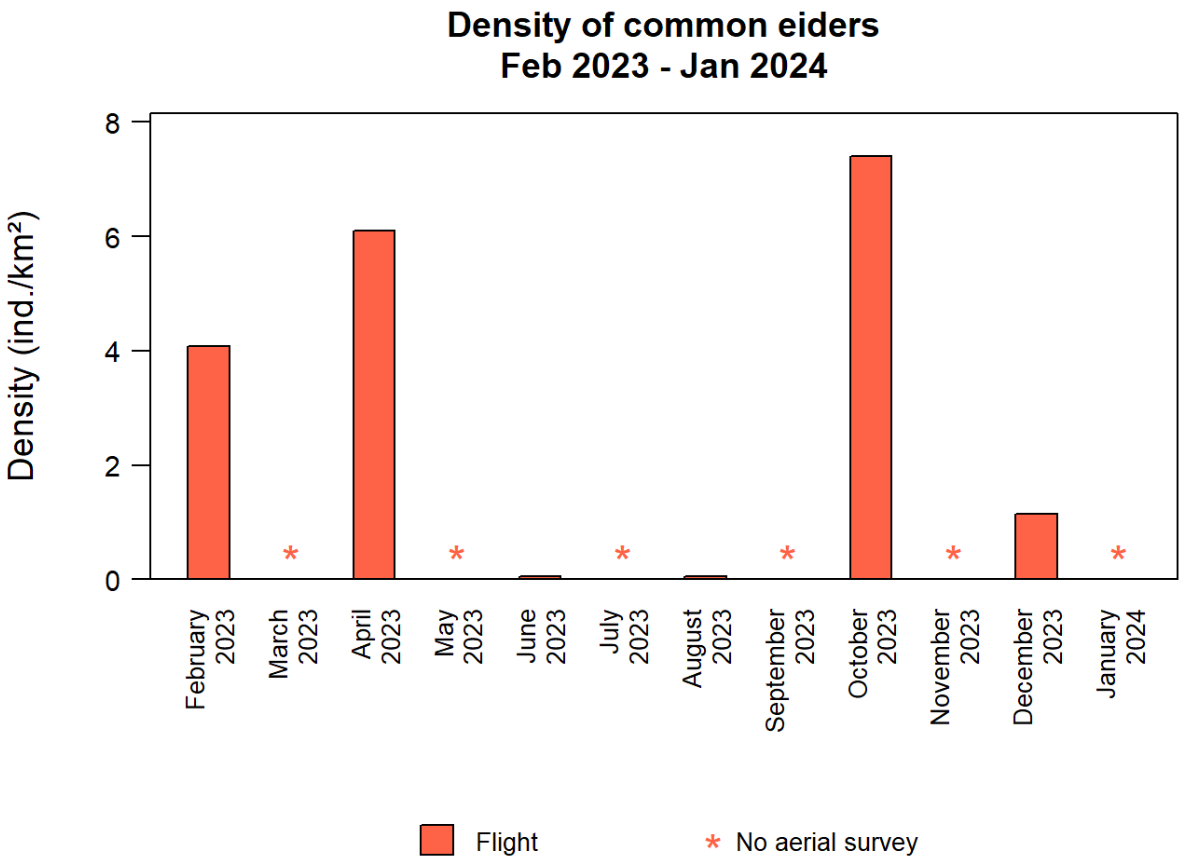


Figure 5-8 Monthly densities of common eiders during digital aerial surveys in the survey area between February 2023 and January 2024.

Common eiders were present in large densities throughout the entire study area with birds also located within and around the operating OWF Kriegers Flak (Figure 5-9). During summer, only few individuals were observed around Møn as well as south of Falsterbo and northwest of Kriegers Flak. During autumn, densities increased with more common eiders located along the coastal areas of Denmark and Sweden, particularly south of Falsterbo. Several flocks were also observed in the southern parts of the study area and in and around Kriegers Flak. During winter, individuals were mainly located south of Falsterbo and along the Danish coasts.Some individuals were present in the areas around Kriegers Flak and close to Rügen.

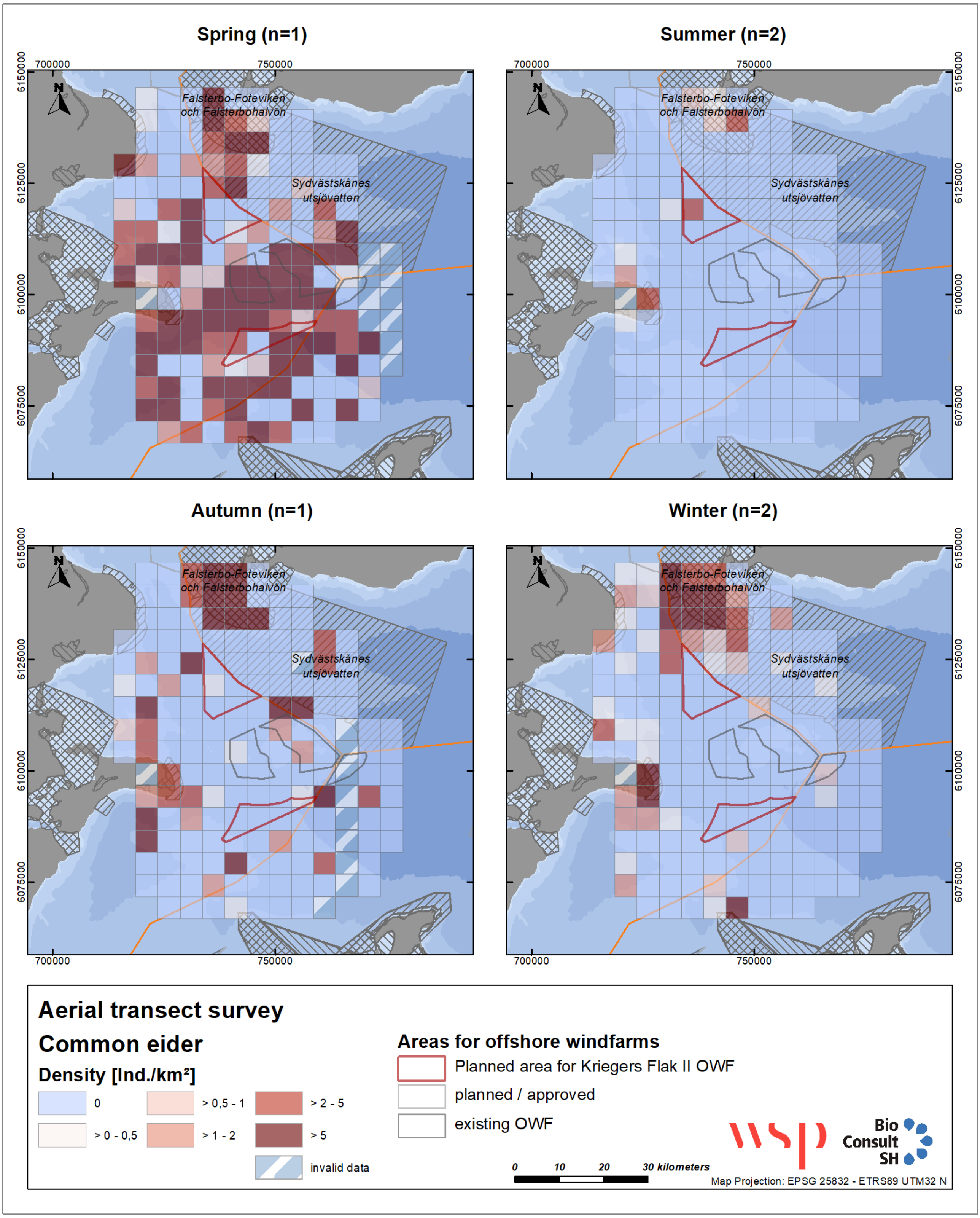
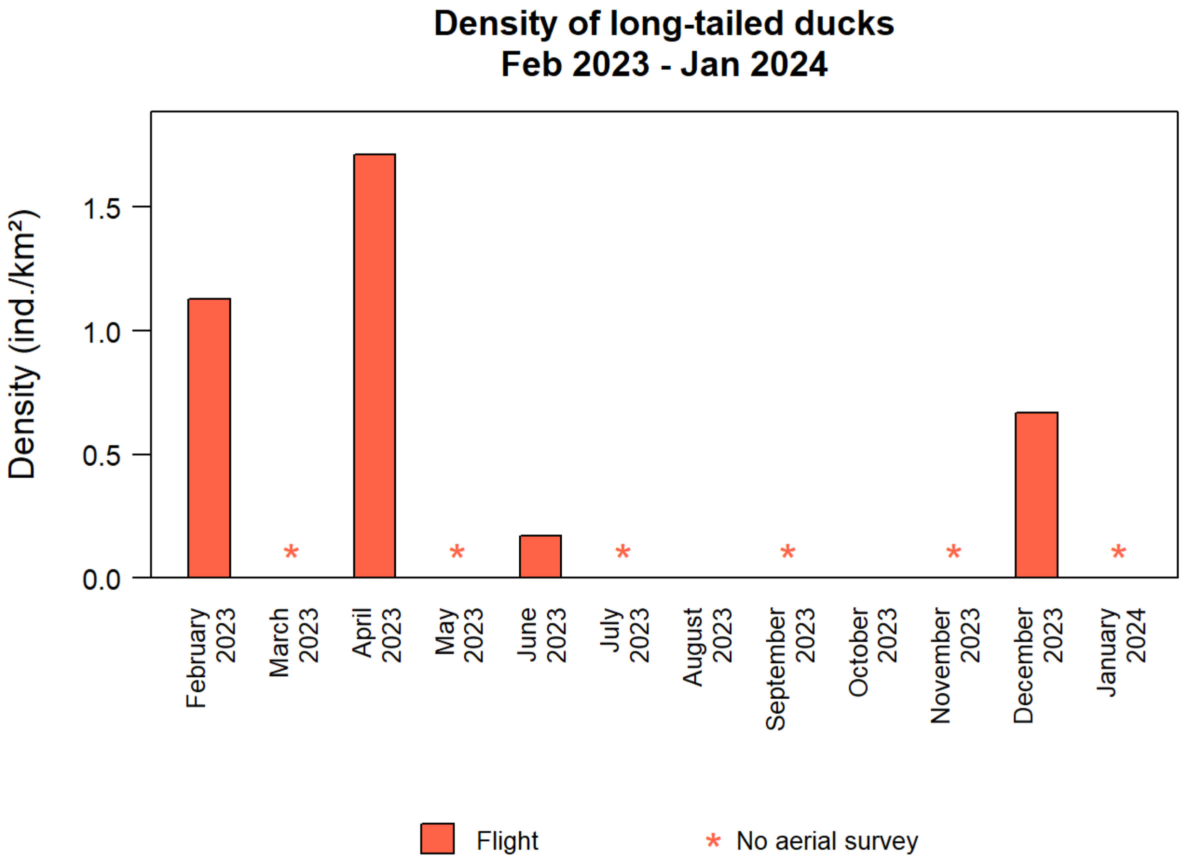

Spring (n=1)
Summer (n=2)
Autumn (n=1)
Winter (n=2)
700000
750000
6150000
6125000
6100000
6075000
Falsterbo-Foteviken och Falsterbohalvön
Sydvästskånes utsjövatten
Aerial transect survey
Common eider
Density [Ind./km²]
0
> 0 - 0,5
> 0,5 - 1
> 1 - 2
> 2 - 5
> 5
invalid data
Areas for offshore windfarms
Planned area for Kriegers Flak II OWF
planned / approved
existing OWF
0 10 20 30 kilometers
Map Projection: EPSG 25832 - ETRS89 UTM32 N
Bio Consult SH

Figure 5-9 Distribution of common eiders in the survey area per season during the digital aerial surveys between February 2023 and October 2023. Seasonal classification species-specific according to GARTHE ET AL. (2007).

LONG-TAILED DUCK

With 1,570 individuals, long-tailed ducks were the third most common species of resting birds observed in the area. Most individuals occurred in the April survey when the density reached 1.71 ind./km². This month corresponded to the density of spring as well. No long-tailed ducks were observed in the flights of August and October, which corresponded to the seasons of summer and autumn, respectively (Figure 5-10). The seasonal density in winter was 0.9 ind./km².



Density of long-tailed ducks
Feb 2023 - Jan 2024
Density (ind./km²)
0.0
0.5
1.0
1.5
February 2023
March 2023
April 2023
May 2023
June 2023
July 2023
August 2023
September 2023
October 2023
November 2023
December 2023
January 2024
Flight
No aerial survey

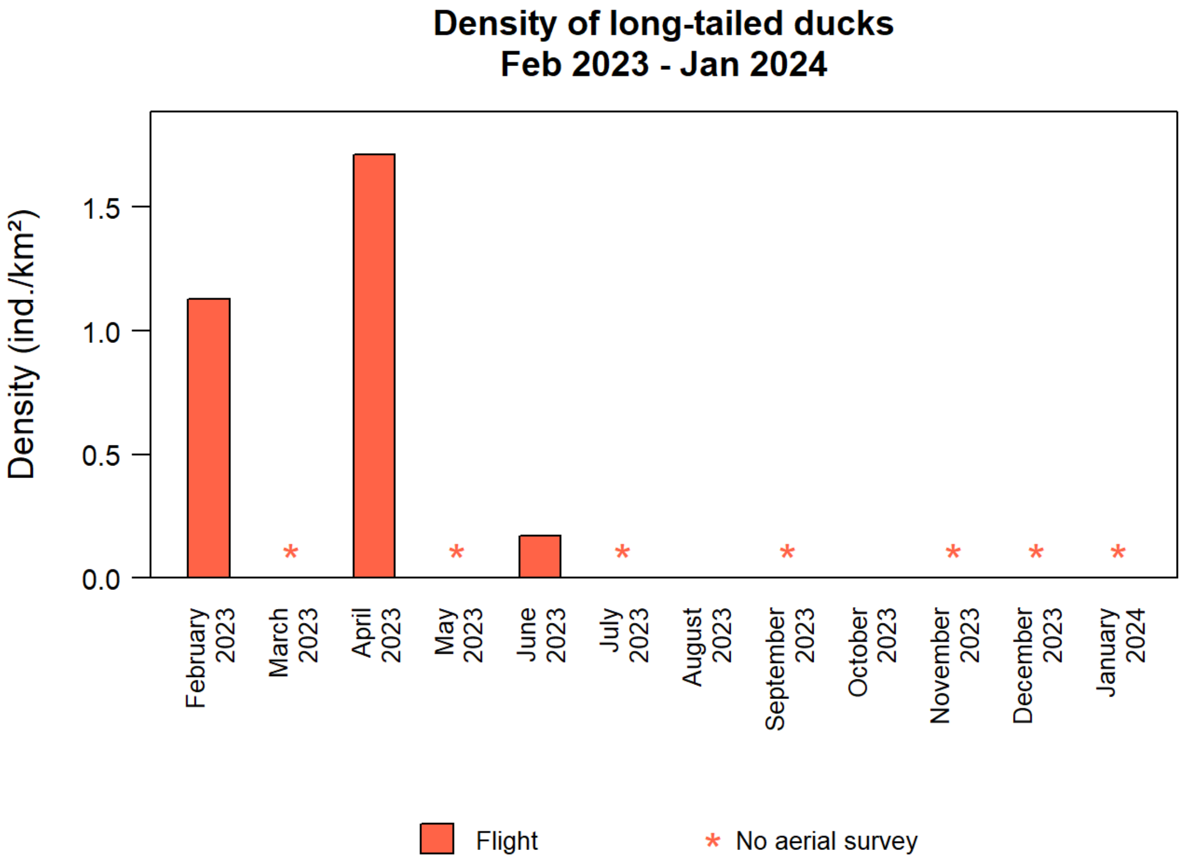


Figure 5-10 Monthly densities of long-tailed ducks during digital aerial surveys in the survey area between February 2023 and January 2024.

Highest densities of long-tailed ducks were observed close to the coast during spring (both, the northern and western part of the survey area, Figure 5-11). In spring and winter, they were observed at medium densities in the middle of the survey area within or close to the existing Kriegers Flak OWF. During summer, only few individuals were found south of Falsterbo as well as around the coastel waters of Møn. During winter, individuals were generally spread across the entire study area with most birds found along the coast of Rügen and Denmark, as well as south of Falterbo up to the areas north of the operating OWF Kriegers Flak.

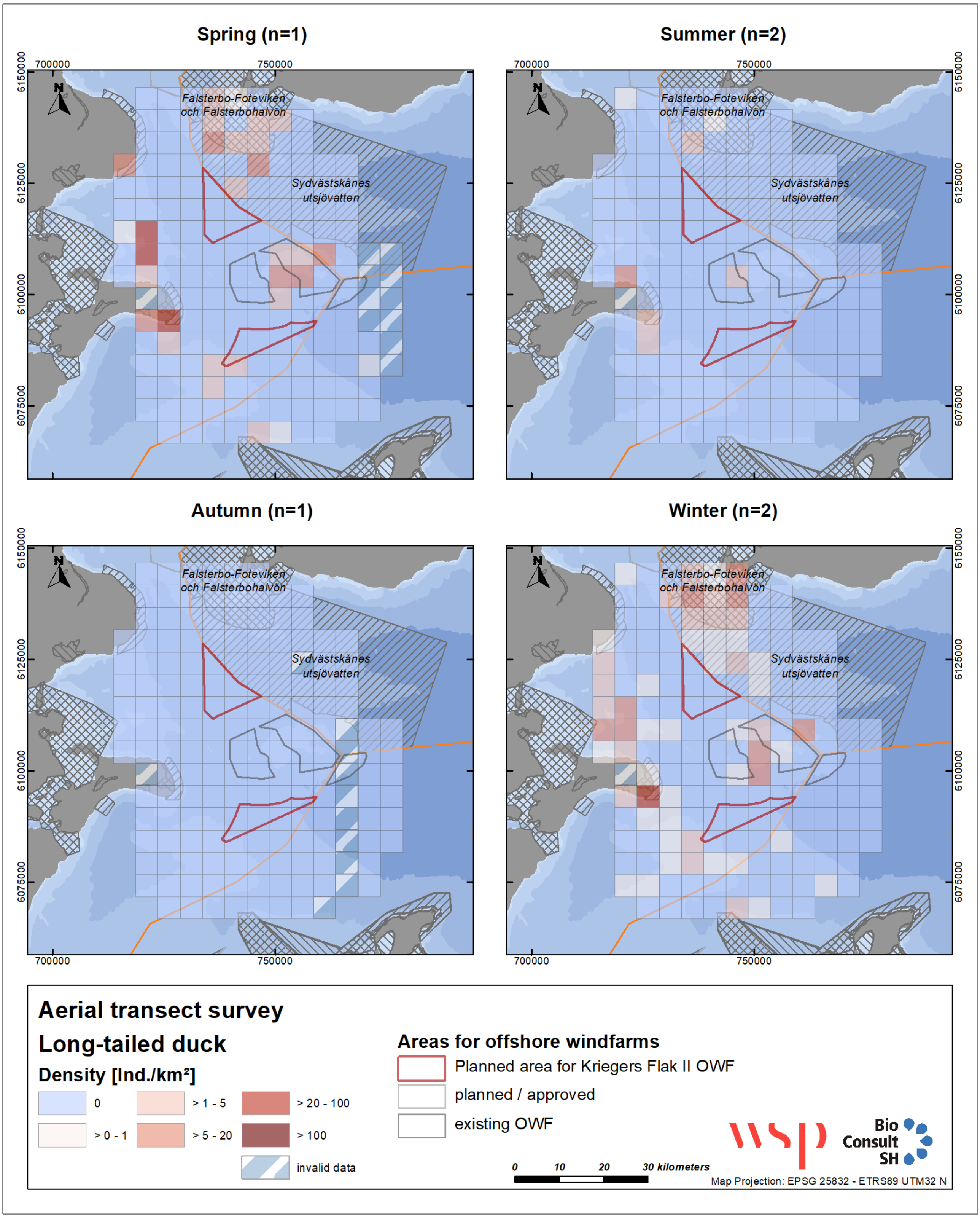


Figure 5-11 Distribution of long-tailed ducks in the survey area per season during the digital aerial surveys between February 2023 and October 2023. Seasonal classification species-specific according to GARTHE ET AL. (2007).

COMMON SCOTER

Common scoters were the second most common species of resting birds in the survey area. A total of 7,777 individuals were observed during the whole survey period. In addition, there were 333 ducks that could not be properly identified as belonging to this species or to the close related velvet scoter and were thus classified as common/velvet scoter. These latter are not included here. The density of common scoter was highest in December (5.6 ind./km²), closely followed by the density in February (5.3 ind./km²). Thus, the highest seasonal density occurred in winter: 5.4 ind./km²). Two flights occurred in the summer season which were in June and August when the density was the lowest (on average, 0.05 ind./km²). Density increased again in October (autumn, 2.4 ind./km², Figure 5-12).

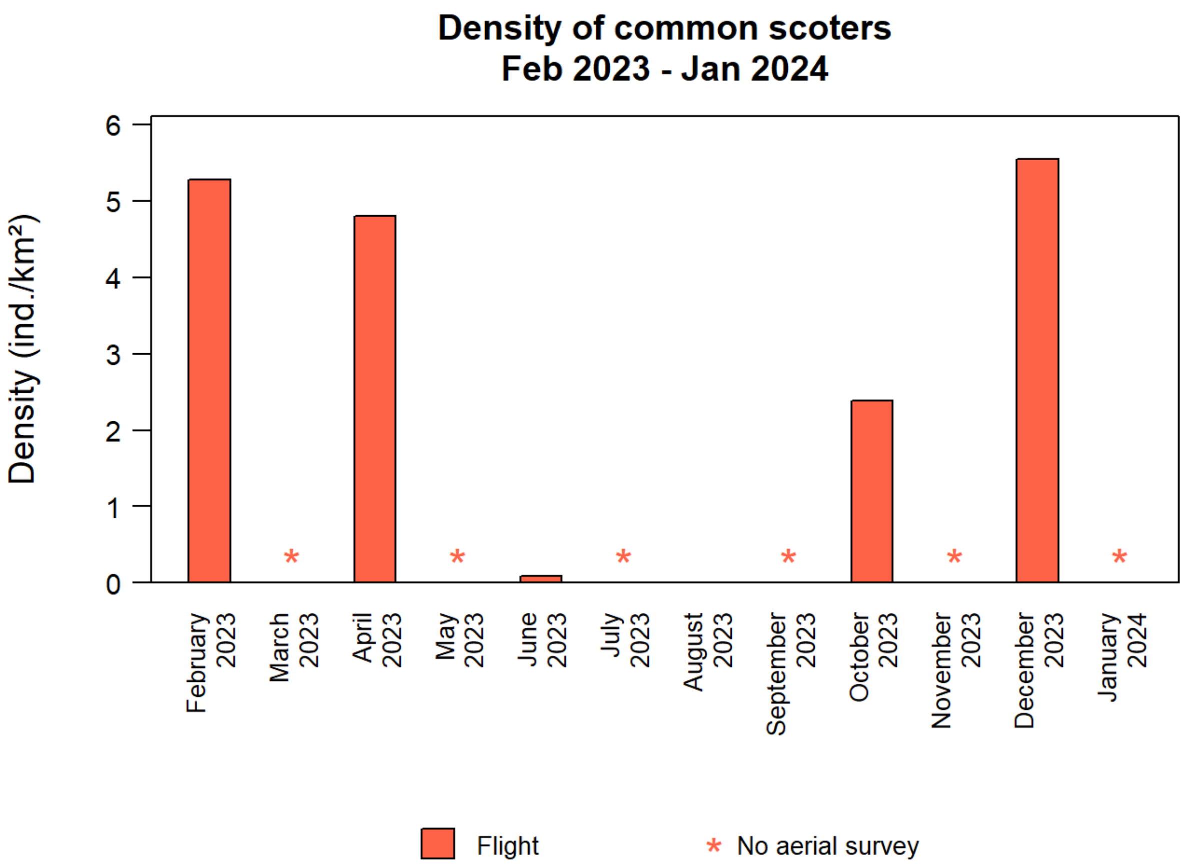


Figure 5-12 Monthly densities of common scoters during digital aerial surveys in the survey area between February 2023 and January 2024.

Common scoters mainly occurred in the coastal shallow areas during spring, but several individuals were also observed between the operating OWF Kriegers Flak (Figure 5-13) In spring and winter, they occurred in a broad band from the northeastern tip of Rügen towards the western tip of Møn. During summer, only few individuals were found south of Falstervo, as well as north and south of Møn. In Autum, common scoters were located south of Falsterbo and north of Møn as well, with more individuals present compared to the summer.

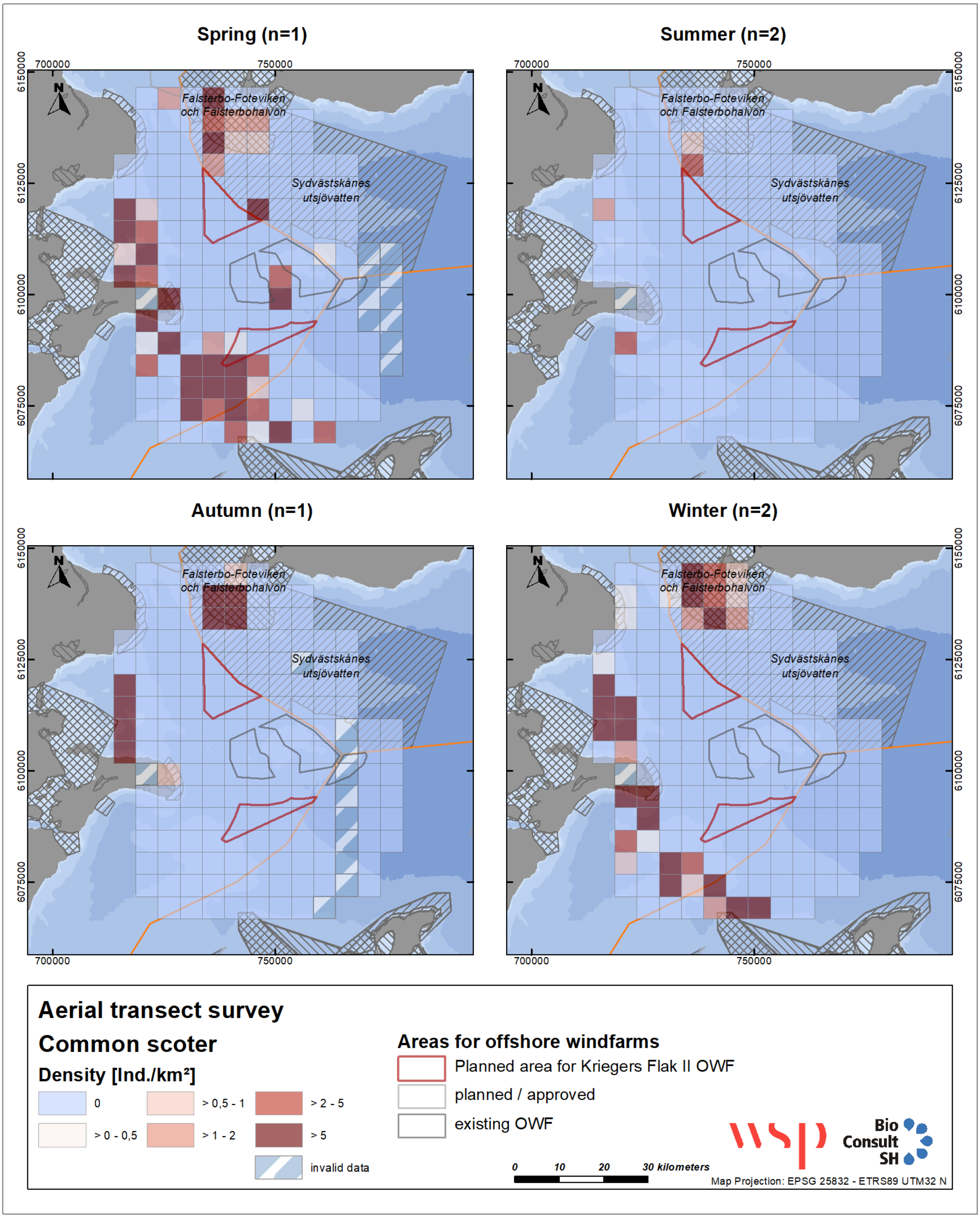


Figure 5-13 Distribution of common scoters in the survey area per season during the digital aerial surveys between February 2023 and October 2023. Seasonal classification species-specific according to GARTHE ET AL. (2007).

VELVET SCOTER

In comparison to the other three species of ducks, velvet scoters were less abundant. Still, 631 individuals of this species were observed during the six digital aerial surveys. The highest density occurred in February (winter, 0.6 ind./km²). Densities decreased towards the warmer season. In fact, no velvet scoters were sighted in summer (June and August). In autumn (October), numbers had increased again, and they decreased slightly in the survey of December (Figure 5-14).

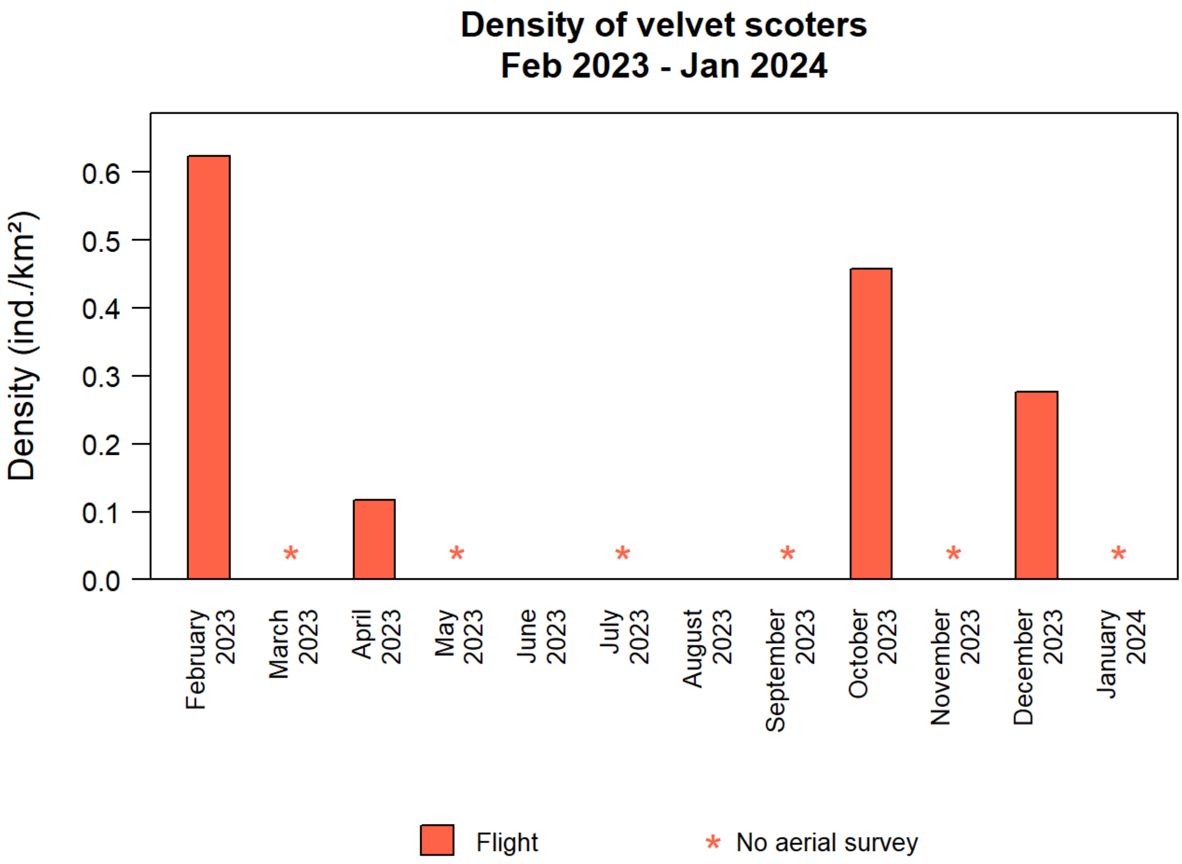


Figure 5-14 Monthly densities of velvet scoters during digital aerial surveys in the survey area between February 2023 and January 2024.

Highest densities of velvet scoters were observed during spring and winter, only few individuals were found in autumn and none in summer (Figure 5-15). During spring, they were mainly located along the coastlines, but few individuals were also observed northwest of the operating OWF Kriegers Flak. In autumn, the distribution was mostly restricted to Falsterbo and a small area north of Møn. During winter, velvet scoters were mostly located south of Falsterbo and in the coastal waters north and south of Møn, as well as southwest of Rügen. No individuals were found within or close to the operating OWF Kriegers Flak.

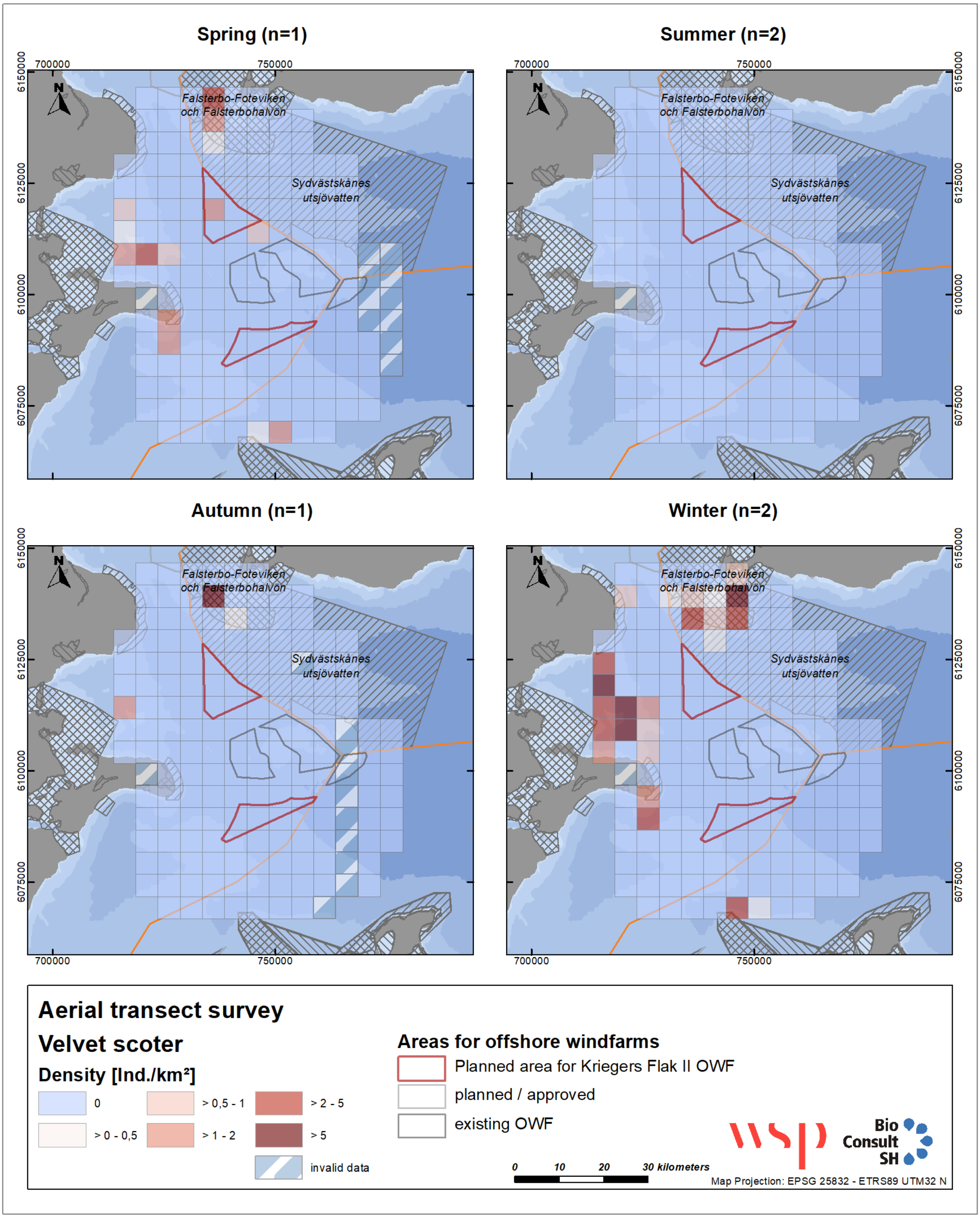

Spring (n=1)
Summer (n=2)
Autumn (n=1)
Winter (n=2)
700000
750000
6150000
6125000
6100000
6075000
N
Falsterbo-Foteviken
och Falsterbohalvön
Sydvästskånes
utsjövatten
Aerial transect survey
Velvet scoter
Density [Ind./km²]
0
> 0 - 0,5
> 0,5 - 1
> 1 - 2
> 2 - 5
> 5
invalid data
Areas for offshore windfarms
Planned area for Kriegers Flak II OWF
planned / approved
existing OWF
0
10
20
30 kilometers
Map Projection: EPSG 25832 - ETRS89 UTM32 N
Bio
Consult
SH

Figure 5-15 Distribution of velvet scoters in the survey area per season during the digital aerial surveys between February 2023 and October 2023. Seasonal classification species-specific according to GARTHE ET AL. (2007).

GULLS

A total of six species of gulls were observed in the survey area during the five digital aerial surveys. The most common one was the herring gull whose total abundance represented 2.9% of all resting birds seen in the area. In order of abundance, the following species also occurred in the area: common gulls (2.0%), black-headed gulls (1.0%), great black-backed gulls (0.6%), little gulls (0.2%) and lesser black-backed gulls (0.1%). The abundances of the first four are described in the following pages.

BLACK-HEADED GULL

A total of 217 individuals of black-headed gulls were surveyed between February 2023 and January 2024. These gulls were found in all surveys at relatively similar densities, and their highest values occurred in the survey of August (0.19 ind./km²) In terms of seasonal densities, spring density (April) was the highest (0.13 ind./km²). Seasonal densities in summer and autumn season (average of August and October, 0.1 ind./km², Figure 5-16) were at similar level (~0.1 ind./km²), and the seasonal density in winter was the lowest (0.05 ind./km²).

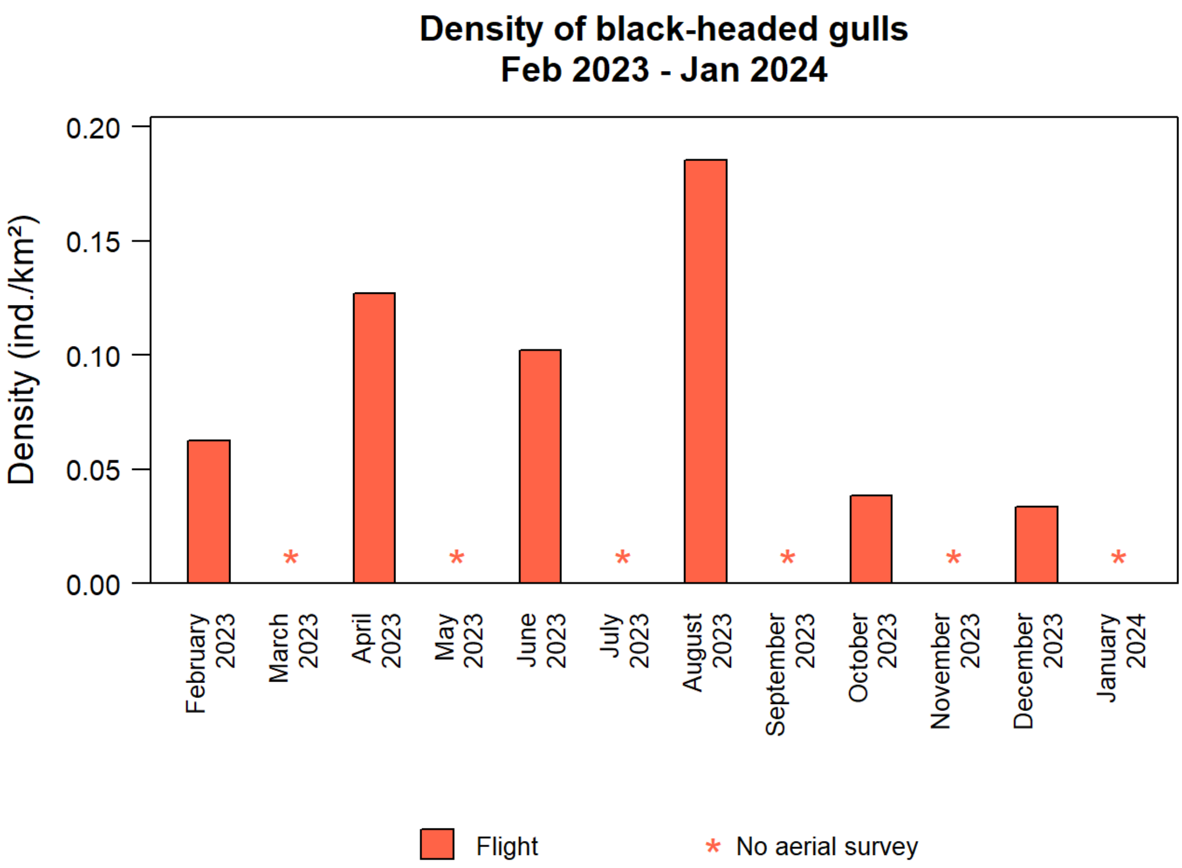
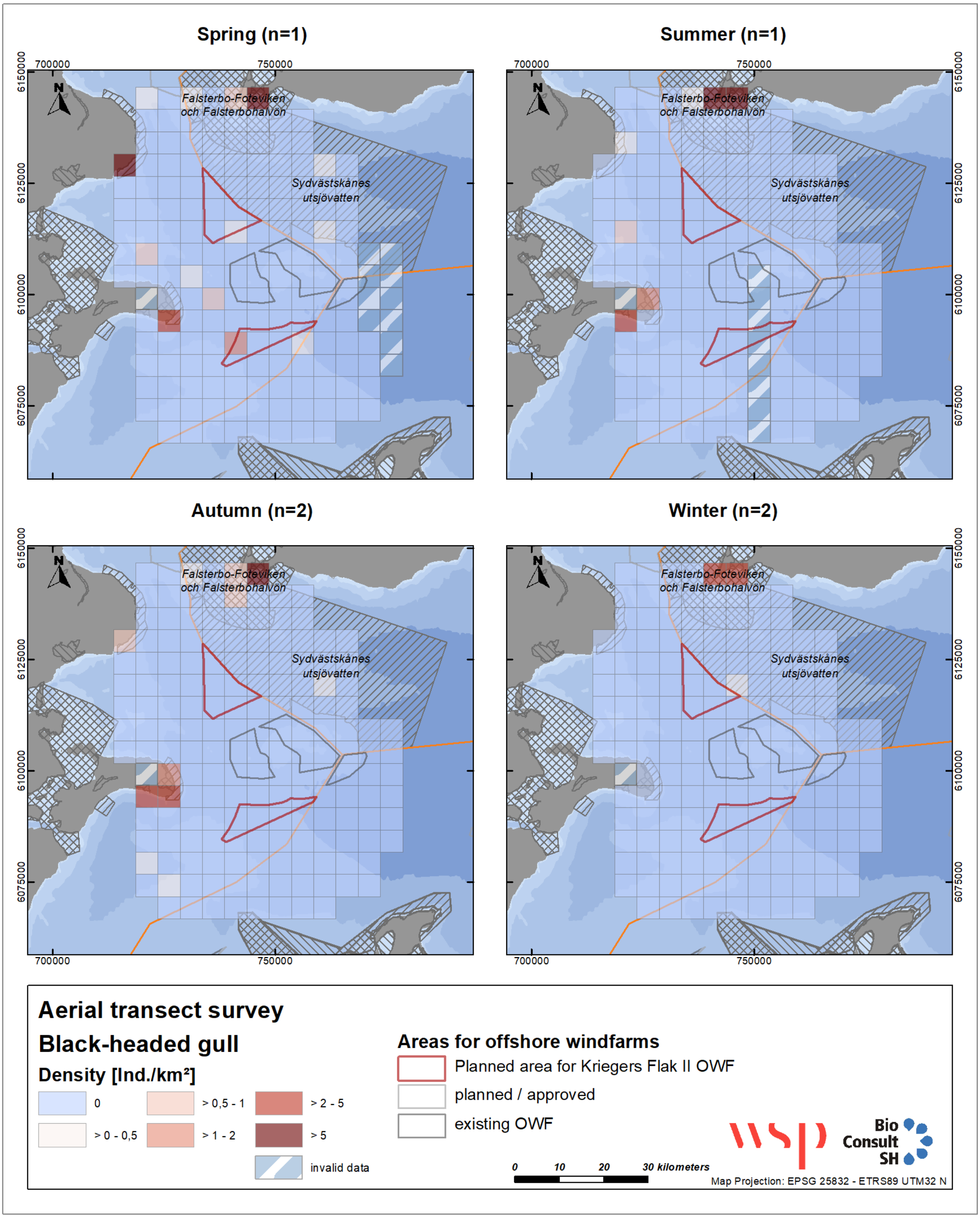


Figure 5-16 Monthly densities of black-headed gulls during digital aerial surveys in the survey area between February 2023 and January 2024.

Black-headead gulls were observed in the study area during all seasons, albeit in rather low densities (Figure 5-17). They were generally located along the coasts of Denmark and Sweden, particularly found in high densities at Falsterbo, Møn and the areas close to Rødvig. These hotspots were consistently frequented during all seasons. During spring, few individuals were also observed in the central parts of the pre-investigation area.



Spring (n=1)
Summer (n=1)
Autumn (n=2)
Winter (n=2)
700000
750000
6150000
6125000
6100000
6075000
Falsterbo-Foteviken
och Falsterbohalvön
Sydvästskånes
utsjövatten
N
Aerial transect survey
Black-headed gull
Density [Ind./km²]
0
> 0 - 0,5
> 0,5 - 1
> 1 - 2
> 2 - 5
> 5
invalid data
Areas for offshore windfarms
Planned area for Kriegers Flak II OWF
planned / approved
existing OWF
0 10 20 30 kilometers
Map Projection: EPSG 25832 - ETRS89 UTM32 N
Bio Consult SH

Figure 5-17 Distribution of black-headed gulls in the survey area per season during the digital aerial surveys between February 2023 and October 2023. Seasonal classification species-specific according to GARTHE ET AL. (2007).

COMMON GULL

Common gulls were the second most common species of gulls in the area. A total of 456 individuals were observed in the survey area during the six digital aerial surveys. They occurred during all flights, but their numbers were much lower in the warm season, especially in August (< 0.01 ind./km²). Their maximum monthly density was in October (0.35 ind./km²). These two contrasting densities belong to the seasonal density of autumn (0.2 ind./km²). Thus, the seasonal density of spring (April 2023) was 0.3 ind./km² and thus the highest seasonal density. In summer, the seasonal density (June) was 0.06 ind./km² and the winter density was 0.18 ind./km² (December 2023, Figure 5-18).

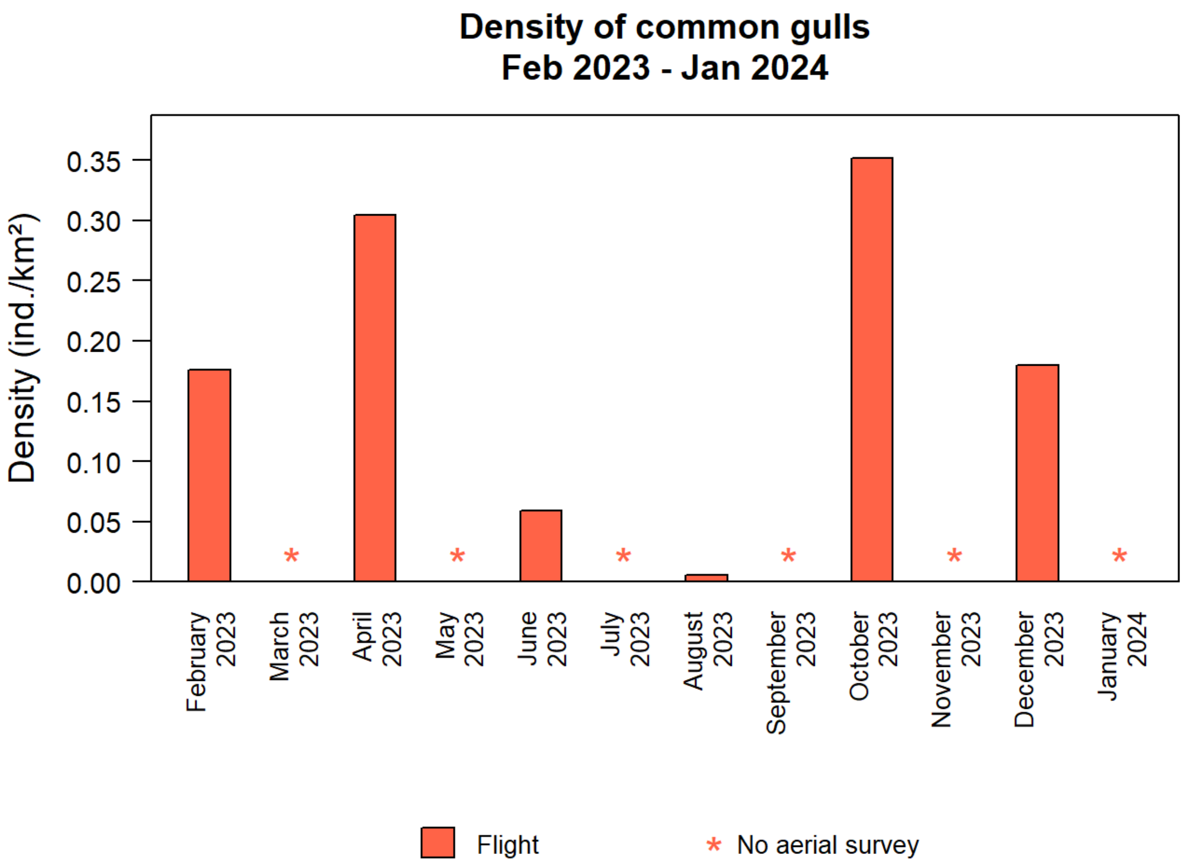


Figure 5-18 Monthly densities of common gulls during digital aerial surveys in the survey area between February 2023 and January 2024.

Common gulls were distributed throughout the whole area but were more frequently observed at locations closer to the coast, specifically in autumn . In autumn and especially in winter, they were also observed in the eastern part of the pre-investigation area, as well as offshore. Several individuals were observed within or close by the operating OWF Kriegers Flak during all seasons (Figure 5-19).

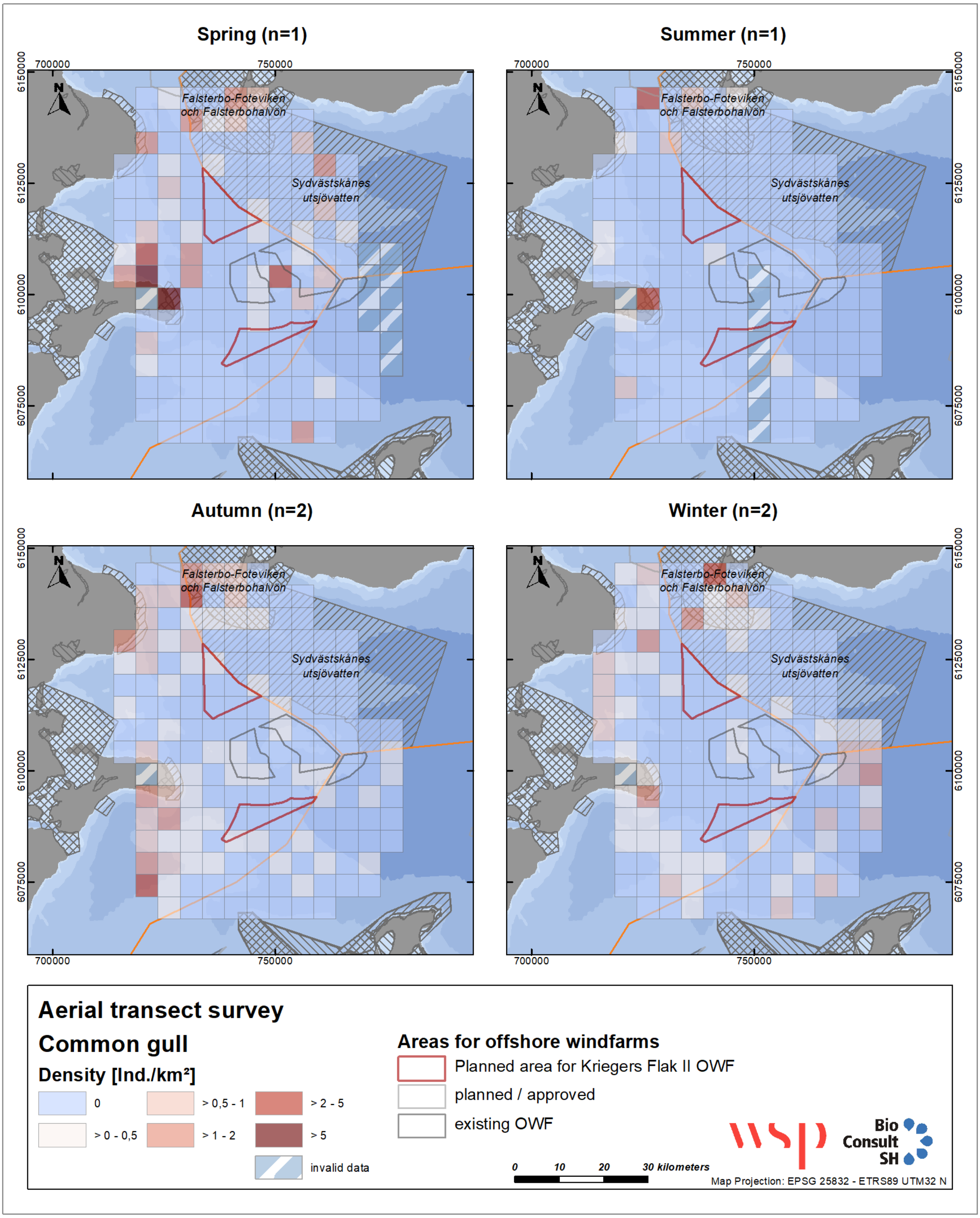


Figure 5-19 Distribution of common gulls in the survey area per season during the digital aerial surveys between February 2023 and October 2023. Seasonal classification species-specific according to GARTHE ET AL. (2007).

HERRING GULL

Herring gulls were the most common species of gulls in the area. A total of 652 individuals were observed which represented 2.9% of all resting birds found in the area. They were present in all flights, but their densities were lower in June and August and the highest in October (0.58 ind./km²). in terms of seasons, the August flight would also be considered as belonging to autumn, thus, the value of August and October were averaged. The seasonal density of autumn was then 0.33 ind./km², and thus slightly lower than the seasonal density of spring (April, 0.36 ind./km²), but larger than that of winter (0.26 ind./km², Figure 5-20).

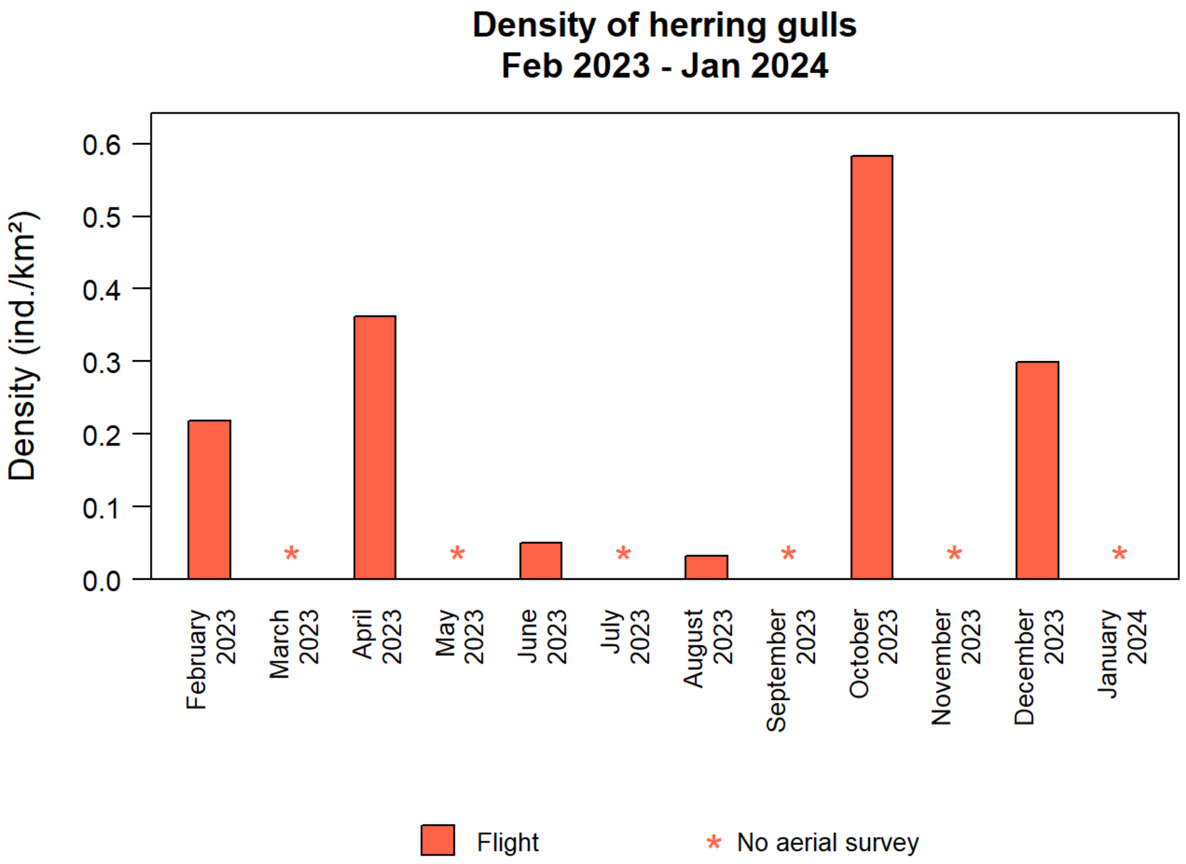


Figure 5-20 Monthly densities of herring gulls during digital aerial surveys in the survey area between February 2023 and January 2024.

Herring gulls were present in the study area year-round with highest densities found during spring and autumn and lowest densities observed in summer (Figure 5-21). They were generally located across the entire study area, but preferred coastal zones of Denmark and Sweden during summer. Except for summer, several herring gulls were located within and in close proximity to the operating OWF Kriegers Flak. During winter, more birds were located further offshore in the eastern parts of the study area compared to the other seasons. Additionally, larger flocks were found at Falsterbo.

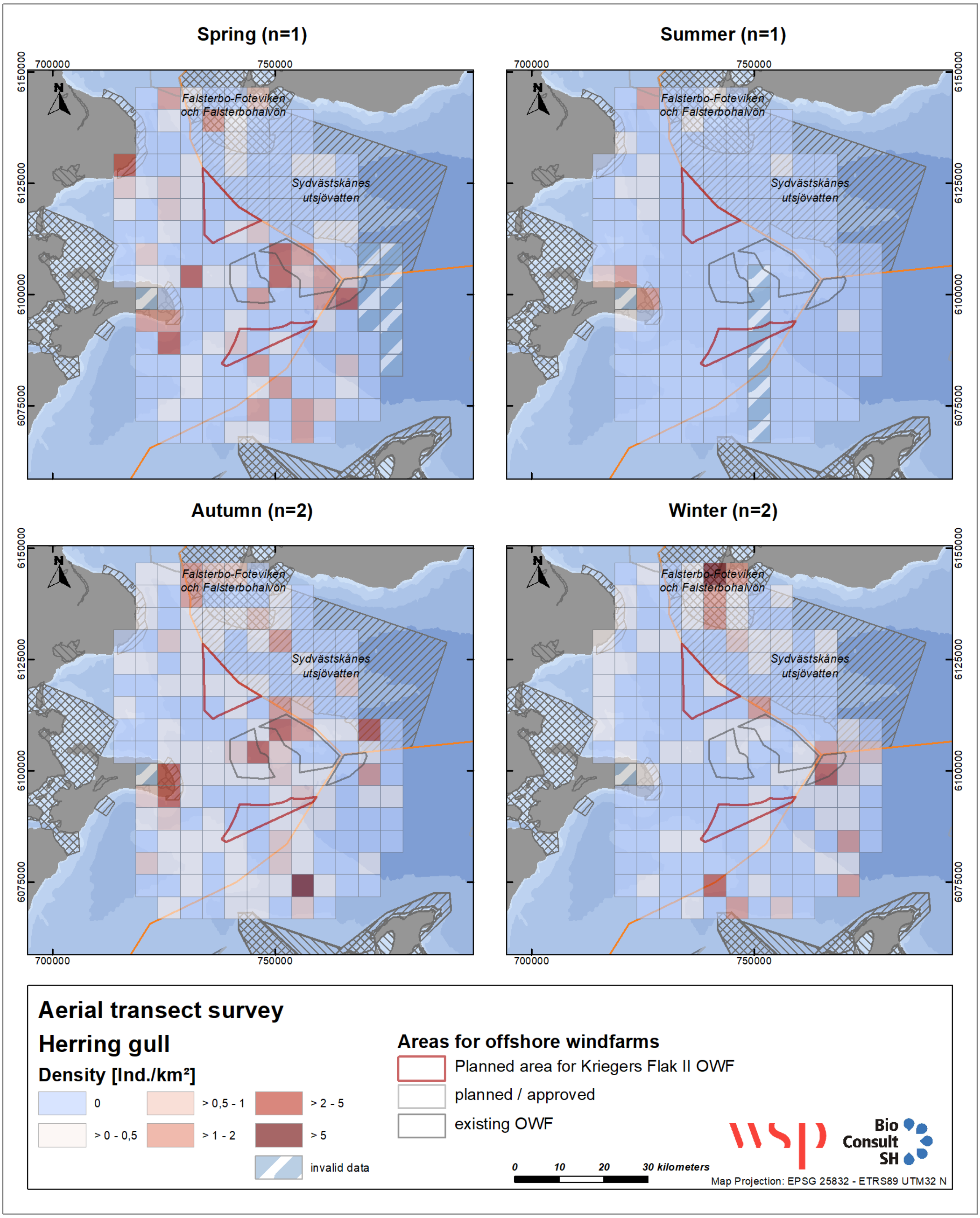


Figure 5-21 Distribution of herring gulls in the survey area per season during the digital aerial surveys between February 2023 and October 2023. Seasonal classification species-specific according to GARTHE ET AL. (2007).

GREAT BLACK-BACKED GULL

Great black-backed gulls were not as common as the other gulls, in total 136 individuals were recorded during the whole survey period. They were not present in the survey of June and their densities were very low in April and August (< 0.01 ind./km²). Their monthly density was highest in October 2023 (0.2 ind./km², Figure 5-22). As with the other gulls, the density of August was averaged with the density of October to obtain an average seasonal density for autumn: 0.11 ind./km². This season was the season where most of the great black-backed gulls were spotted, followed by the winter season (average of February and December, 0.05 ind./km²).

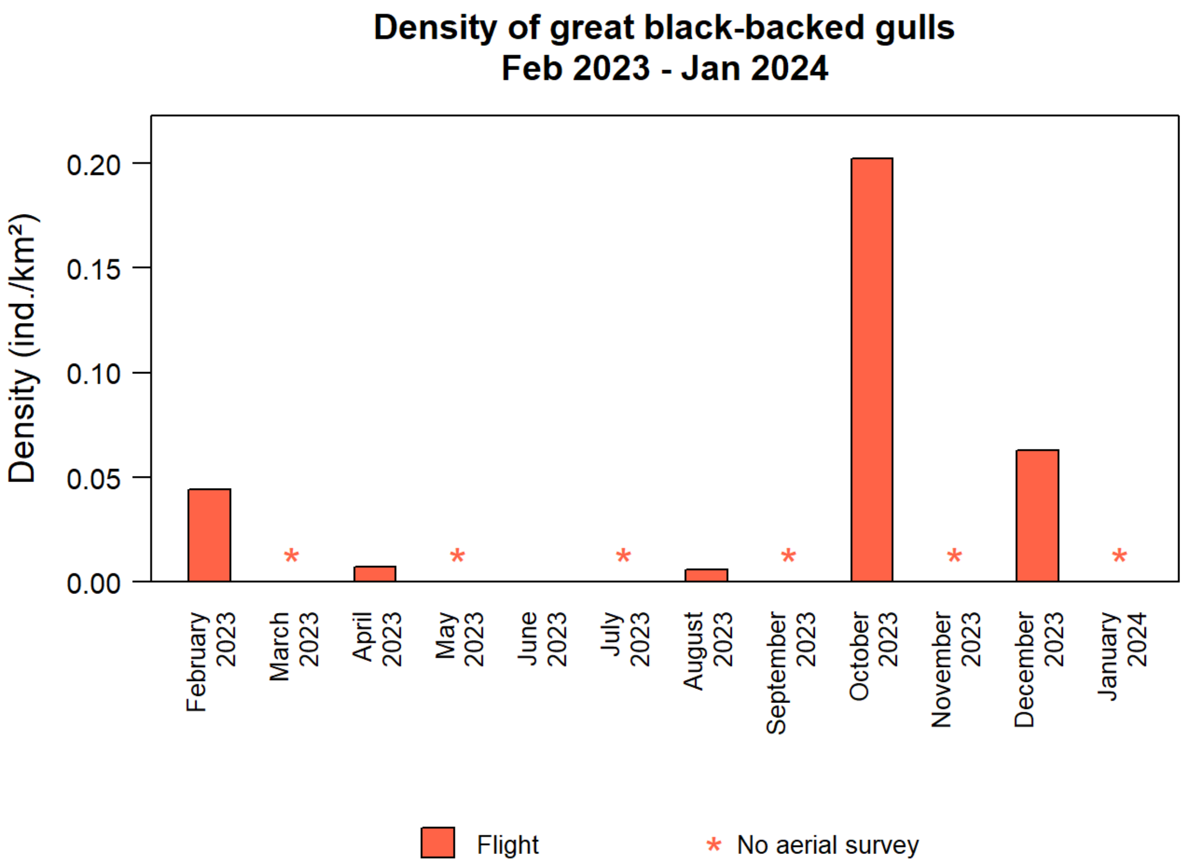


Figure 5-22 Monthly densities of great black-backed gulls during digital aerial surveys in the survey area between February 2023 and January 2024.

Only single great black-backed gull individuals were observed in the study area during spring, none were present during the summer (Figure 5-23). The highest densities were observed during autumn with individuals spread across the entire study area. During this period, the were found more frequently in southern parts close to Rügen, as well as close to Falsterbo. Several individuals were located within the operating OWF Kriegers Flak. During winter, great black-backed gulls were found mainly along the coast of Germany, Denmark and Sweden, but several individuals were also observed in the southeastern part of the study area.

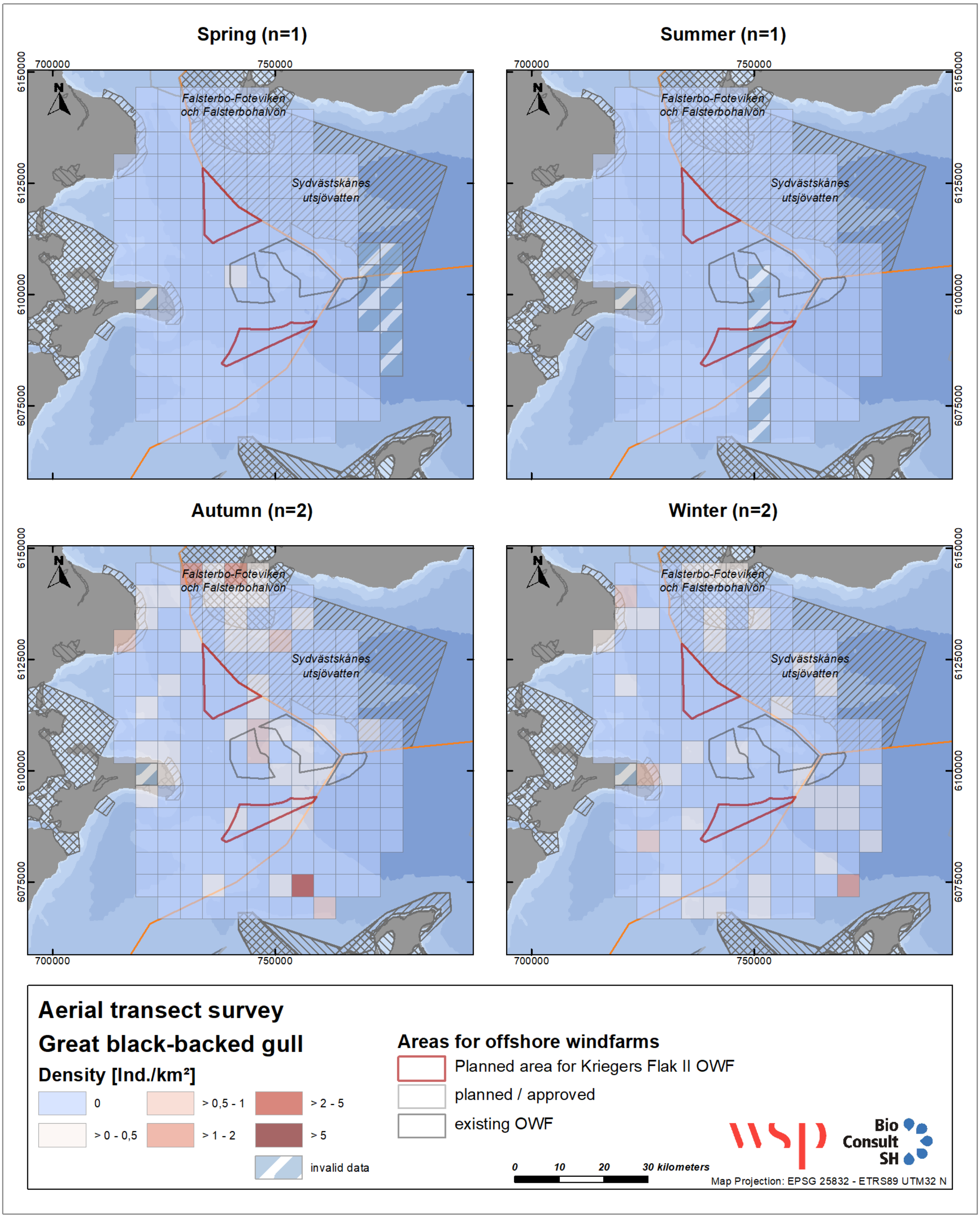


Figure 5-23 Distribution of great black-backed gulls in the survey area per season during the digital aerial surveys between February 2023 and October 2023. Seasonal classification species-specific according to GARTHE ET AL. (2007).

TERNS

Terns were not very common, but altogether represented 0.5% of all resting birds. Three to four species of terns were seen in the area: Sandwich tern (43 individuals) was the most common identified species (0.19%). There were 67 individuals of common/Arctic terns (the birds could not be assigned to any of the species) and 5 individuals of little terns were also detected. Terns were present in three out of the six digital aerial flights. They did not occur in the colder months: February, October and December (which corresponds to the winter season) and their monthly density was highest in August, which corresponds to the autumn season (0.31 ind./km², Figure 5-24).

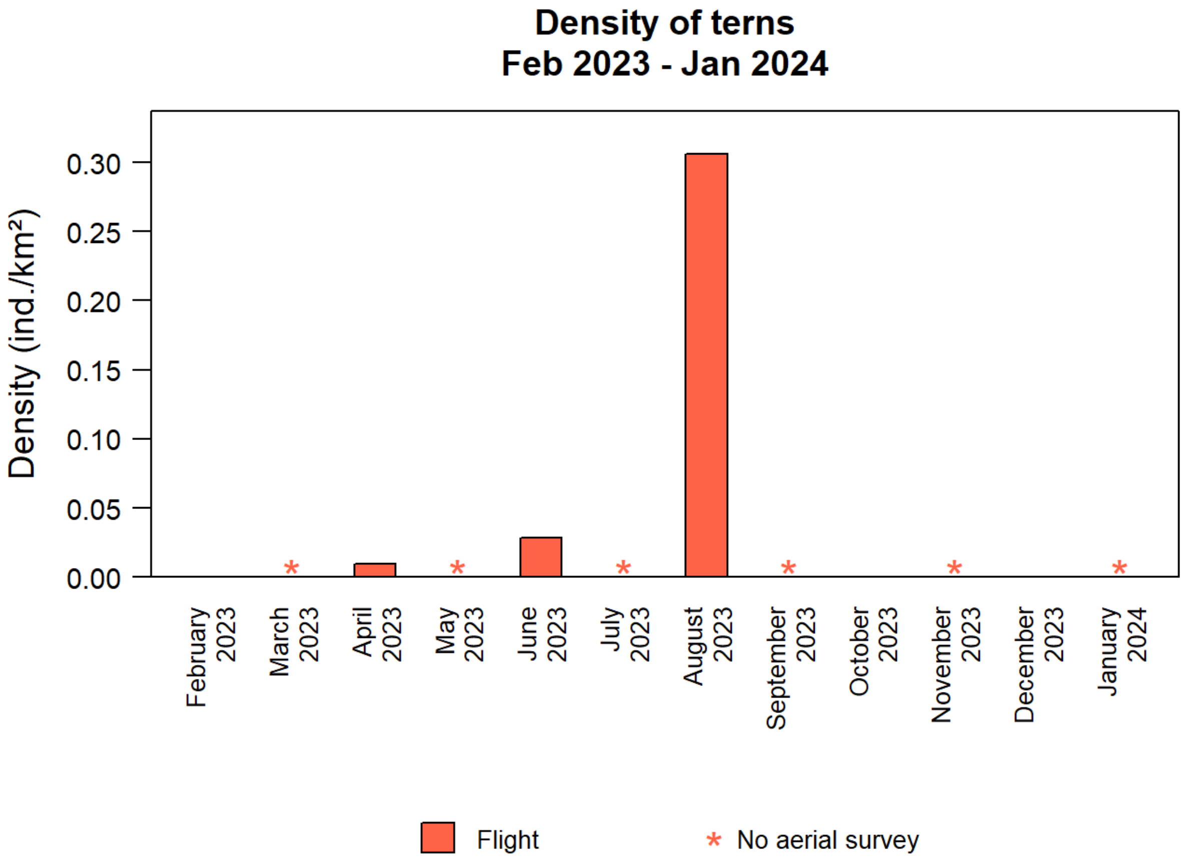


Figure 5-24 Monthly densities of terns during digital aerial surveys in the survey area between February 2023 and January 2024.

Terns were only sporadically observed during spring and summer, mostly in the northwestern parts of the study area along the Danish and Swedish coasts (Figure 5-25). During autumn, a few smaller flocks were found close to Falsterbo and within the Swedish SPA, as well as west of the operating OWF Kriegers Flak. Single individuals were also observed in the southern parts of the study area. No terns were present during winter.

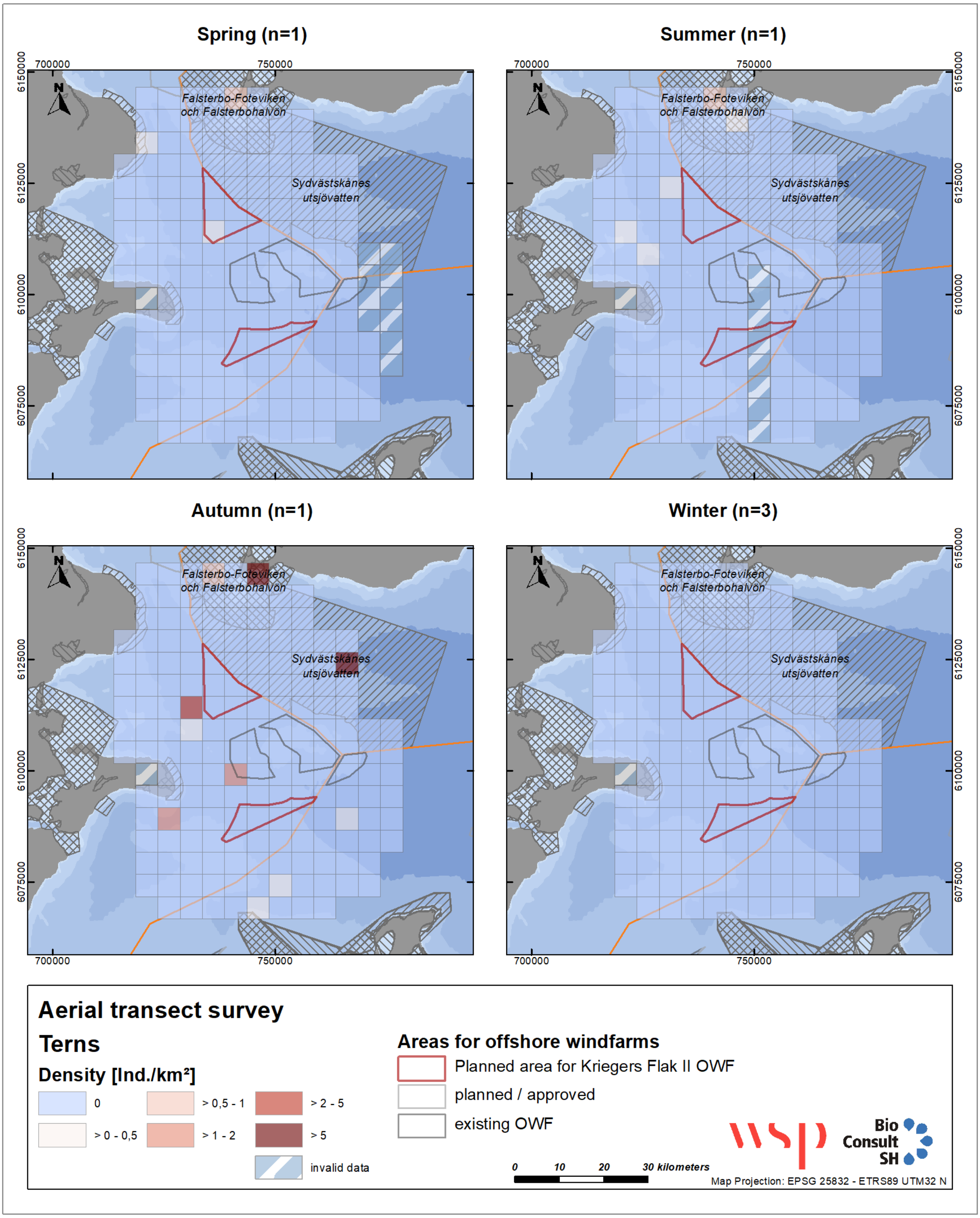


Figure 5-25 Distribution of terns in the survey area per season during the digital aerial surveys between February 2023 and October 2023. Seasonal classification species-specific according to GARTHE ET AL. (2007).

AUKS

Auks were the third most abundant species group in the pre-investigation area and altogether represented 4.4% of all resting birds detected in the area during the six digital aerial surveys. There were in total three species of auks detected, of which the most common ones were razorbills and common guillemots that occurred at similar numbers (1.6%). There were also 224 individuals that could not be told apart and remained as common guillemots/razorbills. In addition to these species there were 30 individuals of black guillemots which represented 0.13% of all resting birds in the area.

COMMON GUILLEMOT

Common guillemots occurred during all flights but at very different abundances. Densities were lower in the warmer months. The highest monthly density was observed in February 2023 (0.58 ind./km²). The lowest density was in August (0.003 ind./km²). This month corresponded also to the autumn density of the species, whereas the seasonal density of winter was the average of the densities in February, October and December (0.23 ind./km², Figure 5-26).

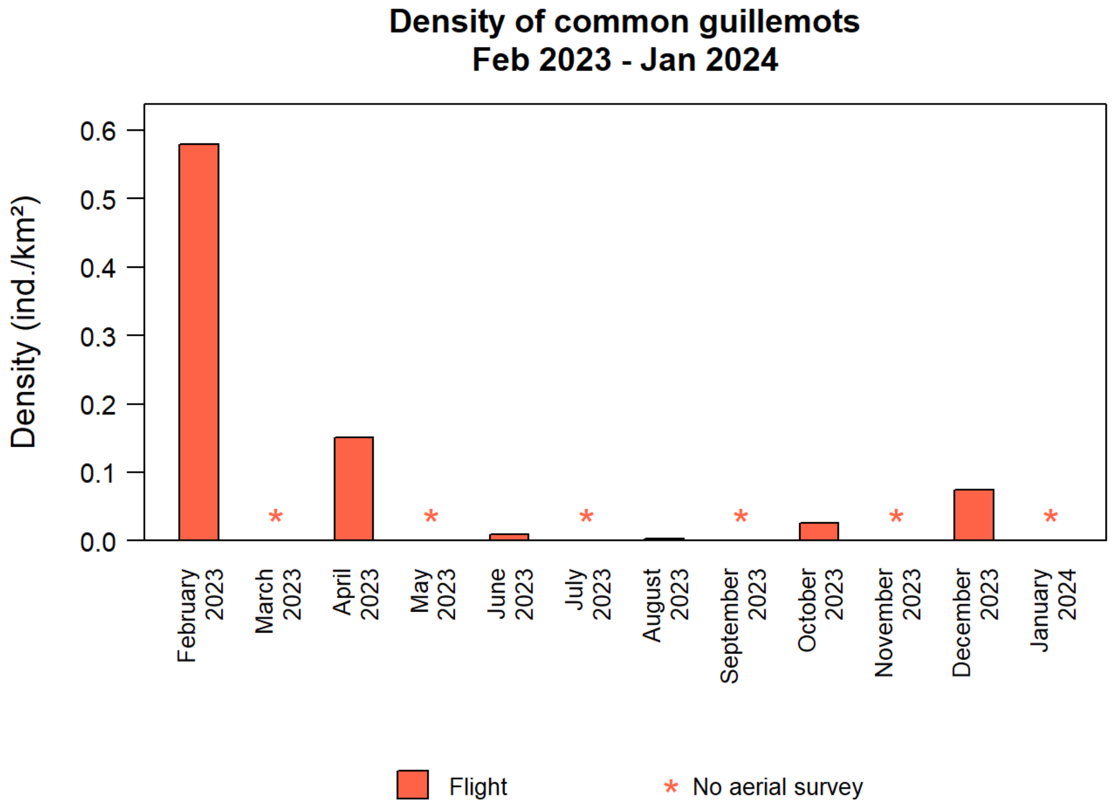


Figure 5-26 Monthly densities of common guillemots during digital aerial surveys in the survey area between February 2023 and January 2024.

Common guillemots occurred throughout the whole pre-investigation area during winter with highest densities located in the centre within the operating OWF (Figure 5-27). Several individuals were scattered along the coastline, as well as in areas further offshore. During spring, less individuals were present, mainly located in the central and northwestern parts of the study area. Again, several individuals were observed within the operating OWF Kriegers Flak. Only very few common guillemots were observed in the study area during summer and none were found during autumn.

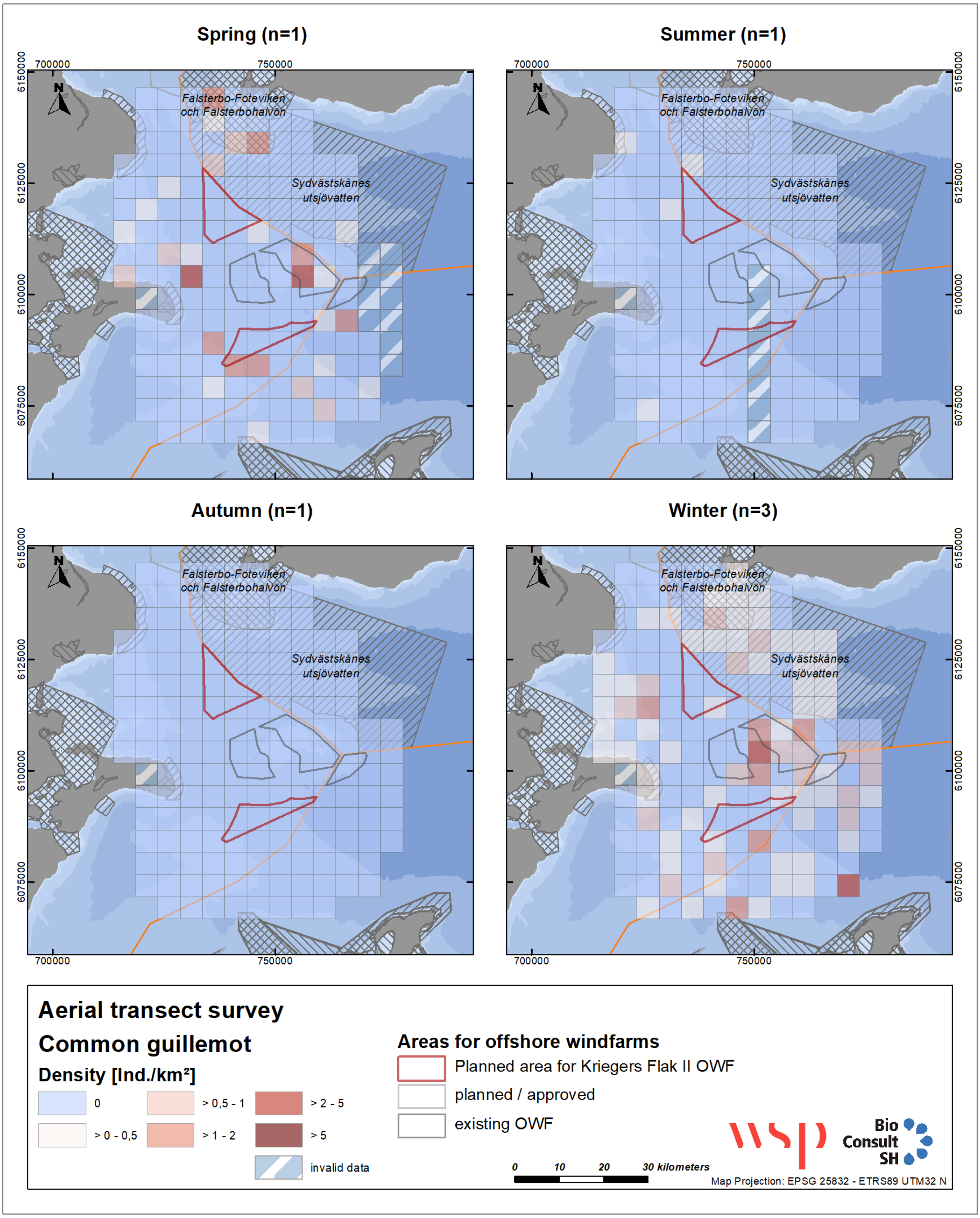


Figure 5-27 Distribution of common guillemots in the survey area per season during the digital aerial surveys between February 2023 and October 2023. Seasonal classification species-specific according to GARTHE ET AL. (2007).

RAZORBILL

Razorbills were not present in the flights of June or August. Their densities were highest in February (0.46 ind./km²), which together with the density in October and December corresponded to the winter season (seasonal density of winter: 0.17 ind./km²). This value was lower than the density of spring (April): 0.34 ind./km² (Figure 5-28).

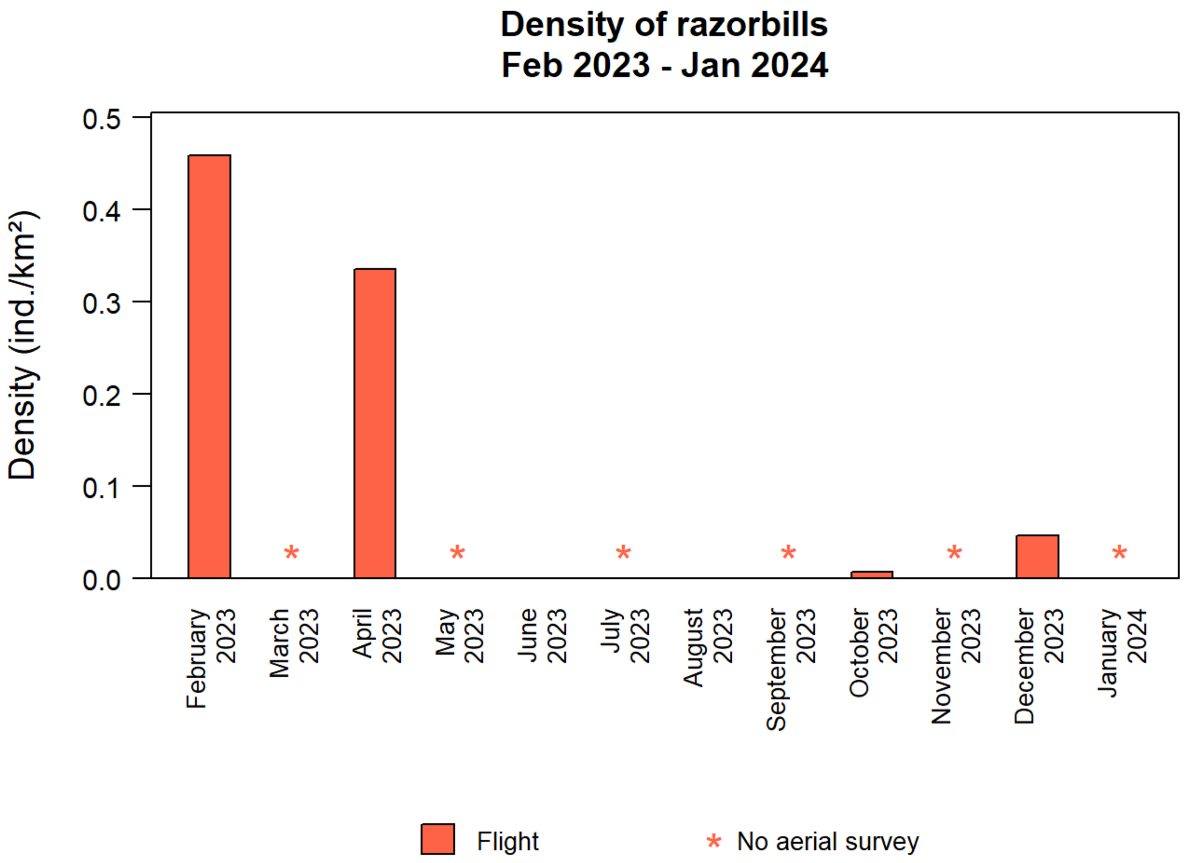


Figure 5-28 Monthly densities of razorbills during digital aerial surveys in the survey area between February 2023 and January 2024.

Spatially, razorbills were distributed throughout the whole pre-investigation area during spring and witnerThe highest densities in spring were observed in the centre of the survey area within the existing Kriegers Flak OWF. During autumn, several individuals were again present in the central part within the operating OWF, but larger numbers of razorbills were also present in the southern and northern parts of the study area. Very few individuals were also observed within the limits of the proposed OWF areas of KF II OWF S(during spring and winter, Figure 5-29). No razorbills were detected during summer and autumn.

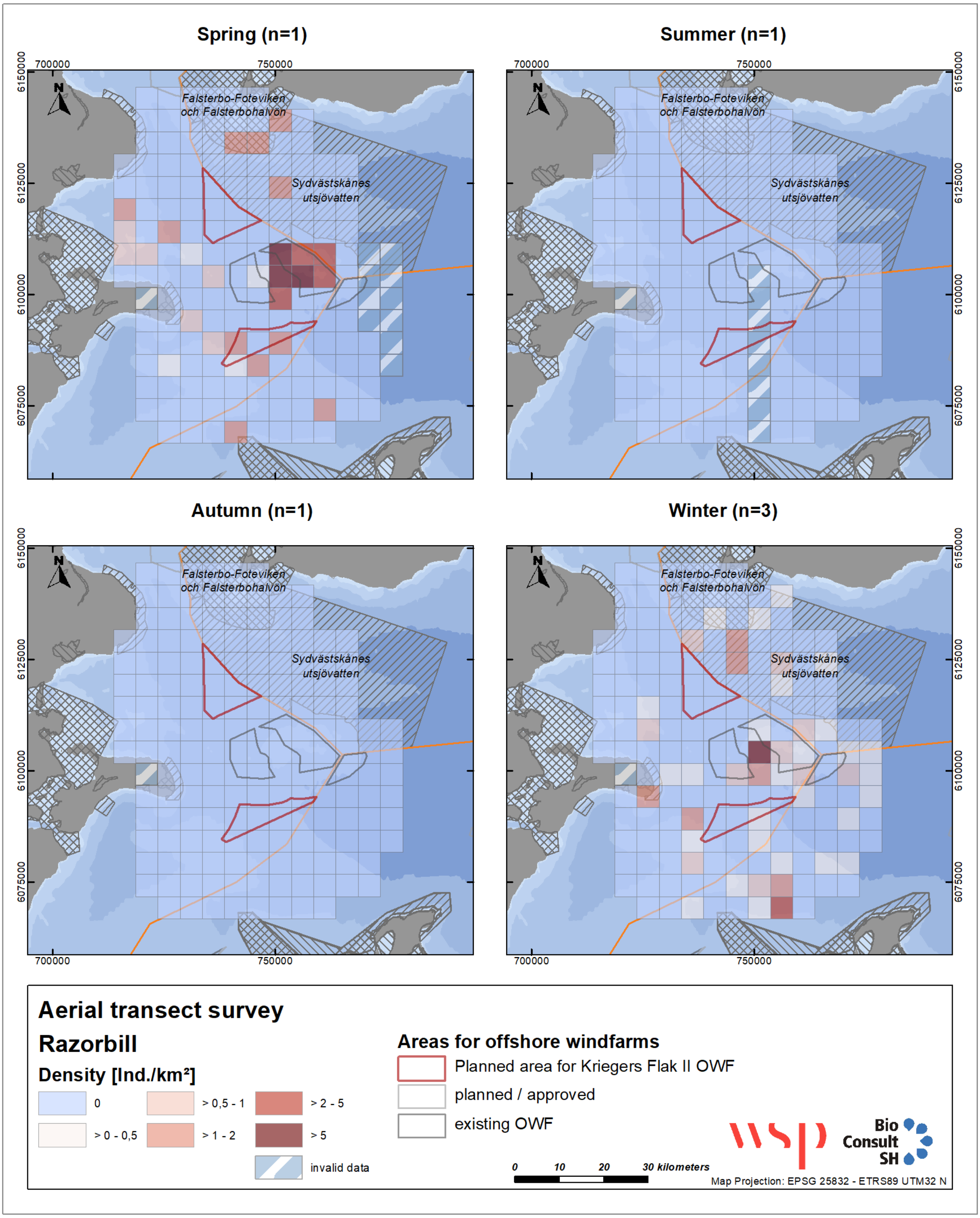


Figure 5-29 Distribution of razorbills in the survey area per season during the digital aerial surveys between February 2023 and October 2023. Seasonal classification species-specific according to GARTHE ET AL. (2007).

5.2 MIGRATING BIRDS

Bird migration data which included observer-based information (visual sightings, nocturnal flight calls) and radar measurements (vertical and horizontal) is presented in this chapter. Analyses are presented for all migrating bird individuals first and then for relevant (in terms of abundance) species groups (highlighting individual species). Data for both OWF KF II N and S are presented separately for the whole year 2023. The appendix (Table A-2 and Table A-3) includes species lists with information on numbers of all individuals observed, taxonomical information and species conservation status.

5.2.1 OBSERVER-BASED DATA

ALL SPECIES

DAY MIGRATION

SPECIES COMPOSITION

Similar numbers of migrating birds were registered for both seasons in 2023 in KF II OWF N. In spring, 7,854 birds were identified to 62 species. In autumn, a total of 7,987 birds belonging to 94 species were observed. In spring, 562 birds (7.2% of the total birds registered in the season) could not be identified to the species level. In autumn, this number was almost three times larger with almost 20% (1,567 birds) of all birds that could not be identified to the species level.

The species composition was similar between seasons, with some groups such as geese and ducks being the most abundant. Geese represented half of all migrating birds seen during spring (50.6%), and 36.9% of all migrating birds in autumn. Barnacle geese was the most commonly occurring species in both seasons. Ducks represented roughly 30% of all migrating birds observed in both seasons, with two species being the most common: common scoter and common eider. The latter was especially abundant in spring.

A large number of species (and individuals) of songbirds were registered in autumn, thus songbirds represented the third most common group of migrating birds during autumn (12.4%). Species relatively abundant were: sky lark, barn swallow and Eurasian siskin. Cormorants represented about 5% of migrating birds during both seasons. Other groups occurred at much lower proportions, but still represented at least 1% of all migrating birds in one of the seasons and are presented in more detail in the next section.

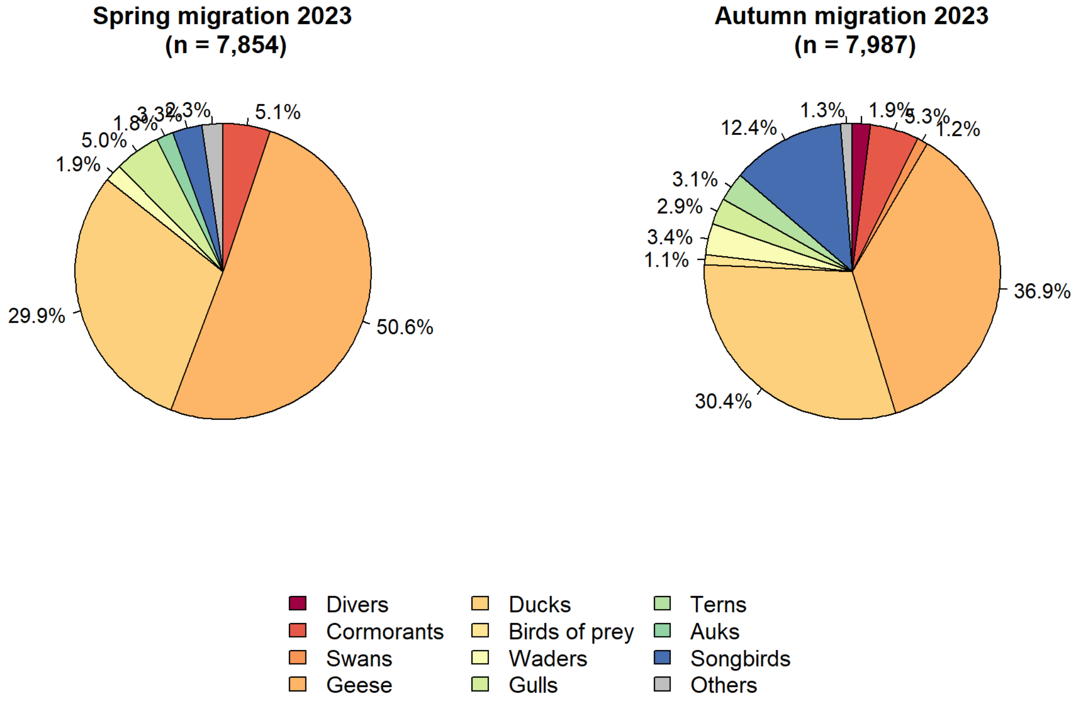


Figure 5-30 Percentage of observed diurnal migratory species in 2023 at the pre-investigation area KF II OWF N, grouped into high-category taxa. All species groups, whose abundance represent at least 1% of the total are shown and are presented according to taxonomic order (starting at the top, in a clockwise order, thus songbirds appear last). The category "Others" (grey) includes all other bird taxa whose percentage was < 1%.

The species group composition at the southern area, KF II OWF S looked rather different. In general, there were more birds migrating through this area. While during the whole survey period, there were 15,841 birds observed at KF II OWF N, there were three times as many birds spottted at the southern pre-investigation area (45,637 in both seasons). During spring, there was a larger number of migrating birds (27,355) than during autumn (18,282). Again, geese and ducks were the most common species groups, but they were observed at much larger numbers than in the KF II OWF N area. Thus, other species groups apart from songbirds and gulls, occurred in comparatively much lower numbers and are not shown in Figure 5-31.

In spring, geese represented 82.8% of all migrating birds, of which a third were barnacle geese. Most the remaining geese were unidentified black geese. In autumn, the proportion of geese was lower (59.1%), and most of them were barnacle geese, with about a third of the geese not being identified to the species level. Another species worth mentioning, that occurred often, was the greater white-fronted goose (see next section). In spring, ducks represented 12.8% of all migrating birds, whereas in autumn they made up for a quarter of all migrating birds. In spring, the most commonly occuring duck species was the common scoter (7.3%), followed by the common eider (4.5%) whereas ducks were mainly dominated by common eiders during autumn migration (18%). Songbirds were the third most common group of diurnally migrating birds in autumn, with 12.4% of the total. In spring, they were comparatively occurring in lower numbers. The most commonly occurring species of songbirds were starlings, Eurasian siskins and sky larks (which represented 3.1%, 2.5% and 1.7% of all migrating birds in autumn, respectively).

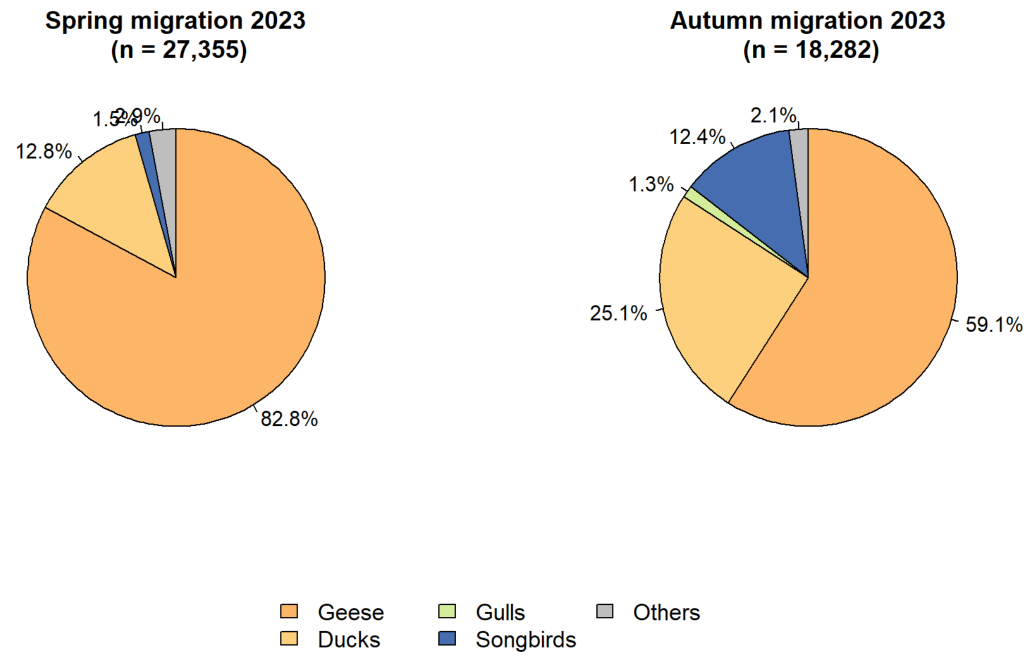


Figure 5-31 Percentage of observed diurnal migratory species in 2023 at the pre-investigation area KF II OWF S, grouped into high-category taxa. See Figure 5-30 for more details.

MIGRATION INTENSITY

There were in total 33 days of surveys with analysable data, with 5 for each month in spring and 18 days spread between August and November for autumn. Mean migration intensity was at similar ranges in both seasons with autumn being marginally larger (72.7 vs. 82.8 ind./h). Both, in spring and in autumn, migration intensity increased towards the end of the season. There was a peak migration event on the 14th of May, with 340 birds/h. In autumn, the maximum migration event occurred on the 13th of November with 201 birds/h (Table 5-3, Figure 5-32). This corresponded to migration events of geese (see next section).

Table 5-3. Monthly and seasonal migration rates (ind./h) calculated from visual observations in 2023 at the pre-investigation area KF II OWF N.

2023	Migration intensity (ind./h)			Number of individuals	Number of survey days [planned]
	Mean (± SE)	Median	Maximal value		
March	50.8 (± 23.4)	27.6	140.4	1470	5
April	83.2 (± 24.6)	59	148	2885	5
May	84 (± 64.2)	13.2	339.9	3499	5
Spring	**72.7 (± 22.8)**	**42.7**	**339.9**	**7854**	**15 [15]**
August	32.2 (± 9.7)	35.1	50.8	991	4
September	90.3 (± 28)	88.9	139.4	1875	3
October	93.7 (± 42.3)	85.5	184.5	1771	4
November	102.2 (± 29.3)	136.2	200.6	3350	7
Autumn	**82.8 (± 15.8)**	**48.5**	**200.6**	**7987**	**18 [20]**

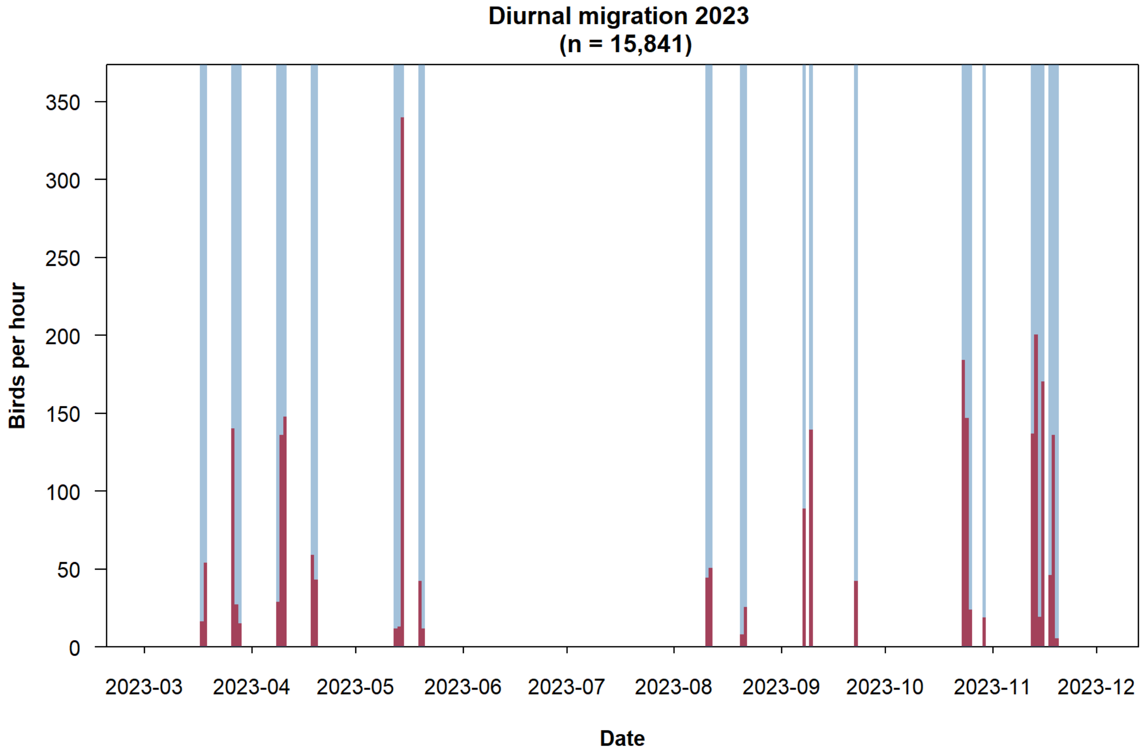


Figure 5-32 Diurnal migration intensity (red bars) derived from visual observations in 2023 at KF II OWF N. Light blue shades indicate the dates of the surveys (33 dates).

Fewer days of survey data collection were done in the pre-investigation area KF II OWF S. However, there were at least three times as many migrating birds observed, and migration intensity was then much larger than in the northern area. Similar levels of migration intensity were reached in both seasons, with the mean value being larger in autumn than in spring (281 vs. 357 birds/h, Table 5-4). There were two peak migration events, one in each season and at similar levels: 1663 vs. 1645 birds/h on the 17th of May and the 18th of October, respectively (Figure 5-33). As in the northern area, these migration events were mainly due to migration of geese. In autumn, there were also some ducks contributing to this maximum value (see next section).

Table 5-4. Monthly and seasonal migration rates (ind./h) calculated from visual observations in 2023 at the pre-investigation area KF II OWF S.

2023	Migration intensity (ind./h)			Number of individuals	Number of survey days]planned]
	Mean (± SE)	Median	Maximal value		
March	54.4 (± 35.3)	54.4	89.7	635	2
April	119.8 (± 22.5)	104.5	193	4061	5
May	533.2 (± 330.9)	62.1	1663.2	22659	5
Spring	**281.1 (± 144.4)**	**92.4**	**1663.2**	**27,355**	**12 [12]**
September	68.6 (± 25.4)	52.8	142.1	1653	4
October	549.3 (± 275.7)	227.6	1645.6	16629	6
Autumn	**357 (± 177.8)**	**86**	**1645.6**	**18,282**	**10 [10]**

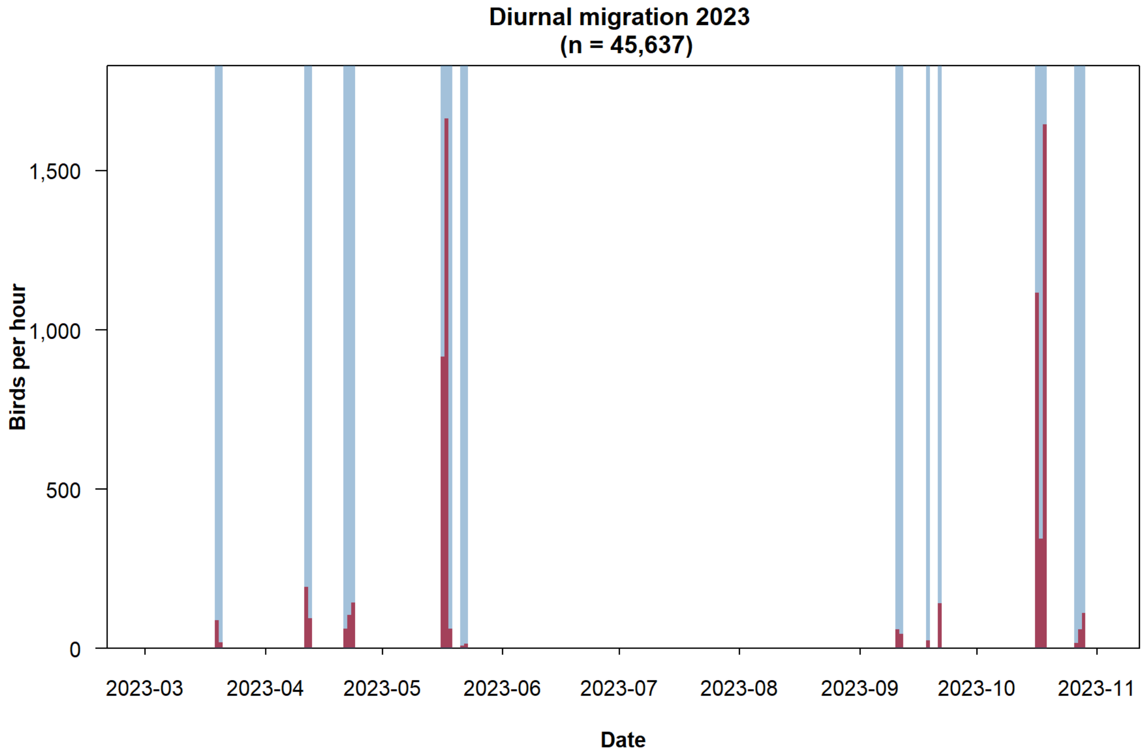


Figure 5-33 Diurnal migration intensity (red bars) derived from visual observations in 2023 at KF II OWF S. Light blue shades indicate the dates of the surveys (22 dates).

FLIGHT ALTITUDE

In the most northern area (KF II OWF N), most migrating birds were flying at very low altitudes. In spring, 71% of all birds were flying at altitudes up to 5 m above sea level, whereas in autumn, it was almost half of all migrating birds (49%, Figure 5-34). Only less than 20% and about 25% of all migrating birds flew above 20 m in spring and autumn respectively in this area. Additionally, in autumn were some birds registered flying at very high altitudes (above 200 m), which were mainly birds of prey.

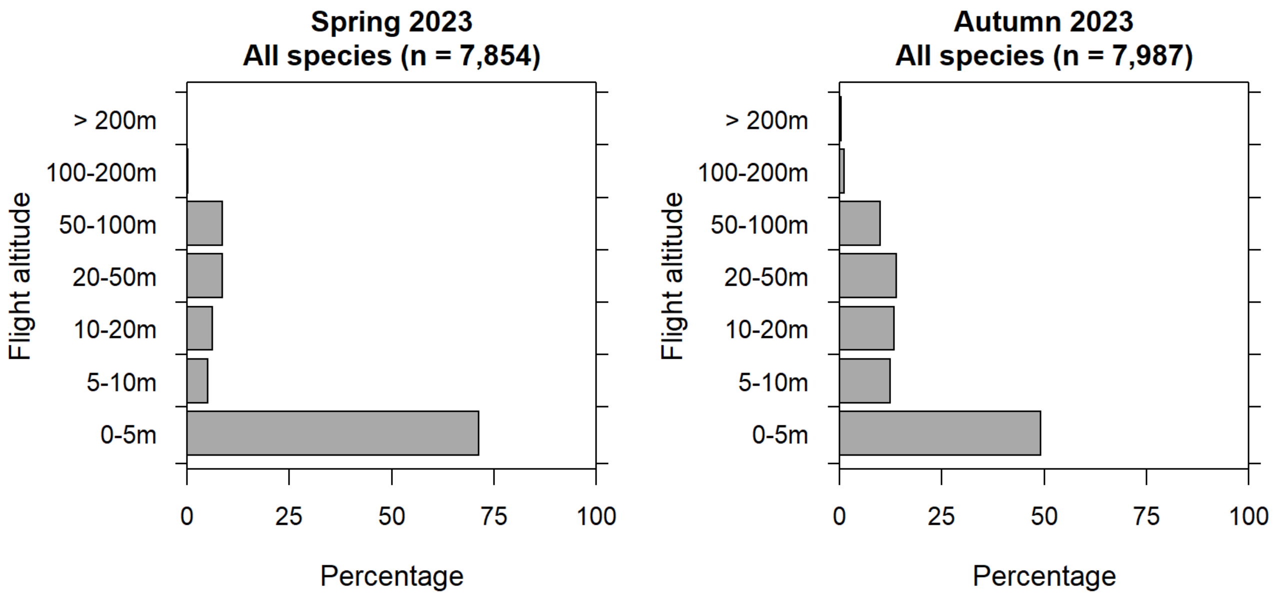


Figure 5-34 Flight altitude distribution of all observed birds during visual observations in spring (left) and autumn (right) 2023 at the pre-investigation area KF II OWF N.

Different patterns of flight altitude distribution were observed in the southern area. Especially in spring, the majority of birds flew at an altitude between 20 and 50 m (41%, Figure 5-35) which were mainly geese (see next section). Only 38% of all migrating birds flew at altitudes below 20 m. In autumn, the pattern was similar to that of the northern area, with the majority of birds flying at altitudes up to 5 m (53%), and about two thirds of all migrating birds flew below 20 m. About 6% of all birds observed were flying at very high altitudes (> 200 m, all corresponded to geese, Figure 5-35, see next section).

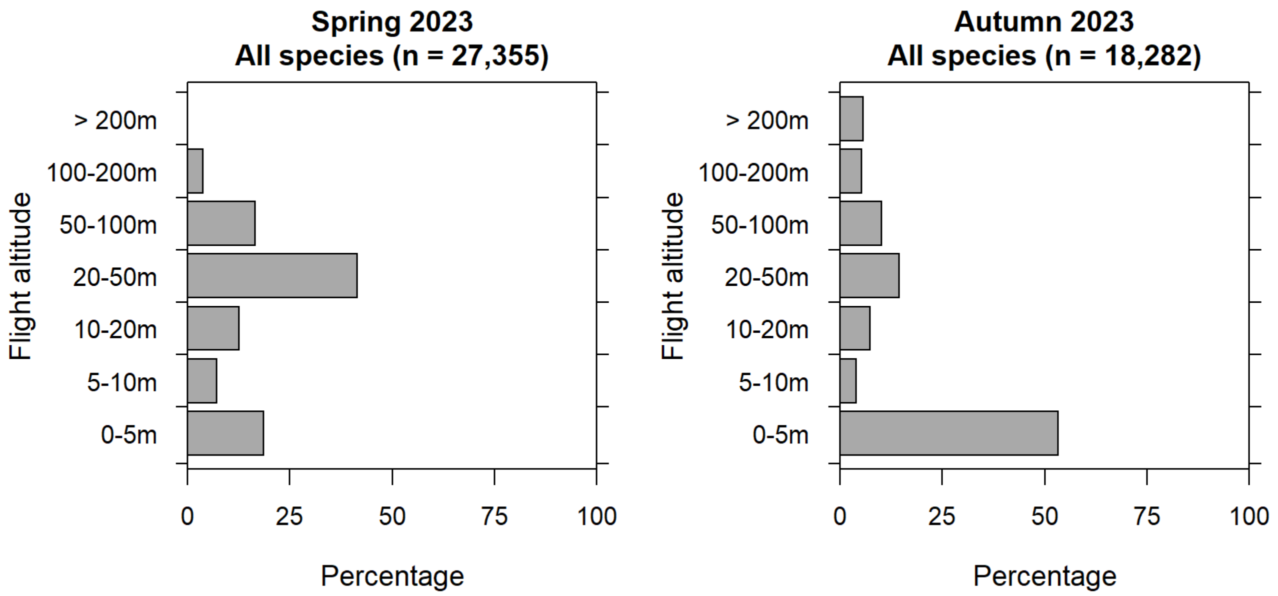


Figure 5-35 Flight altitude distribution of all observed birds during visual observations in spring (left) and autumn (right) 2023 at the pre-investigation area KF II OWF S.

FLIGHT DIRECTION

In general, birds of both areas flew in a NE direction in spring and in a SW direction in autumn, and the direction was less variable in spring than in autumn. There were however, slight differences in the patterns due to the differences in the main groups of birds in each area. In detail, in the northern area, 55.6% were flying in a NE direction, 11.5% and 12.4% were flying in a N and NW direction in spring whereas in autumn, about 38% of all birds flew in a SW and almost 33% flew in a W direction (mainly ducks, Figure 5-36).

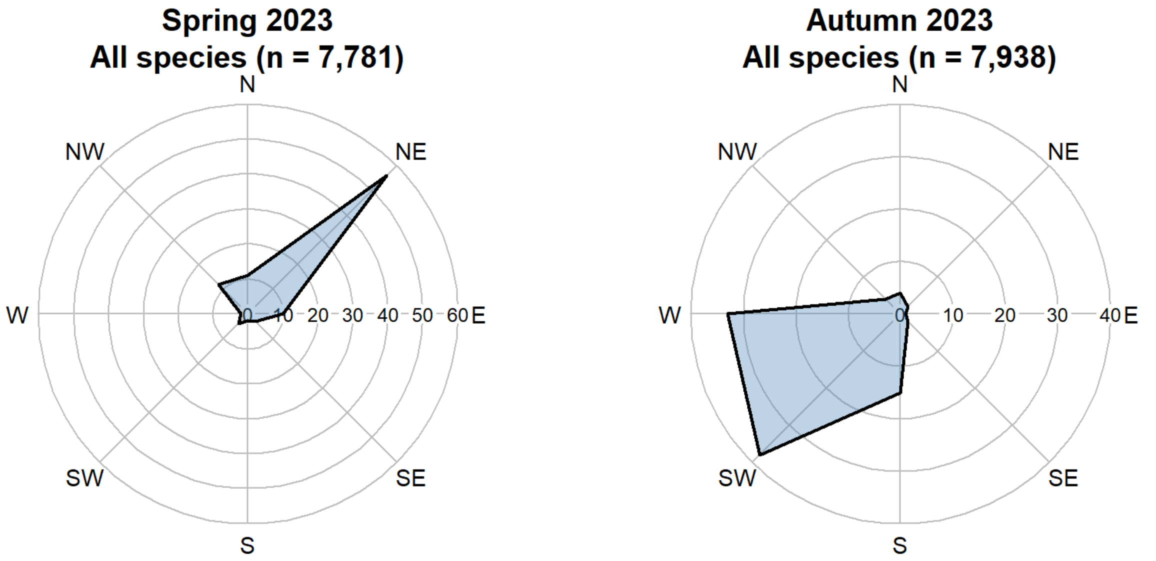


Figure 5-36 Flight directions of all observed birds during visual observations in spring and autumn 2023 at the pre-investigation area KF II OWF N. Observers estimated the flying direction in 45° increments: N = North, NE = Northeast, E = East, SE = Southeast, S = South, SW = Southwest, W =West, NW = Northwest. Numbers on the axis represent percentages.

In the southern area, the NE direction was clearly observed for most migrating birds (89.5%). During autumn, two main migration directions were observed: 58.8% of all birds flew to the SW, whereas 31.7% flew to the west. Only 3% of all observed birds flew in a direction that was not the W, SW or S direction (Figure 5-37).

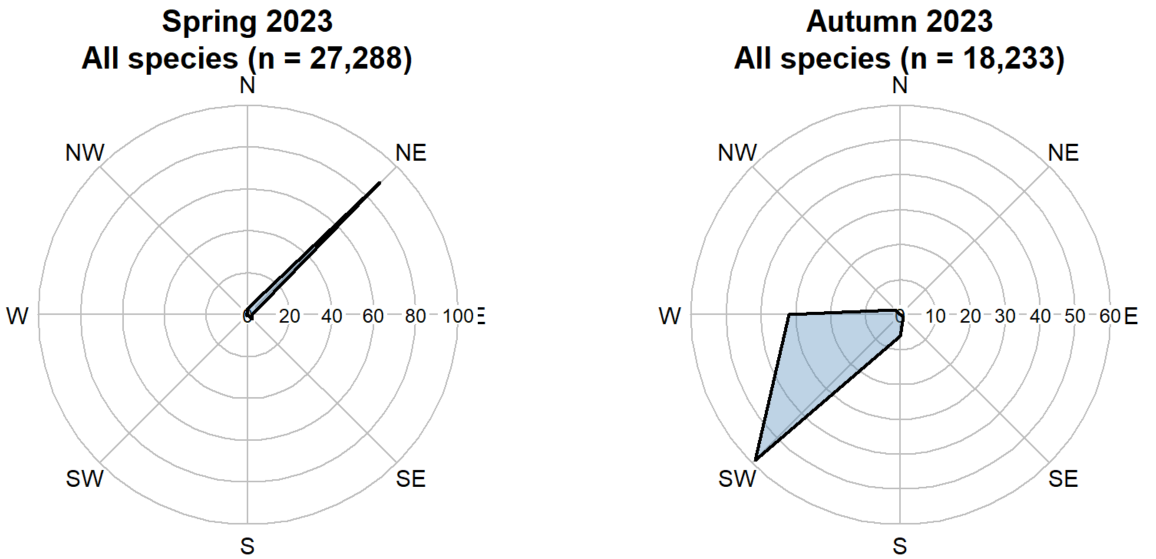


Figure 5-37 Flight directions of all observed birds during visual observations in spring and autumn 2023 at the pre-investigation area KF II OWF S. See Figure 5-36 for details.

DIURNAL PHENOLOGY

During spring, most birds flew in the first half of the day. In the northern area, about 85% of all birds were observed flying in the first 6 hours, whereas in the southern area, the percentage increased to almost 90% (Figure 5-38, Figure 5-39). There were two hours in which most migration occurred. In the northern area, it was at 4 and 5 hours (42% of the total) after civil morning twilight, whereas in the southern area, it was at 5 and 6 hours (about 54% of the total). In autumn, the pattern was different in both areas, with a peak at two hours after civil morning twilight in the northern area (26%), where in general most migrating birds were also observed during the first part of the day (1-6 hours after civil morning twilight, about 76%, Figure 5-38). In the southern area, the highest peak of migration was observed just in the last hour of the day before the civil evening twilight (20.4%) with a second peak at 9 hours (16.3%), so that most birds were in general observed later in the day (61%, Figure 5-39).

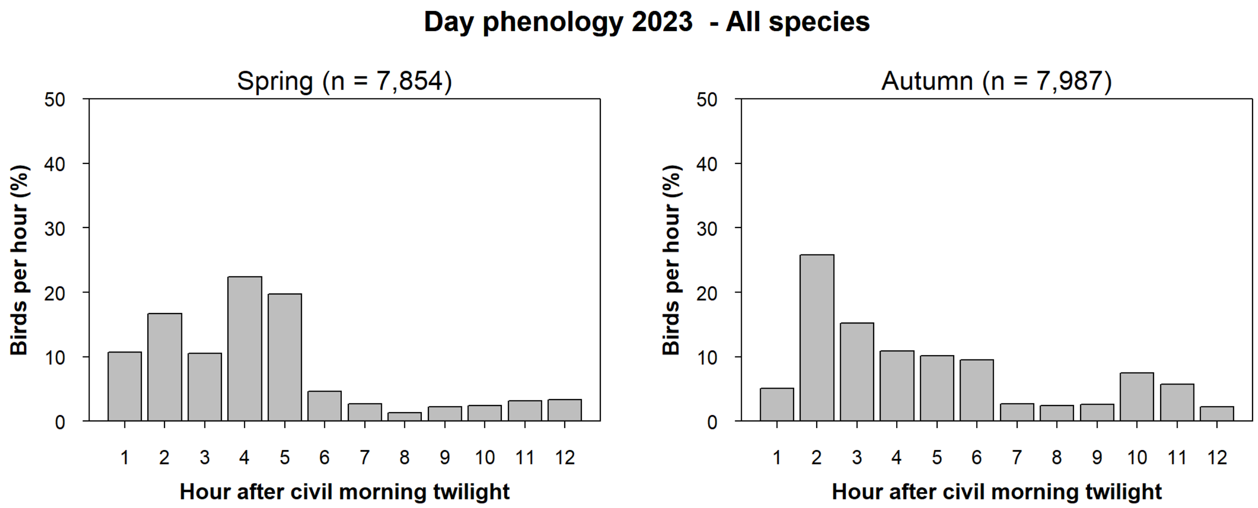


Figure 5-38 Diurnal phenology of all observed birds in 2023 at the pre-investigation area KF II OWF N. Observations were combined for all observations days in each season, and hours were standardized so that every day would have a 12 hours length, irrespective of the date.

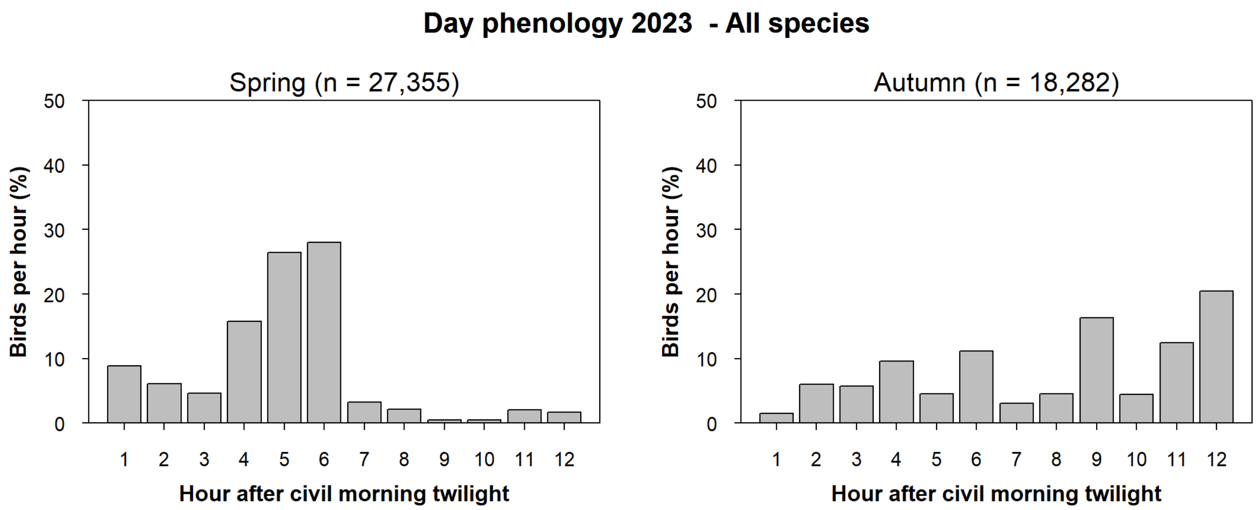


Figure 5-39 Diurnal phenology of all observed birds in 2023 at the pre-investigation area KF II OWF S. See Figure 5-38 for details.

NOCTURNAL MIGRATION

SPECIES COMPOSITION

The analysis of nocturnal flight calls showed that there were more calls heard in autumn than in spring at both pre-investigation areas. Songbirds were by far the most abundant species groups in both seasons and all areas but were more common in the southern area. In spring, songbirds made up 67.5% of all calls at the pre-investigation area KF II OWF N, whereas gulls represented 25.6% of all calls and waders 6.1% (Figure 5-40). At the pre-investigation area KF II OWF S, songbirds made up almost 95% of all calls heard, and gulls and ducks contributed to less than 5% of all calls in that same season (Figure 5-41). In autumn, songbirds made up 92.1% of all birds the northern area with waders representing 7.7% of all calls. At the southern area, songbirds made up 97% of all calls and waders represented just 3% of all calls. Other groups were virtually absent (Figure 5-40 and Figure 5-41).

In terms of species, there were calls of 12 identified species in spring and of 30 identified species in autumn at the northern area. In autumn, there were many waders (9 species) and songbirds other than thrushes (14) heard. In both seasons, thrushes were very abundant making up 50% of all calls in spring and 75% of all calls in autumn (Figure 5-40). Here the most common species in both seasons were the redwing and the common blackbird. Of the other songbirds, the most common species was the European robin (*Erithacus rubecula*).

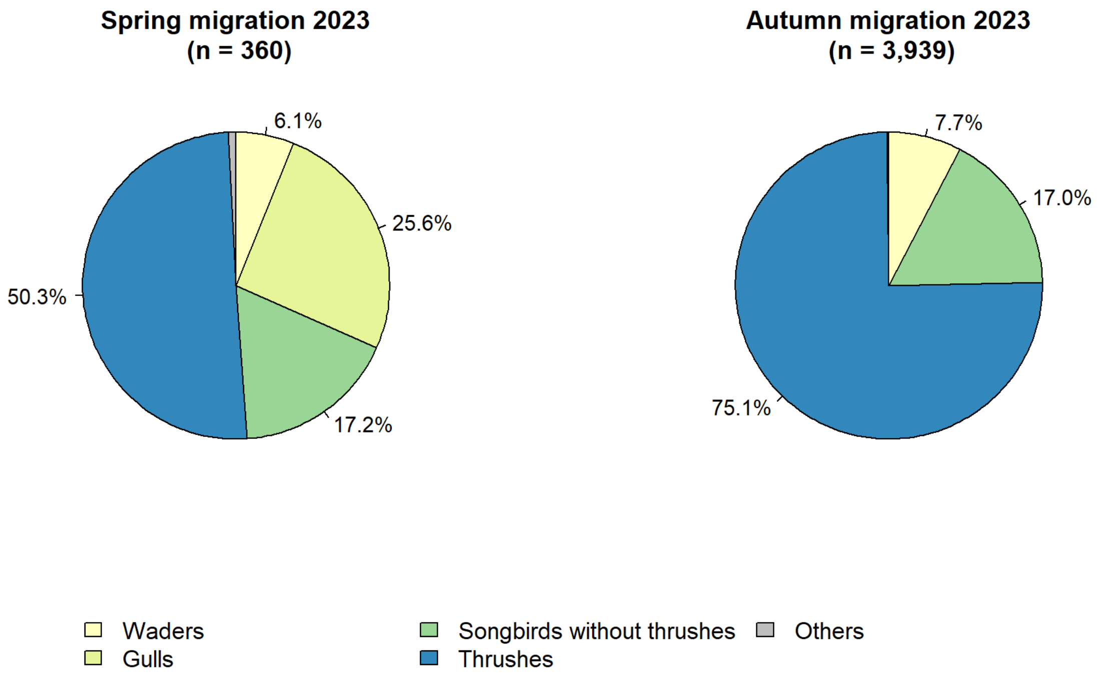


Figure 5-40 Percentage of nocturnal migratory species (based on acoustic observations) grouped into high-category taxa in spring and autumn 2023 at the pre-investigation area KF II OWF N. See Figure 5-30 for more details.

In the southern area, there were also more identified species in autumn, but not as many as in the northern area. There was a total of 19 species: 10 species of songbirds (no thrushes) and 4 species of waders (see next section for more details). In spring, there were 14 species belonging to different groups, but there were only three songbird species other than thrushes and one species of waders. In spring, thrushes dominated the bird migration during the night with about 72% of all calls belonging to this group and especially to song thrushes, redwings and common blackbirds. In autumn, however, most calls belonged to the European robin (68.5%), and thrushes represented in total just 16.2% of all calls in that season.

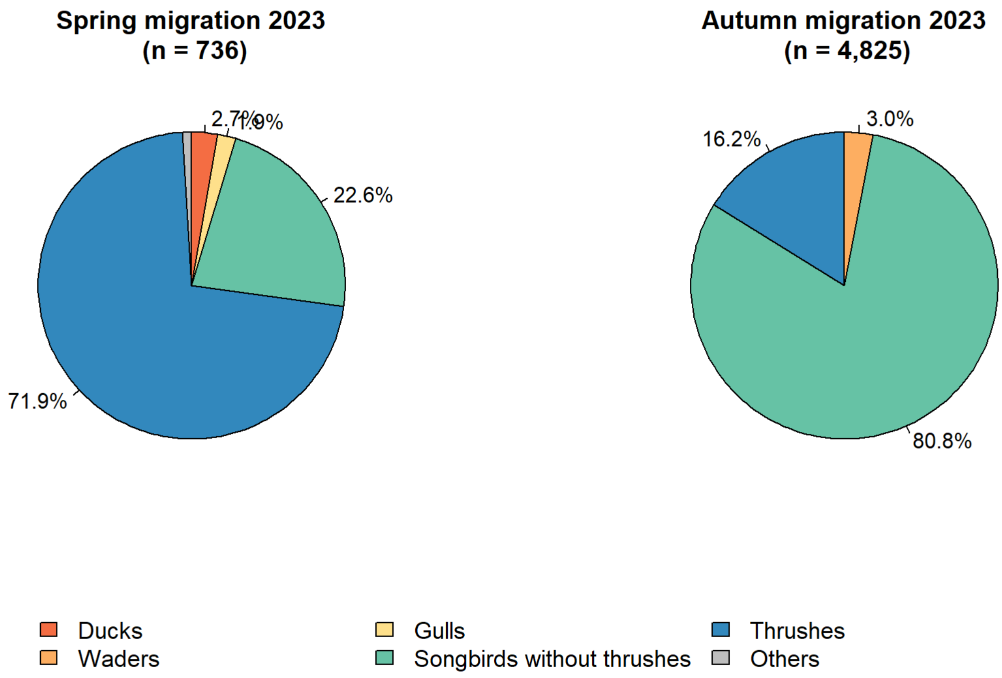


Figure 5-41 Percentage of nocturnal migratory species (based on acoustic observations) grouped into high-category taxa in spring and autumn 2023 at the pre-investigation area KF II OWF S. See Figure 5-30 for more details.

MIGRATION INTENSITY

As already mentioned in the previous pages, there were fewer birds in spring than in autumn for both areas. Thus, nocturnal migration intensity was much lower in spring than autumn in both, the northern and southern area, which is also confirmed by the vertical radar data. In the northern area, mean migration intensity was 5.5 calls/h (Table 5-5), whereas in the southern area, it was a bit higher (13.3 calls/h,

Table 5-6). This was mainly due to a higher migration intensity in March in the south (59 calls/h on average,

Table 5-6). The peaks were also higher in the south than in the north (66 calls/h vs. 27 calls/h). Interestingly, there were no bird calls registered in May for any of the areas, although there were 5 nights of collection in each area (Figure 5-42, Figure 5-43), which indicates that more birds of non-calling species crossed the area at that time since the vertical radar can show that bird migration also took place during these nights
In autumn, migration intensity was 33 calls/h in the north and 98 calls/h in the south, on average (Table 5-5 and

Table 5-6). In the northern area, the maximum intensity was 170 calls/h and registered in November, whereas in the southern area was a very high peak of 774 calls/h in September, with almost no calls heard in November.

Table 5-5. Monthly and seasonal migration rates (calls/h) calculated from nocturnal flight calls (acoustic observations) in 2023 at the pre-investigation area KF II OWF N.

2023	Migration intensity (calls/h)			Number of calls	Number of survey nights [planned]
	Mean (± SE)	Median	Maximal value		
March	6.7 (± 5.3)	0	27.2	144	5
April	9.9 (± 4.3)	7.2	25.4	216	5
May	0 (± 0)	0	0	0	5
Spring	**5.5 (± 2.4)**	**0**	**27.2**	**360**	**15 [15]**
August	3.4 (± 2.4)	0.8	12.8	64	5
September	41.8 (± 22)	25.6	124.8	983	5
October	42.7 (± 19.3)	42.7	82.6	1076	4
November	43.2 (± 27.9)	6.5	170.4	1816	6
Autumn	**32.8 (± 10.7)**	**8.2**	**170.4**	**3939**	**20 [20]**

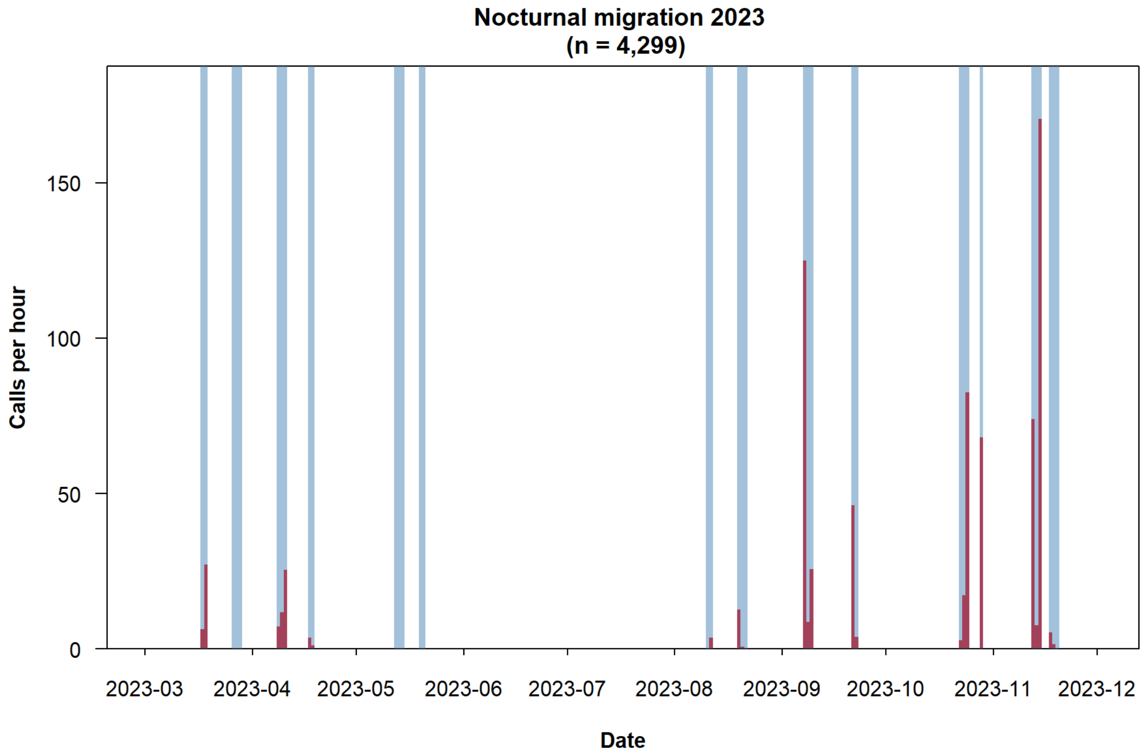


Figure 5-42 Nocturnal migration intensity (red bars) derived from acoustic observations (flight calls) in 2023 at KF II OWF N. Light blue shades indicate the dates of the surveys (35 dates).

Table 5-6. Monthly and seasonal migration rates (calls/h) calculated from nocturnal flight calls (acoustic observations) in 2023 at the pre-investigation area KF II OWF S.

2023	Migration intensity (calls/h)			Number of calls	Number of survey nights [planned]
	Mean (± SE)	Median	Maximal value		
March	58.9 (± 6.9)	58.9	65.8	544	2
April	9.5 (± 2.6)	12	16.2	192	5
May	0 (± 0)	0	0	0	5
Spring	**13.8 (± 6.4)**	**3.4**	**65.8**	**736**	**12 [12]**
September	213 (± 187.5)	37.5	773.7	4047	4
October	25 (± 9.9)	25.4	58.5	776	5
November	0.3 (± 0)	0.3	0.3	2	1
Autumn	**97.7 (± 75.5)**	**18.4**	**773.7**	**4825**	**10 [10]**

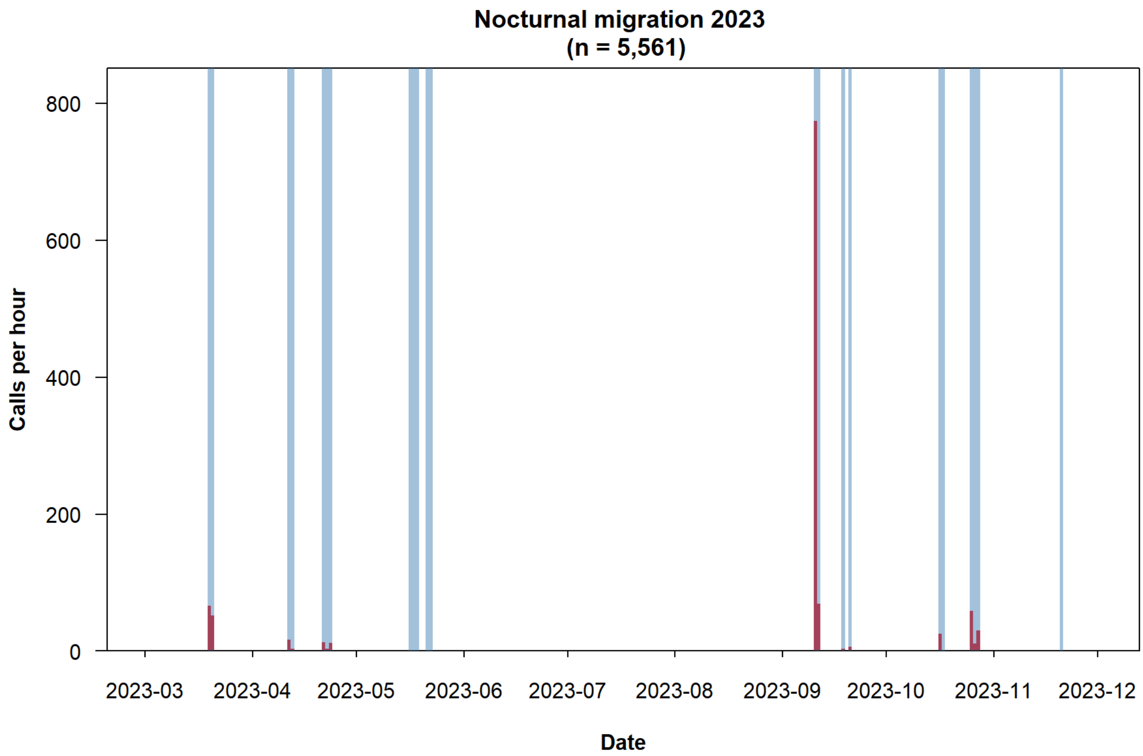


Figure 5-43 Nocturnal migration intensity (red bars) derived from acoustic observations (flight calls) in 2023 at KF II OWF S. Light blue shades indicate the dates of the surveys (22 dates).

In spring, a very similar pattern of nocturnal migration emerged after the analysis for both areas. Most migration calls were heard at the middle of the night and coincidentally there were two high migration peaks at 6 and 8 hours after the civil evening twilight at both areas (42% and 66% of all nocturnally migrating bird calls heard at KF II OWF N and S, respectively, Figure 5-44 and Figure 5-45). In autumn, nocturnal migration occurred during the whole night, but most of the migrating bird calls were heard during the first part of the night at the KF II OWF N area (65% of all), with two peaks at 3 and 5 hours after civil evening twilight (Figure 5-44). In contrast, at the southern area, bird calls were increasingly and progressively more heard towards late in the night with a small peak at 12 and 9 hours after civil evening twilight. About 74% of all calls were then heard during the last 6 hours of the night (Figure 5-45).

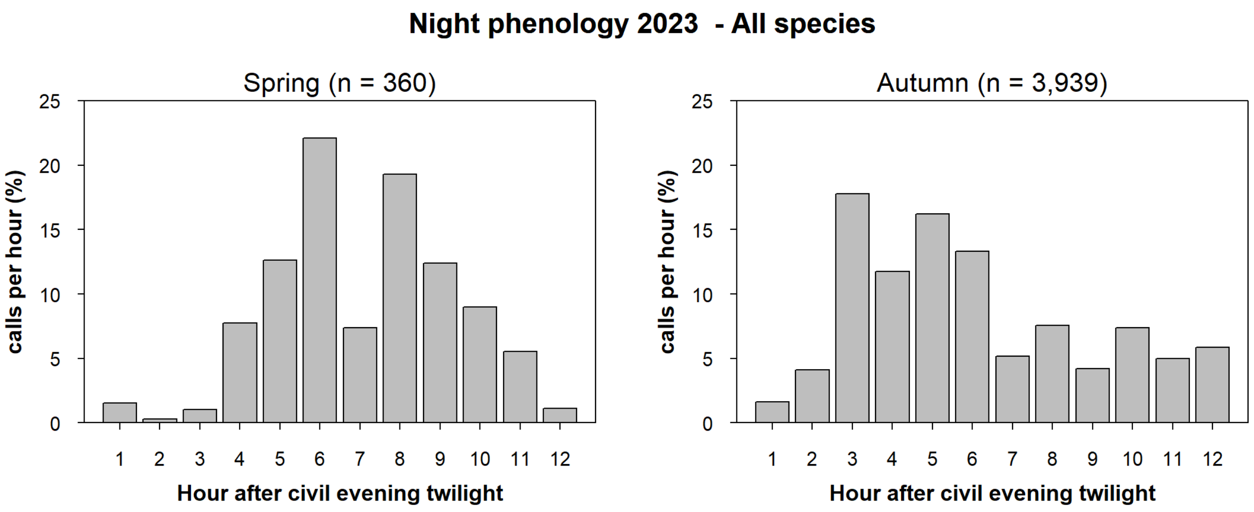


Figure 5-44 Nocturnal phenology of all observed birds in spring and autumn 2023 at the pre-investigation area KF II OWF N. See Figure 5-39 for details.

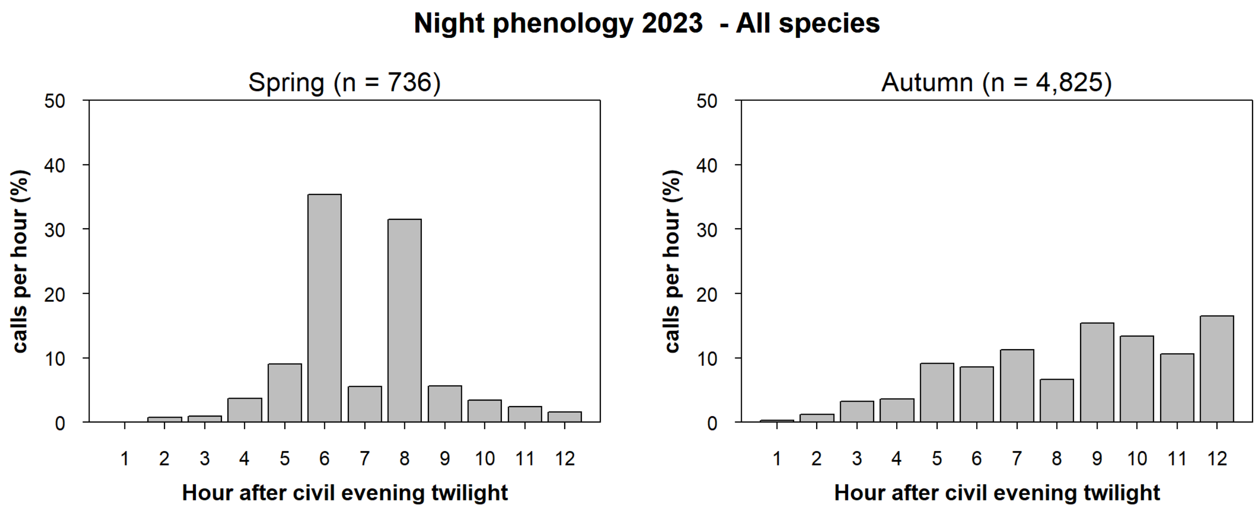


Figure 5-45 Nocturnal phenology of all observed birds in spring and autumn 2023 at the pre-investigation area KF II OWF S. See Figure 5-39 for details.

RELEVANT SPECIES GROUPS

In the following section, the migration patterns of the most relevant species groups encountered at the pre-investigation area KF II OWF (N and S) are further described. Summaries of migration intensities obtained from visual observations are provided in Table 5-7 and Table 5-8 whereas information on migration intensity obtained from nocturnal flight calls is provided in Table 5-9 and Table 5-10, for each area respectively. Note that the tables include all birds encountered in each area, but patterns of species groups that reached at least 1% of abundance in any season (at each area) are considered for further detail.

OVERVIEW

Table 5-7 Main migration patterns for the species groups found at the pre-investigation area KF II OWF N in spring and autumn 2023 during visual observations. Number of individuals and identified species (in parentheses) in each group are also indicated together with the mean, maximum and peak date of migration intensity for each season (ind./h).

Species groups	Number of ind. (spp.)		Migration intensity spring (ind./h)			Migration intensity autumn (ind./h)		
	Spring	Autumn	Mean	Maximum	Peak date	Mean	Maximum	Peak date
Divers	28 (2)	155 (2)	0.29	1.38	19.04.2023	1.85	8.67	18.11.2023
Grebes	9 (2)	0	0.1	0.76	08.04.2023	0	0	
Gannets	1 (1)	5 (1)	0.01	0.14	18.04.2023	0.06	0.42	12.11.2023
Cormorants	403 (1)	422 (1)	4.24	21.14	26.03.2023	3.69	11.71	07.09.2023
Herons	0	6 (2)	0	0		0.05	0.57	07.09.2023
Swans	28 (3)	93 (2)	0.25	1.12	12.05.2023	1.13	8.89	18.11.2023
Geese	3,977 (4)	2,948 (6)	34.61	332.24	14.05.2023	34.59	170.53	13.11.2023
Ducks	2,347 (9)	2,430 (16)	22.99	99	09.04.2023	22.46	104.14	09.09.2023
Birds of prey	6 (4)	89 (8)	0.06	0.29	10.04.2023	0.88	5.05	15.11.2023
Cranes	47 (1)	0	0.46	4.29	10.04.2023	0	0	
Waders	149 (4)	269 (12)	1.38	15.43	09.04.2023	2.09	17.86	09.09.2023
Skuas	0	16 (1)	0	0		0.13	1.86	07.09.2023
Gulls	396 (7)	232 (8)	3.93	10.86	09.04.2023	2.44	8.42	15.11.2023
Terns	55 (1)	251 (3)	0.49	2.34	19.04.2023	1.77	23.38	11.08.2023
Auks	144 (3)	75 (3)	1.33	3.53	20.05.2023	0.91	5.33	18.11.2023
Pigeons	1 (1)	0	0.01	0.16	17.03.2023	0	0	

Owls	0	3 (2)	0	0		0.03	0.38	29.10.2023
Swifts	0	1 (1)	0	0		0.01	0.12	11.08.2023
Songbirds	256 (19)	992 (25)	2.41	19.45	19.04.2023	10.67	72.47	23.10.2023

Table 5-8 Main migration patterns for the species groups found at the pre-investigation area KF II OWF S in spring and autumn 2023 during visual observations. Number of individuals and identified species (in parentheses) in each group are also indicated together with the mean, maximum and peak date of migration intensity for each season (ind./h).

Species groups	Number of ind. (spp.)		Migration intensity spring (ind./h)			Migration intensity autumn (ind./h)		
	Spring	Autumn	Mean	Maximum	Peak date	Mean	Maximum	Peak date
Divers	49 (3)	16 (2)	0.59	2.5	11.04.2023	0.33	1.65	16.10.2023
Grebes	6 (1)	0	0.08	0.67	11.04.2023	0	0	
Gannets	0	2 (1)	0	0		0.04	0.19	27.10.2023
Cormorants	262 (1)	174 (1)	3.17	10.29	12.04.2023	3.42	11.06	16.10.2023
Herons	2 (1)	3 (1)	0.03	0.33	11.04.2023	0.05	0.55	18.10.2023
Swans	21 (1)	2 (1)	0.21	1.83	22.05.2023	0.03	0.33	10.09.2023
Geese	22643 (4)	10799 (5)	223.85	1655.41	17.05.2023	215.45	1244.91	18.10.2023
Ducks	3,495 (11)	4591 (13)	42.29	166.33	11.04.2023	85.55	357.64	18.10.2023
Birds of prey	14 (2)	105 (9)	0.16	0.83	21.04.2023	2.1	10.35	16.10.2023
Cranes	64 (1)	0	0.84	4	19.03.2023	0	0	
Waders	90 (2)	33 (3)	1.09	8	23.04.2023	0.54	1.69	11.09.2023
Skuas	1 (1)	0	0.01	0.17	21.04.2023	0	0	
Gulls	201 (7)	236 (7)	2.41	5	11.04.2023	4.48	15.45	17.10.2023
Terns	5 (1)	0	0.06	0.53	23.04.2023	0	0	
Auks	72 (2)	49 (2)	0.83	3.07	23.04.2023	0.96	2.48	27.10.2023
Pigeons	4 (2)	3 (1)	0.05	0.48	20.03.2023	0.07	0.71	16.10.2023
Owls	0	1 (1)	0	0		0.02	0.21	28.10.2023
Swifts	1 (1)	0	0.01	0.12	16.05.2023	0	0	

Songbirds	416 (26)	2268 (26)	5.35	27.67	21.04.2023	43.98	120.87	21.09.2023

Table 5-9 Main migration patterns for the species groups found at the pre-investigation area KF II OWF N in spring and autumn 2023 during nocturnal acoustic observations.

Species groups	Number of calls (spp.)		Migration intensity spring (calls/h)			Migration intensity autumn (calls/h)		
	Spring	Autumn	Mean	Maximum	Peak date	Mean	Maximum	Peak date
Herons	0	2 (1)	0	0		0.02	0.42	07.09.2023
Geese	0	6 (1)	0	0		0.05	1	28.10.2023
Ducks	3 (1)	0	0.04	0.67	09.04.2023	0	0	
Waders	22 (4)	302 (9)	0.35	2.59	17.04.2023	3.26	55.16	07.09.2023
Gulls	92 (2)	0	1.37	9.18	10.04.2023	0	0	
Songbirds without thrushes	62 (1)	669 (14)	1	9.5	18.03.2023	6.92	45.47	07.09.2023
Thrushes	181 (4)	2960 (5)	2.77	17.75	18.03.2023	22.57	168.57	14.11.2023

Table 5-10 Main migration patterns for the species groups found at the pre-investigation area KF II OWF S in spring and autumn 2023 during nocturnal acoustic observations.

Species groups	Number of ind (spp)		Migration intensity spring (ind./h)			Migration intensity autumn (ind./h)		
	Spring	Autumn	Mean	Maximum	Peak date	Mean	Maximum	Peak date
Geese	5 (1)	0	0.09	1.05	11.04.2023	0	0	
Ducks	20 (2)	0	0.35	4.21	11.04.2023	0	0	
Waders	1 (1)	144 (4)	0.02	0.21	11.04.2023	3.09	28.21	10.09.2023
Gulls	14 (2)	0	0.31	2.86	20.03.2023	0	0	
Pigeons	0	1 (1)	0	0		0.02	0.21	10.09.2023
Owls	1 (1)	0	0.02	0.18	19.03.2023	0	0	
Songbirds without thrushes	166 (3)	3899 (10)	3.75	23.43	20.03.2023	81.67	729.89	10.09.2023
Thrushes	529 (4)	781 (4)	9.26	62.55	19.03.2023	12.94	58	25.10.2023

DIVERS

Divers represented almost 2% of all migrating birds at the northern area in autumn 2023. In autumn, the species of red-throated diver was more abundant (1.7% see Figure 5-30, Figure 5-46). In spring, however, their numbers were much lower and the group made just 0.3% of all migrating birds. In the southern area, divers were present but their numbers were too low in comparison to the other groups in the area. Nonetheless, their diurnal migration is shown also in Figure 5-47. In general, mean migration intensity of divers was low (the mean in spring of both areas and autumn of the southern area ranged between 0.3 – 0.6 birds/h and the maximum values varied between 1.3 and 2.5 ind./h. At KF II OWF N, however, there were comparatively higher intensities with a mean of 1.8 ind./h and a maximum value of 8.7 ind./h in November.

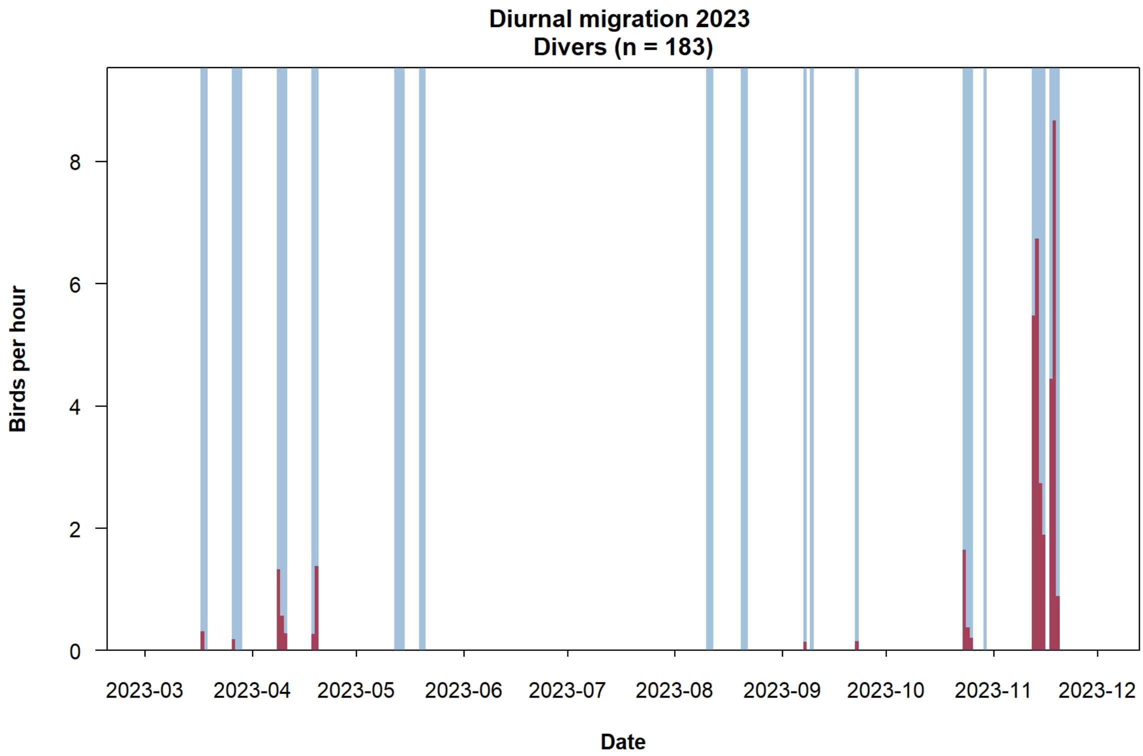


Figure 5-46 Diurnal migration intensity of divers in 2023 at the pre-investigation area KF II OWF N. See Figure 5-32 for details.

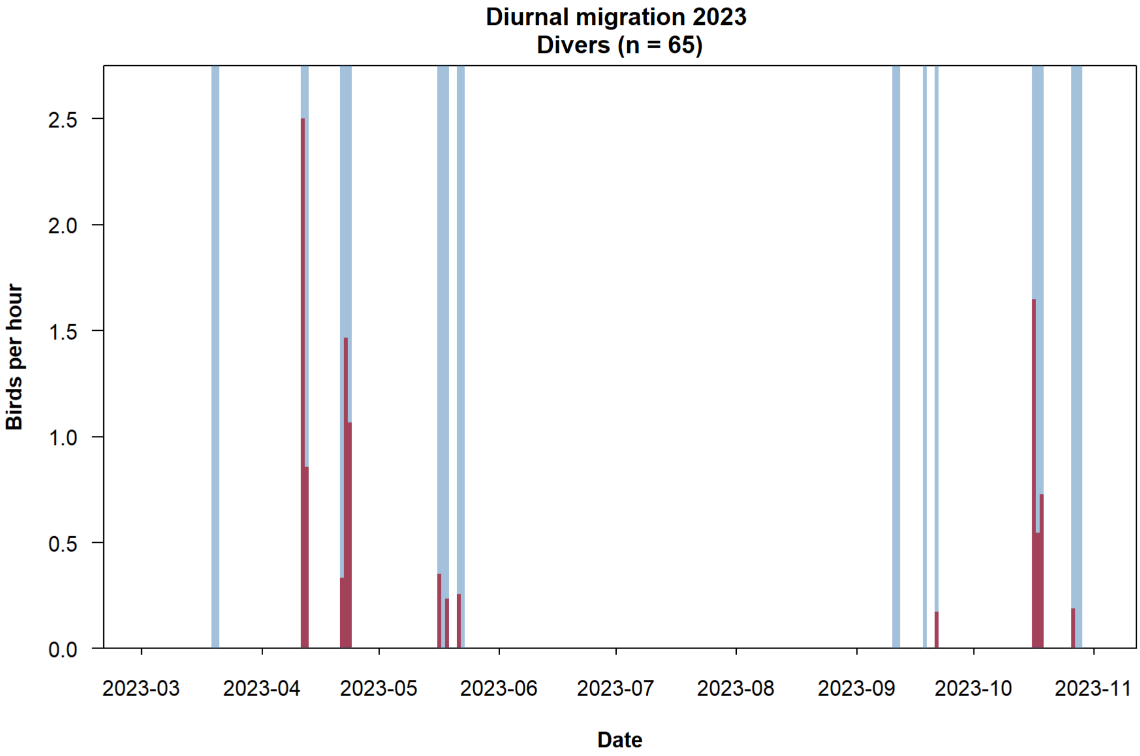


Figure 5-47 Diurnal migration intensity of divers in 2023 at the pre-investigation area KF II OWF S. See Figure 5-32 for details.

The altitude distribution differed for each season and each area. In general, too low numbers were observed to generalize. However, while many flew at low altitudes (< 20 m), a considerable proportion flew between 20 m and 100 m of altitude: about 40% in spring and 47% in autumn at the northern area, and 39% in spring and 12.5% in autumn at the southern area (Figure 5-48 and Figure 5-49).

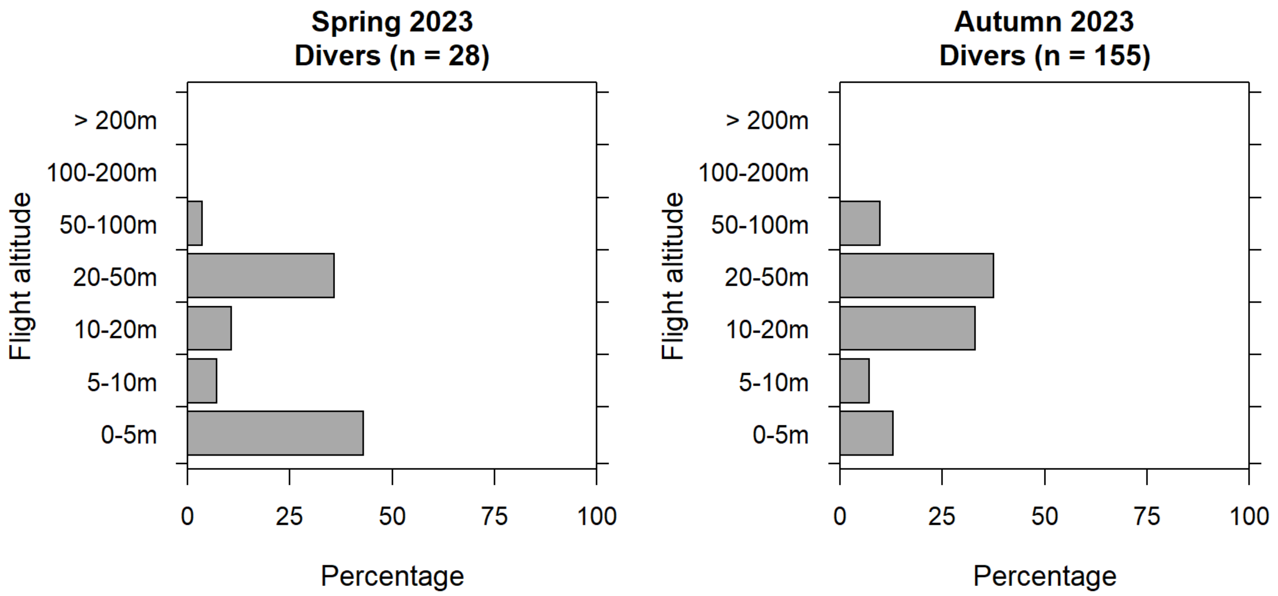


Figure 5-48 Flight altitude distribution of divers during visual observations in 2023 at the pre-investigation area KF II OWF N.

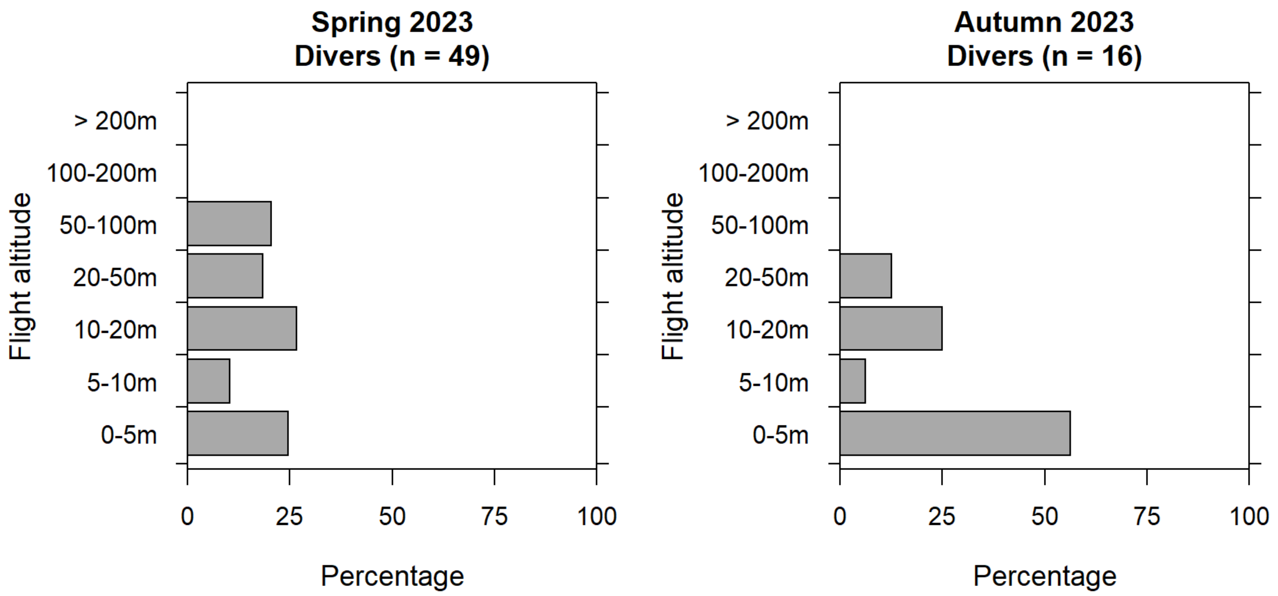


Figure 5-49 Flight altitude distribution of divers during visual observations in 2023 at the pre-investigation area KF II OWF S.

In general, divers flew with a NE direction in spring, especially at the northern area. In the southern area, a large proportion of divers were flying directly towards the east (33%, Figure 5-50, Figure 5-51). In autumn, the main direction was west, both at the northern area and at the southern area (31% of divers at KF II OWF N and 43% of the few divers observed in autumn at KF II OWF S). However, also the NW and the SW were directions of flight commonly observed (Figure 5-50, Figure 5-51).

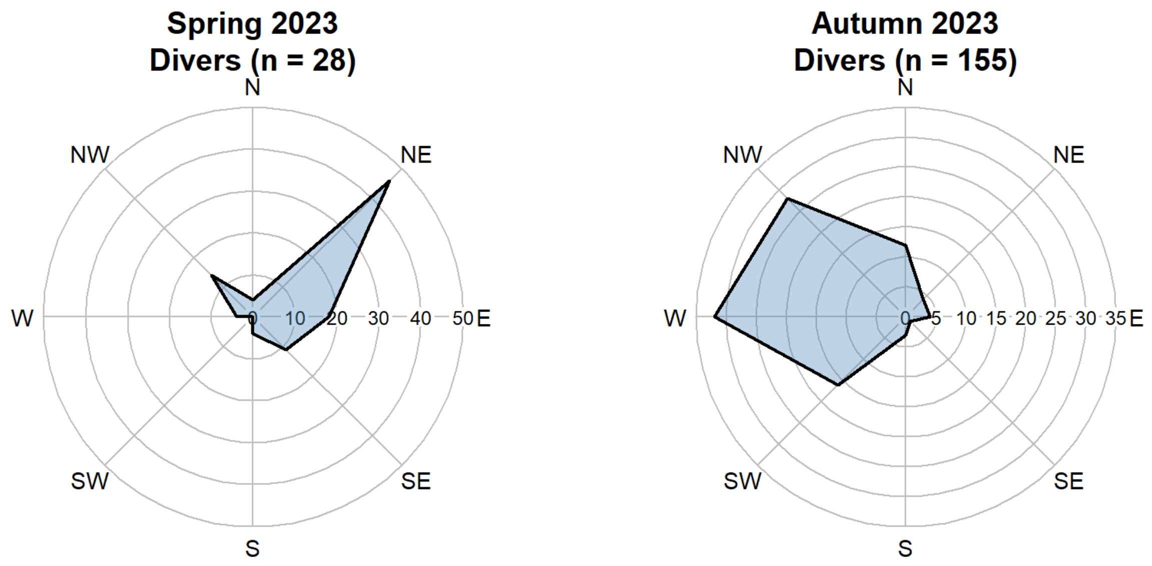


Figure 5-50 Flight direction of divers during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-36 for details.

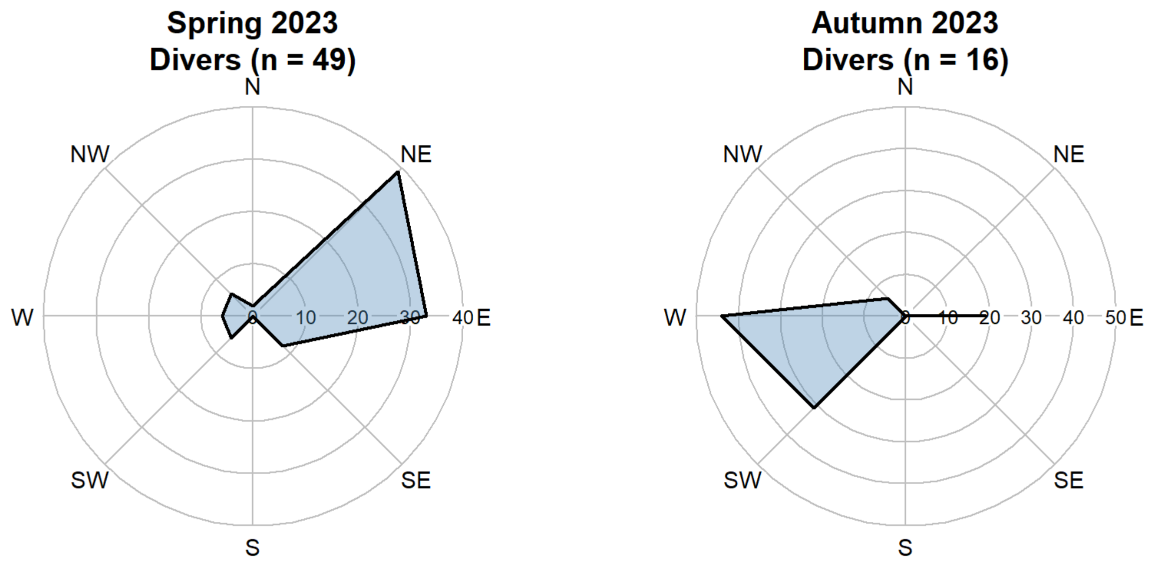


Figure 5-51 Flight direction of divers during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-36 for details.

There were too few individuals of divers in all seasons except autumn at KF II OWF N to infer a phenology pattern. However, divers were observed generally at all hours. In autumn at the northern area where they occurred in larger numbers, they seem to be more often flying in the first part of the day with 83% of all divers flying in the first six hours after civil morning twilight (Figure 5-52, Figure 5-53).

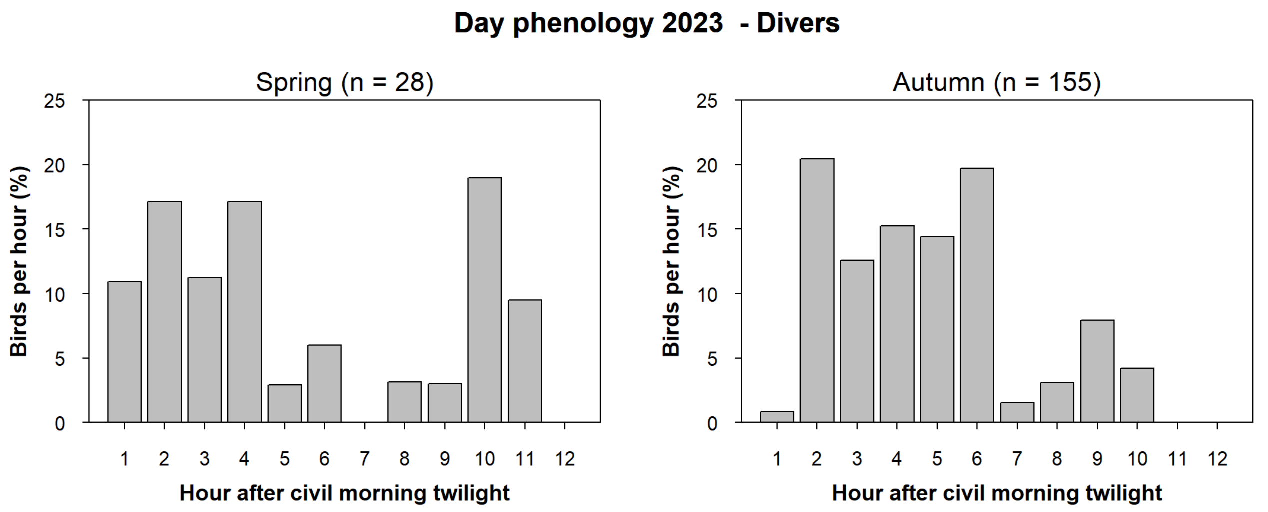


Figure 5-52 Diurnal phenology of divers in spring and autumn 2023 at the pre-investigation area KF II OWF N. See Figure 5-38 for details.

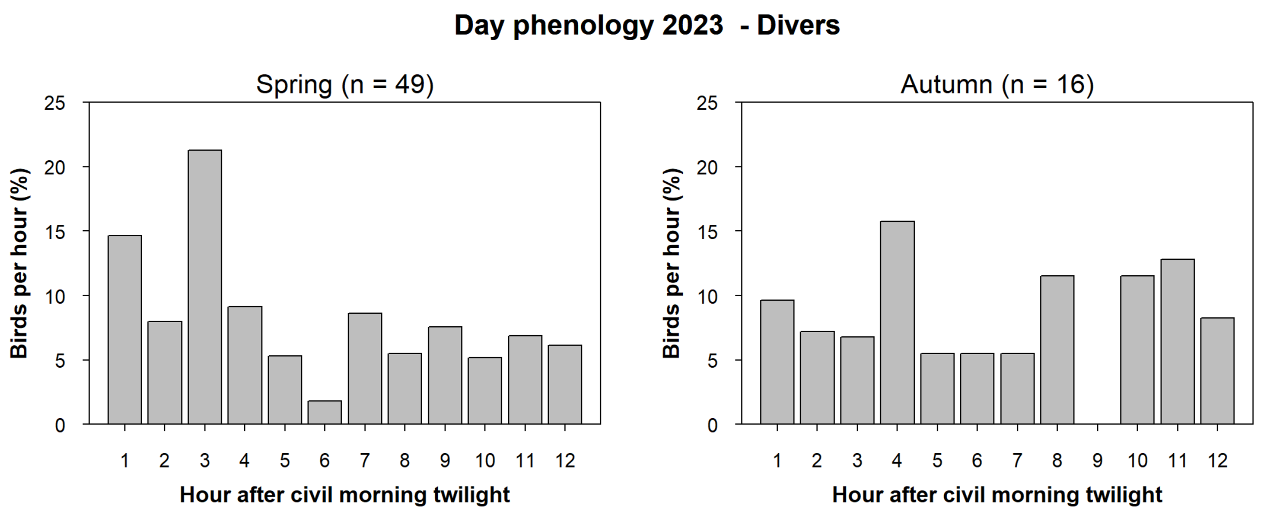


Figure 5-53 Diurnal phenology of divers in spring and autumn 2023 at the pre-investigation area KF II OWF S. See Figure 5-38 for details.

CORMORANTS

Cormorants, or the great cormorant (*Phalacrocorax carbo*), represented about 5% of all diurnally migrating birds in the northern area. In the southern area, they were less abundant, and due to the large number of other groups were comparatively not a large group. Nonetheless, mean intensities and maximum values were at similar ranges in both seasons and both areas. Only in spring at the northern area was there a peak maximum of 21.1 ind./h at the end of March (Figure 5-54 and Figure 5-55). Mean intensity varied between 3.1 and 4.2 for all seasons and all areas (see Table 5-7 and Table 5-8).

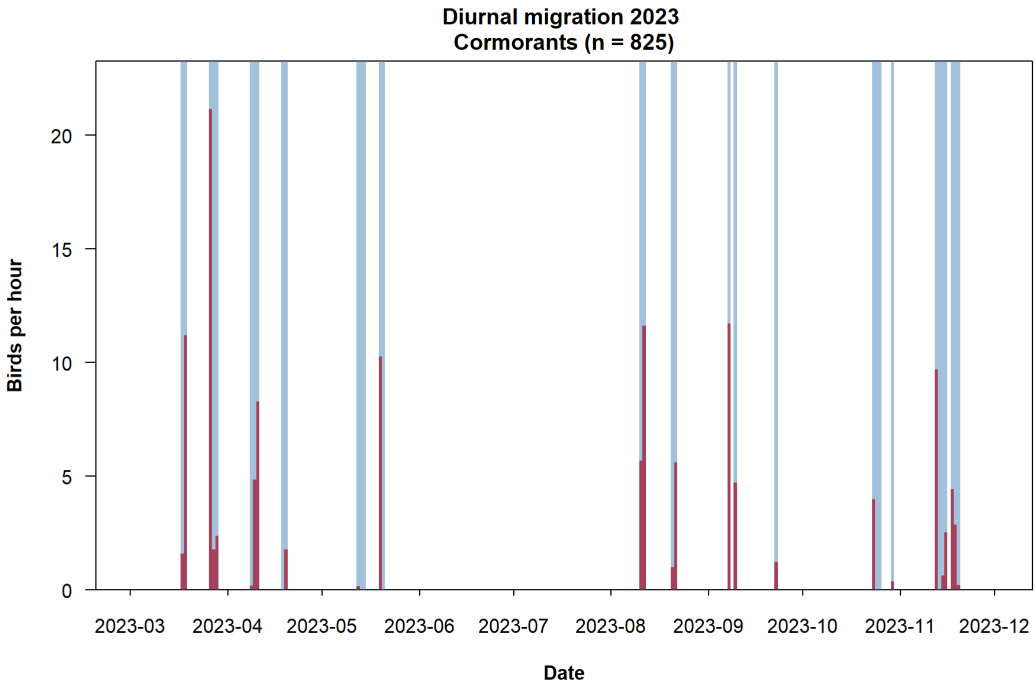


Figure 5-54 Diurnal migration intensity of cormorants (great cormorants) in 2023 at the pre-investigation area KF II OWF S. See Figure 5-32 for details.

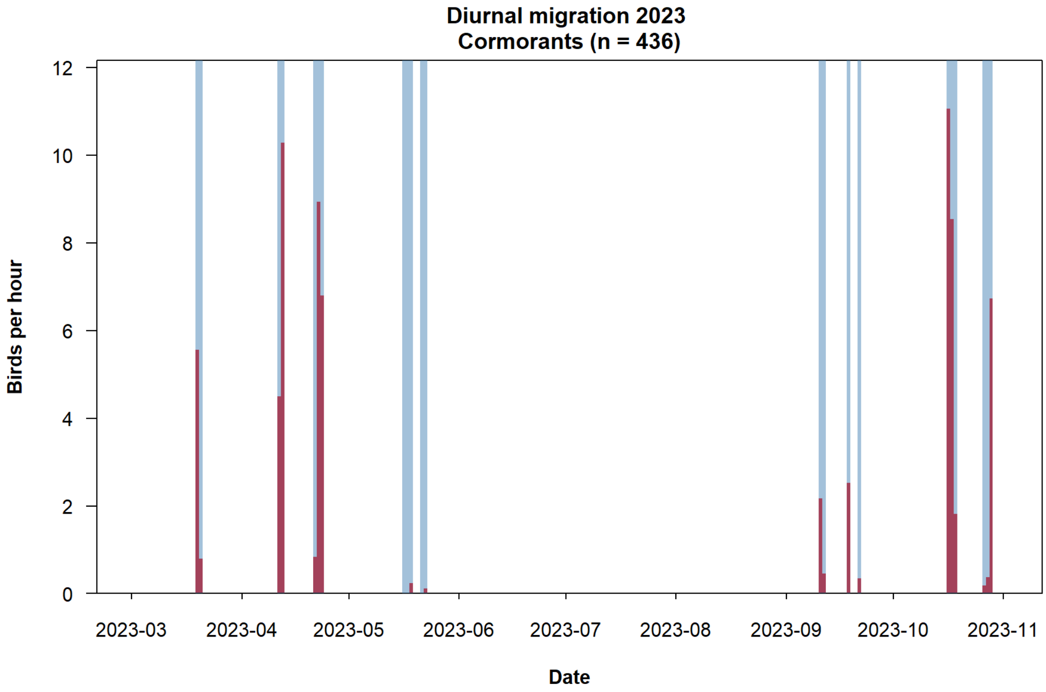


Figure 5-55 Diurnal migration intensity of cormorants (great cormorants) in 2023 at the pre-investigation area KF II OWF S. See Figure 5-32 for details.

Almost 50% of all cormorants were flying at very low altitudes (< 5m), except during the spring at the southern area (37%). Although in general, most flew up to 20 m, quite a few were observed flying at altitudes between 20 and 100 m in all seasons (33% in spring and 16% in autumn in the northern area; and 27% in spring and 37% in autumn at the southern area, Figure 5-56, Figure 5-57).

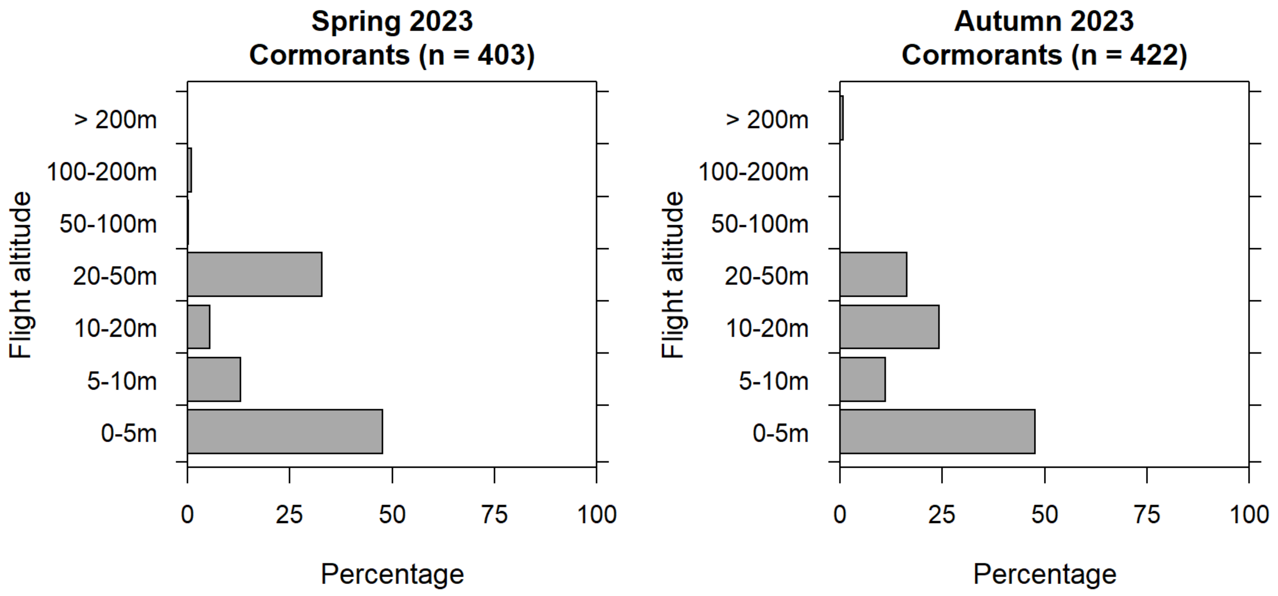


Figure 5-56 Flight altitude distribution of cormorants during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-35 for details.

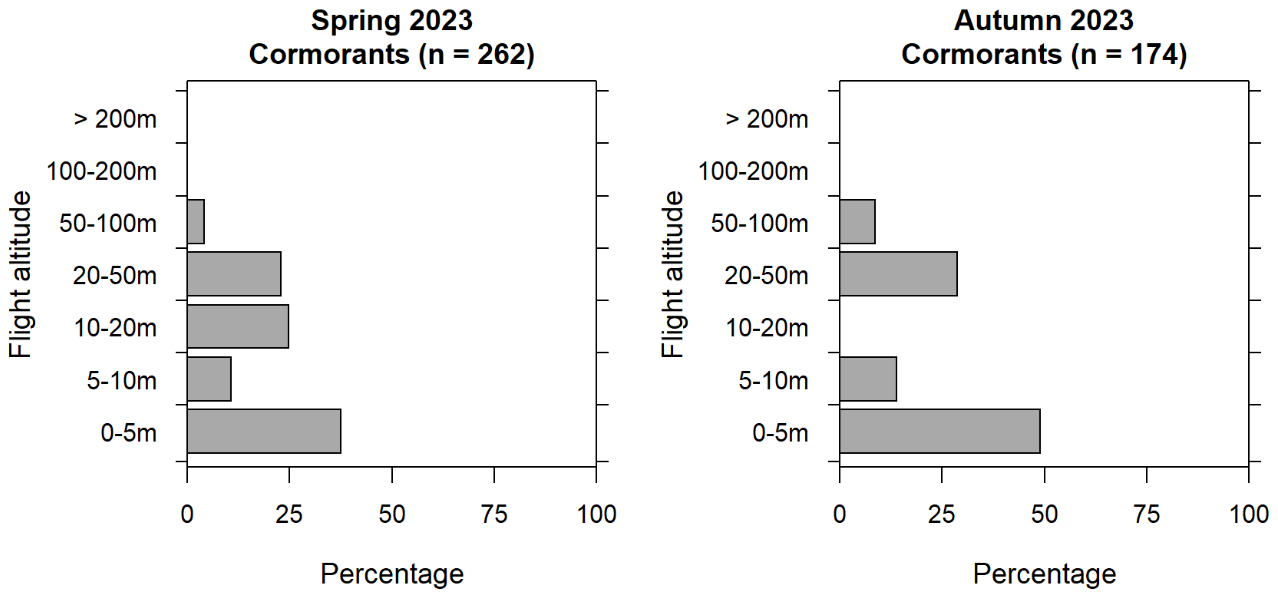


Figure 5-57 Flight altitude distribution of cormorants during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-35 for details.

Most cormorants flew mainly towards the NE in spring. In the southern area, a large proportion also flew towards the N (35%, Figure 5-58, Figure 5-59). In autumn, most cormorants flew to the SW, with smaller proportion of the birds flying also to the west (21% in the northern area and 18% in the southern area). In addition, about 10% of cormorants flew to the NE in both areas.

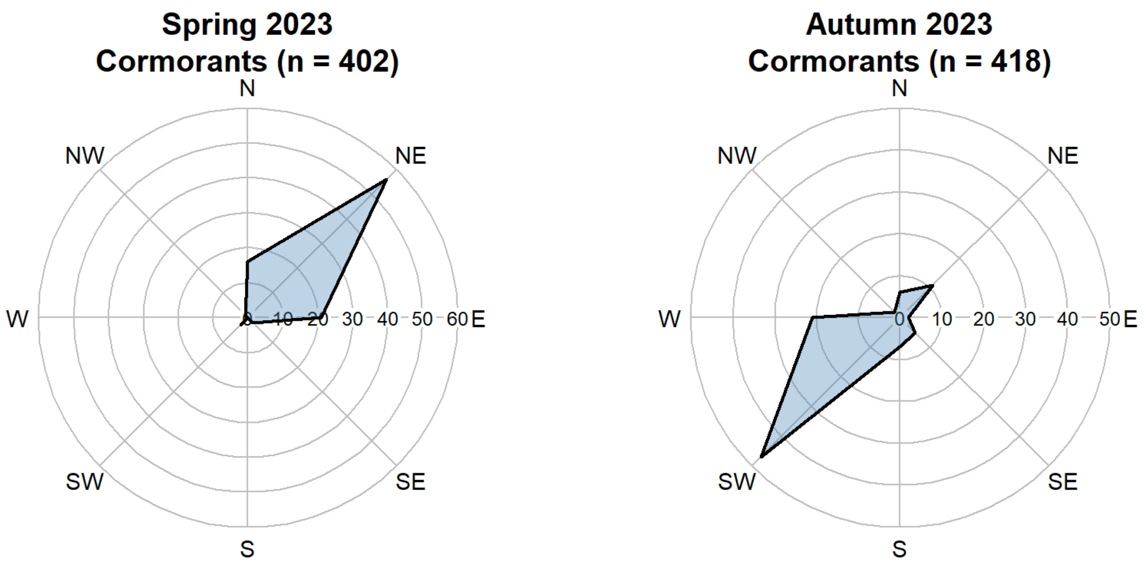


Figure 5-58 Flight direction of cormorants during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-36 for details.

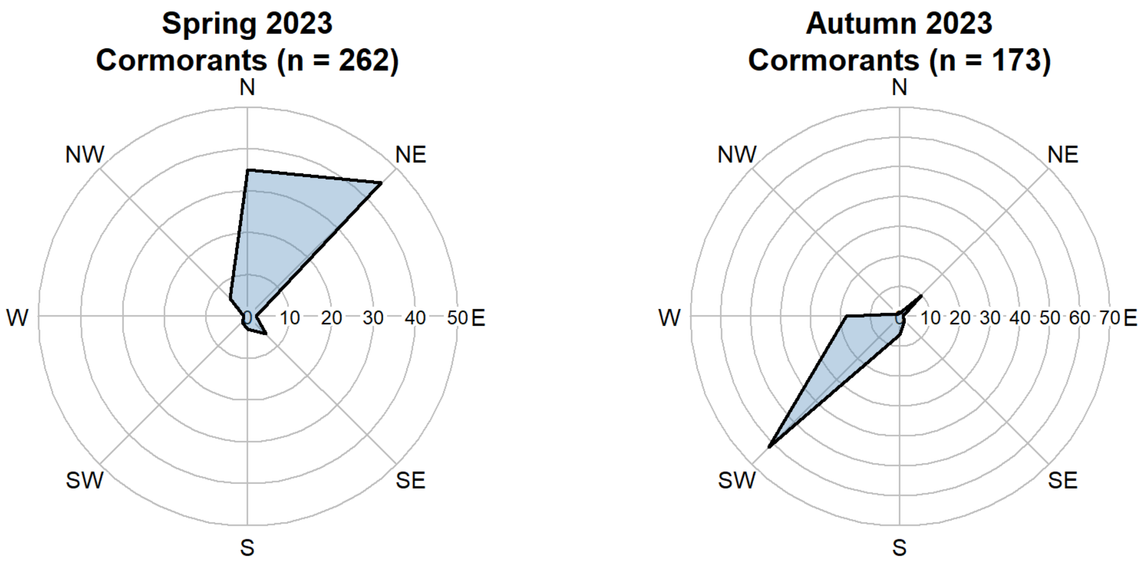


Figure 5-59 Flight direction of cormorants during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-36 for details.

In general, cormorants were seen flying during the first part of the day. In spring, at the northern area, peaks were observed at the third and fourth hour after civil morning twilight while a large peak (almost 50% of all cormorants of the season) was occurring just in the first hour after civil morning twilight in the southern area. In both areas, fewer cormorants were observed after the 8th hour after civil morning twilight. In autumn, a similar pattern was observed: more birds were flying during the first six hours of the day with peaks between 2-4 hours after civil morning twilight (Figure 5-60, Figure 5-61).

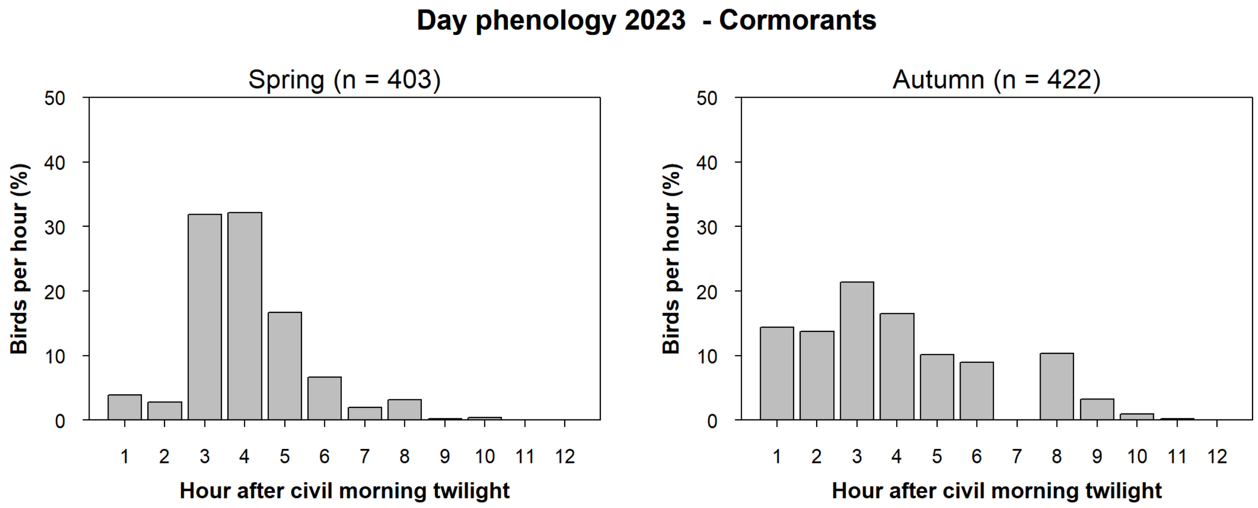


Figure 5-60 Diurnal phenology of cormorants in spring and autumn 2023 at the pre-investigation area KF II OWF N. See Figure 5-38 for details.

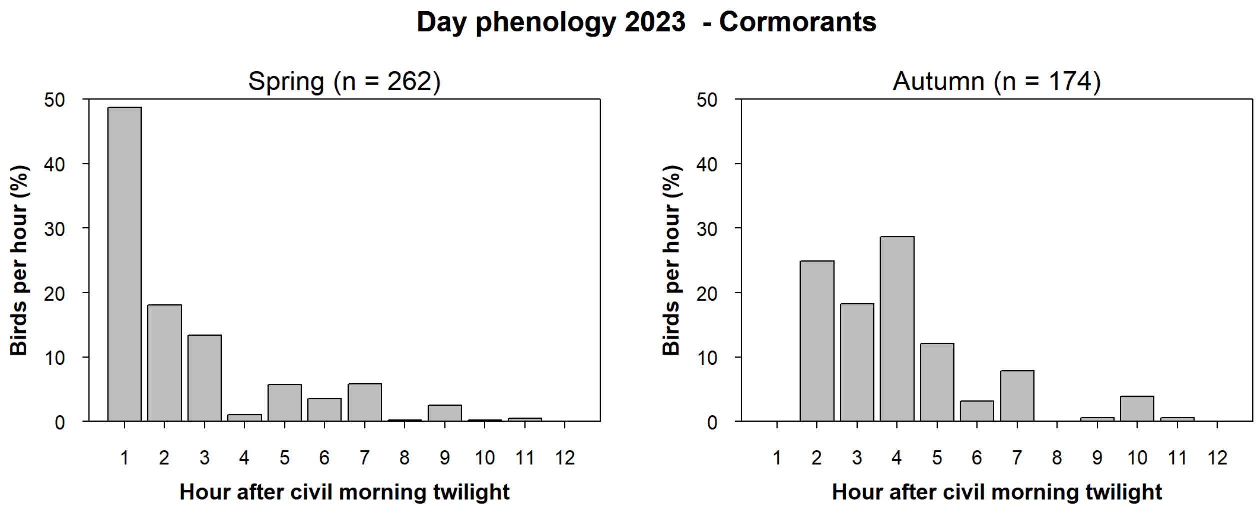


Figure 5-61 Diurnal phenology of cormorants in spring and autumn 2023 at the pre-investigation area KF II OWFS. See Figure 5-38 for details.

SWANS

Swans were only representing about 1.2% of all migrating birds in autumn at the northern area. Most swans observed belonged to the species whooper swan. However, there were also mute swans observed, while in spring a few individuals of Bewick's swan (*Cygnus colombianus bewickii*) were observed too. In spring, mean migration intensity was similarly low in both areas (~ 0.2 ind./h, see Table 5-7 and Table 5-8). The maximum intensity was about 1.1 ind./h and 1.8 ind./h at the northern and southern area respectively, with both events occurring in May, Figure 5-62, Figure 5-63).

In autumn, however, the mean intensity was very different for both areas. Mean intensity was very low at the southern area (0.03 ind./h) whereas the mean intensity in the northern area was 1.1 birds/h, with a peak of 8.9 ind./h late in the season on the 18th of November.

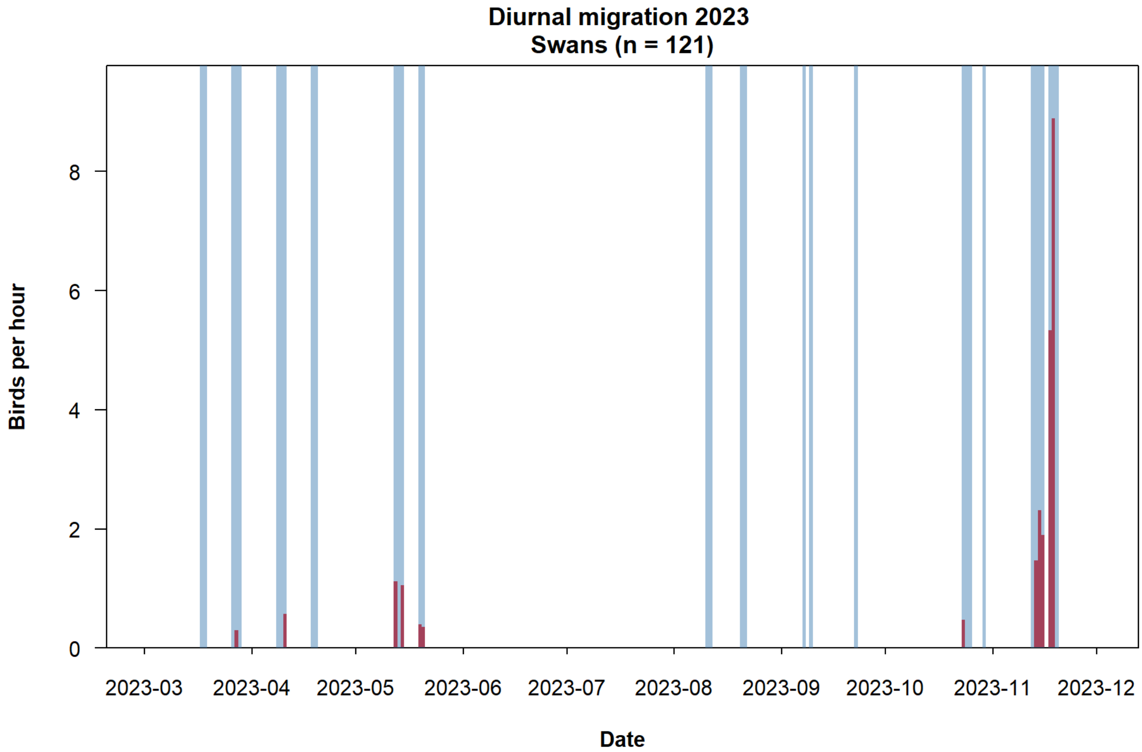


Figure 5-62 Diurnal migration intensity of swans in 2023 at the pre-investigation area KF II OWF N. See Figure 5-32 for details.

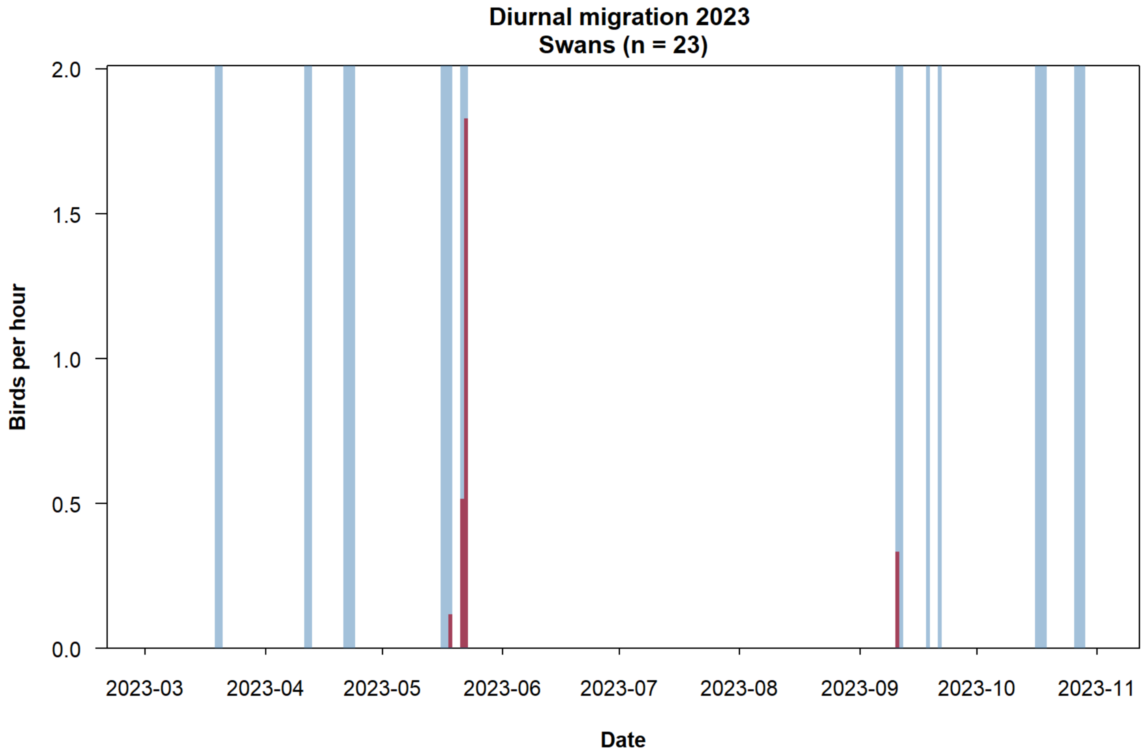


Figure 5-63 Diurnal migration intensity of swans in 2023 at the pre-investigation area S. See Figure 5-32 for details.

In the northern area, the majority of swans was flying below 20 m but about a third was flying above 20 m of altitude (Figure 5-64). In the southern area, all individuals were observed flying below 20 m (Figure 5-65).

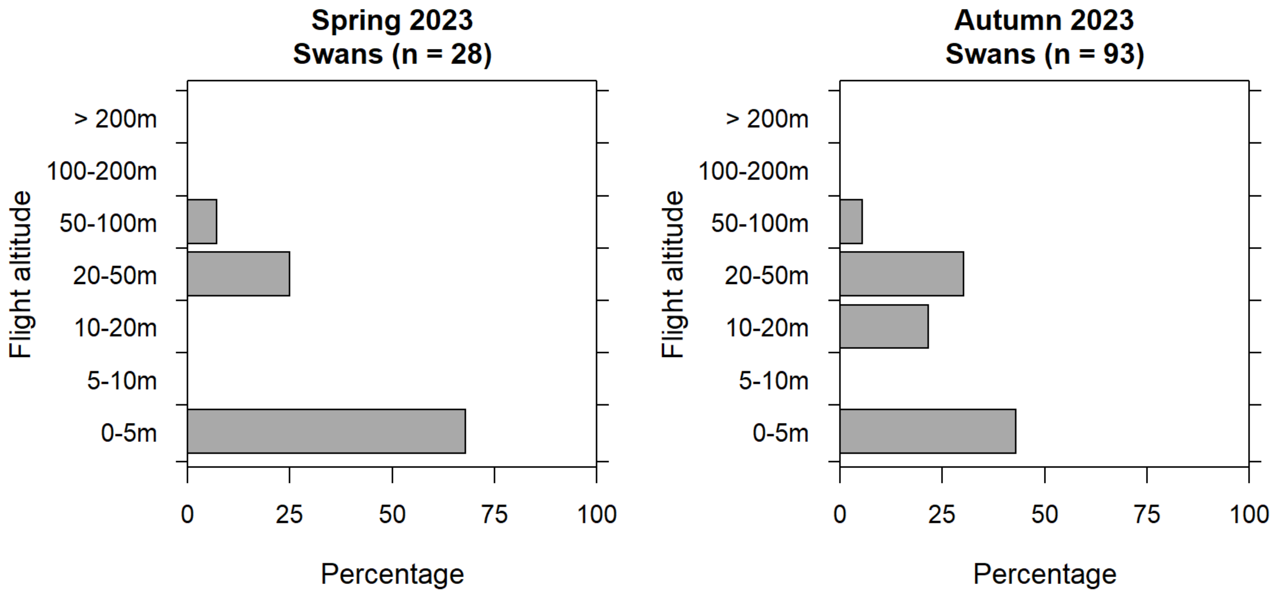


Figure 5-64 Flight altitude distribution of swans during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-35 for details.

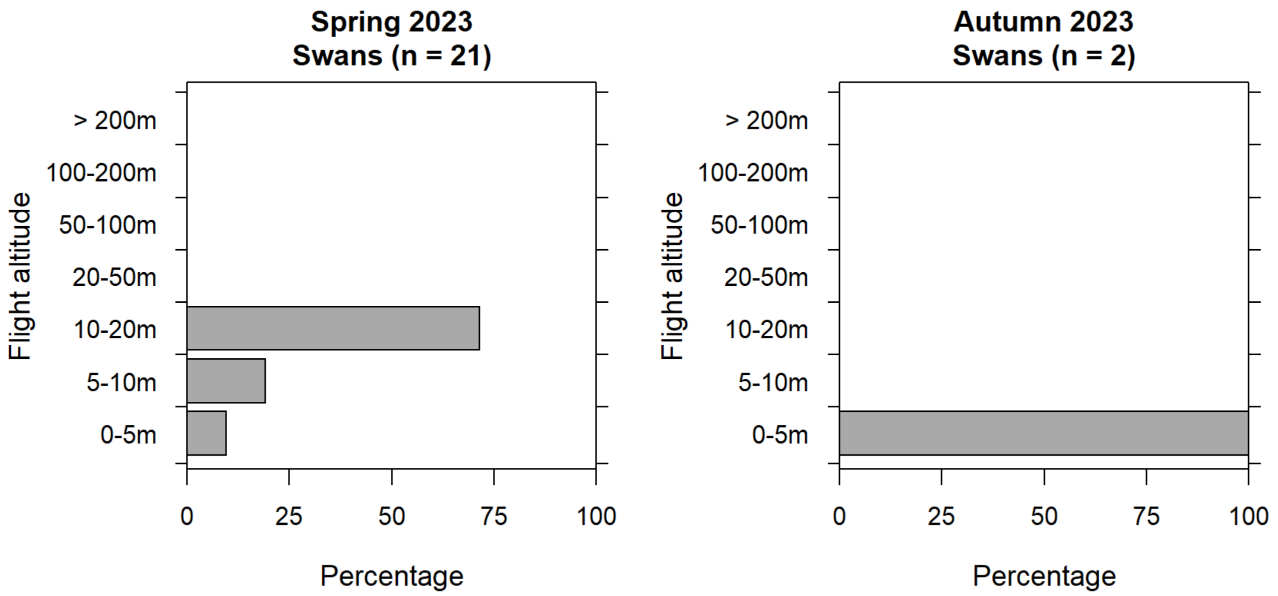


Figure 5-65 Flight altitude distribution of swans during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-35 for details.

Most swans flew towards the west in spring at both areas with some flying towards the NE in the northern area (6 individuals, four of them were Bewick's swans). In autumn, they flew mainly in a west to south direction with most of them flying towards the SW. However, about 19% of swans (all whooper swans) were flying towards the NE too. There were two swans flying to the east in autumn at the southern area (Figure 5-66, Figure 5-67).

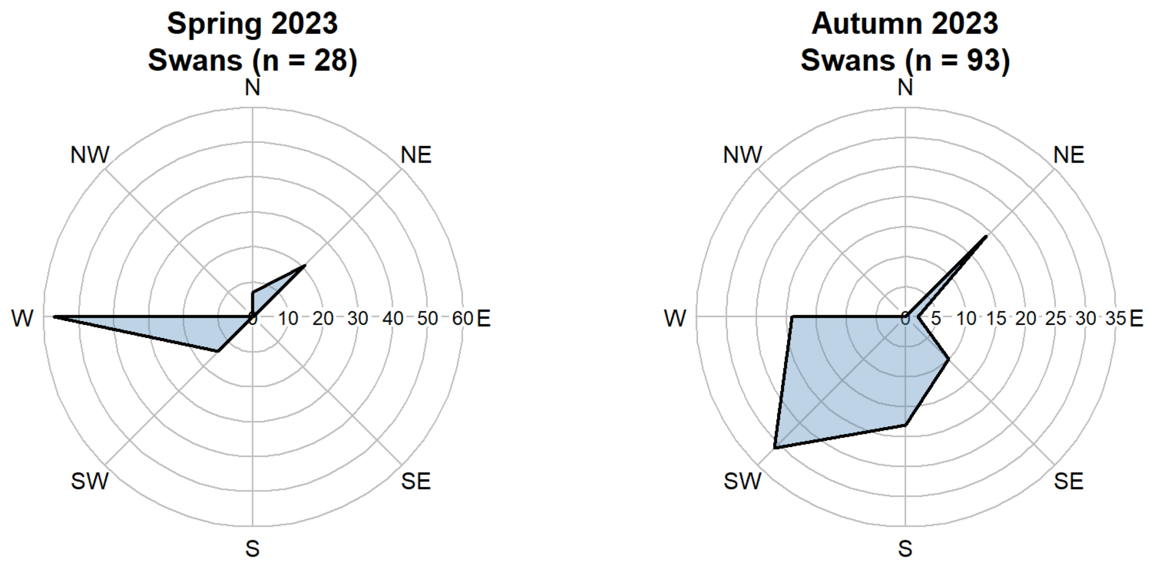


Figure 5-66 Flight direction of swans during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-36 for details.

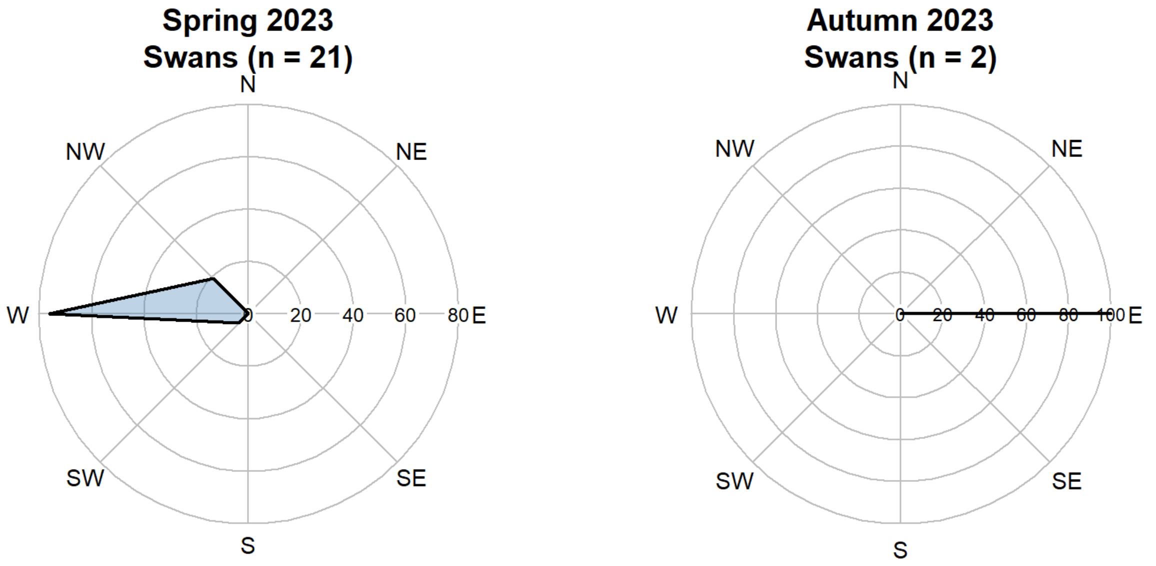


Figure 5-67 Flight direction of swans during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-36 for details.

Swans were observed generally during the whole day period, but there were too few individuals to observe a phenology pattern. Nonetheless, they did not appear just after or before the civil twilights, but rather when there was enough light (Figure 5-68, Figure 5-69).

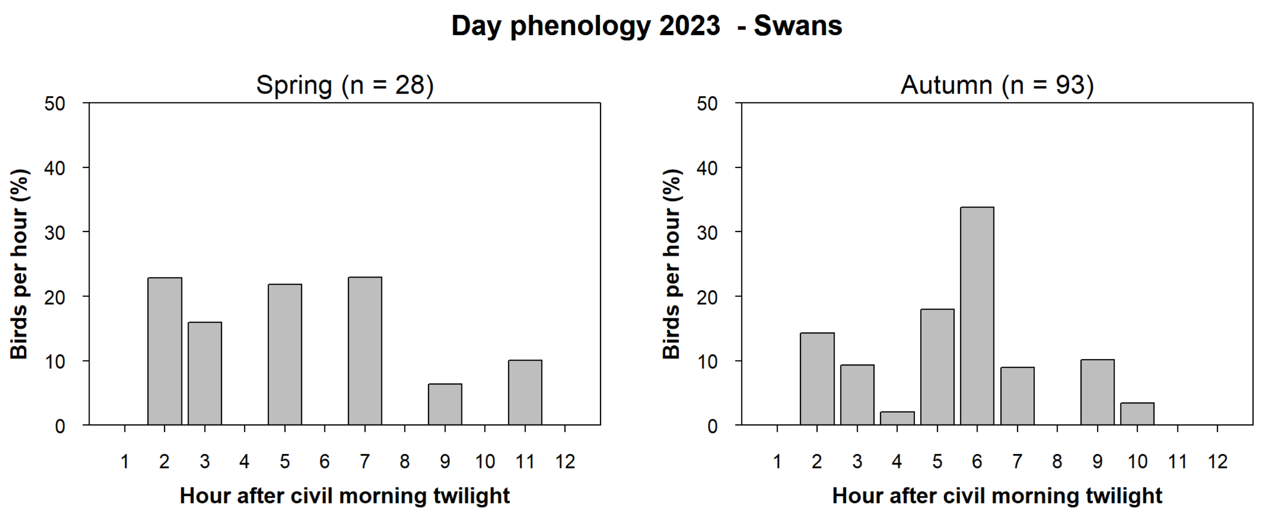


Figure 5-68 Diurnal phenology of swans in spring and autumn 2023 at the pre-investigation area KF II OWF N. See Figure 5-38 for details.

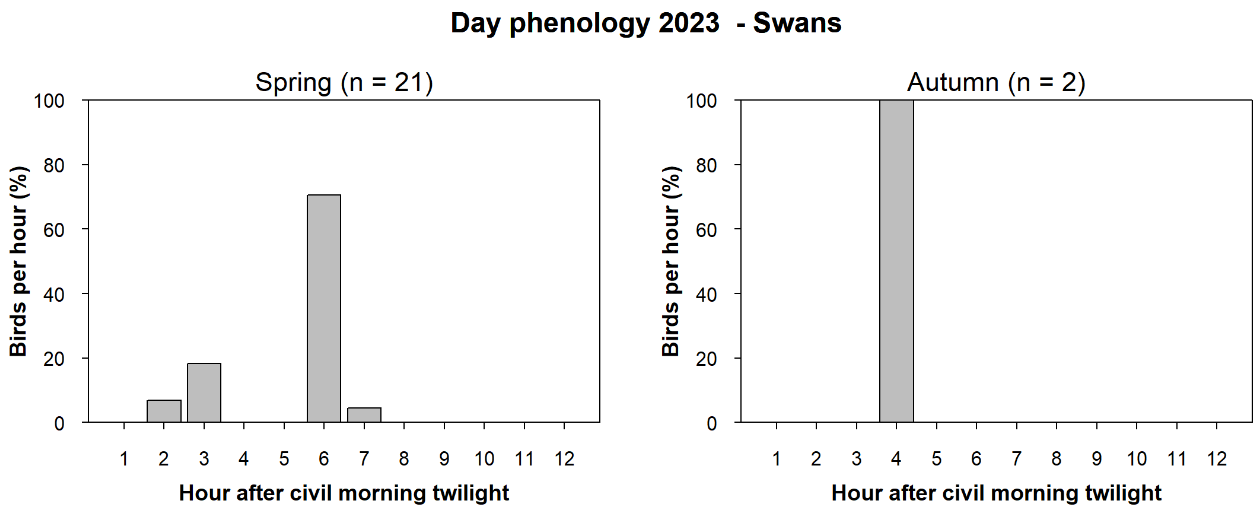


Figure 5-69 Diurnal phenology of swans in spring and autumn 2023 at the pre-investigation area KF II OWF N. See Figure 5-38 for details.

GEESE

Geese were the most common group of birds seen during all seasons at both areas. In spring, the same species were occurring in both areas, but there were more than five times more geese observed in the southern area than in the northern area. The great majority (64%) of the more than 22,000 geese observed were unidentified black geese. Rather similar proportions of the identified species occurred in both areas during spring, with the most common one being the barnacle goose (*Branta leucopsis*) representing 37% and 28.5% of all migrating birds in the northern and southern area, respectively. Other species that occurred in high numbers were the greater white-fronted goose(*Anser albifrons*), the greylag goose (*Anser anser*) and the brent goose (*Branta bernicla*) which represented 6.6%, 4% and 0.65%, respectively of all migrating birds at the northern area in spring, and 1.3%, 0.8% and 0.1%, respectively of all migrating birds in the southern area (in which the unidentified geese made up for > 52% of all migrating birds).

In autumn, there were comparatively fewer geese in both areas, and they made up for a smaller proportion of all migrating birds than in spring. In both areas the most commonly occurring species was the barnacle goose which was dominant in both areas: representing about 29% and 35% of all birds in the northern and southern area, respectively. In the northern area, other species that followed in abundance were the bean goose (*Anser fabalis*) and the greylag goose (1% and 0.8% of all migrating birds, respectively). In the southern area, the greater white-fronted goose and the brent goose were also relatively common representing 3% and 1.4% of all migrating birds in that season, respectively.

Migration intensities were very variable, but on average, similar mean intensities were found for the northern area during spring and autumn (about 34.6 ind./h) and also at the southern area for spring and autumn (215-224 ind./h). A maximum peak of migration was found in spring at the northern area on the 14th of May (332 ind./h), which was twice as high as the highest peak in autumn at that same area (170.5 ind./h, Figure 5-70). In the southern area, the maximum values were much higher, with a large peak of 1655 ind./h on the 17th of May and 1243 ind./h on the 18th of October 2023 (Figure 5-71).

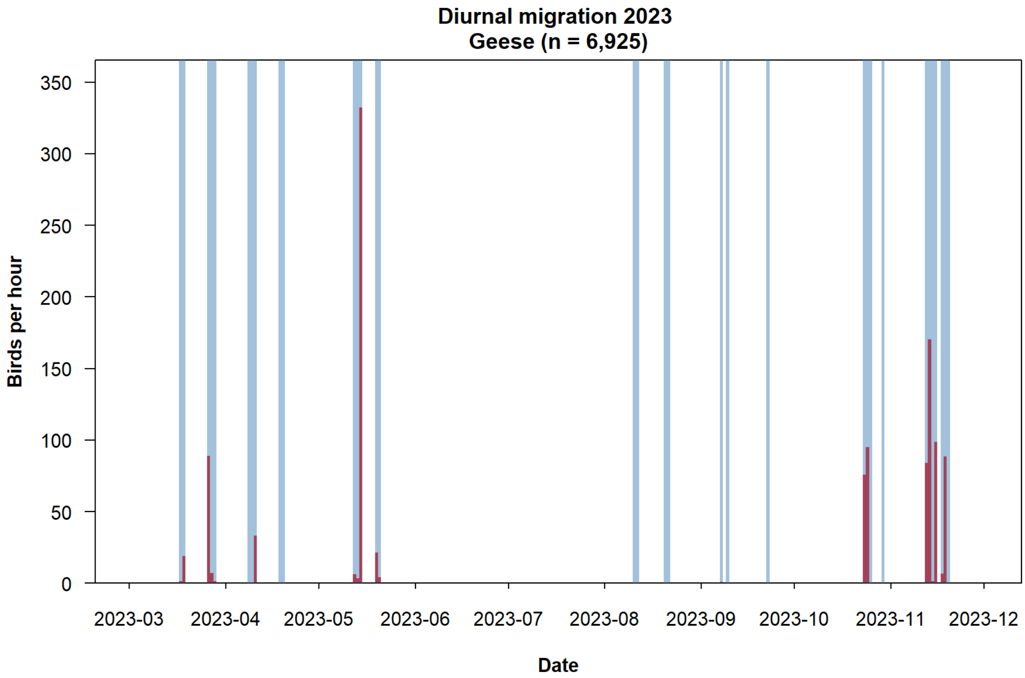


Figure 5-70 Diurnal migration intensity of geese in 2023 at the pre-investigation area KF II OWF N. See Figure 5-32 for details.

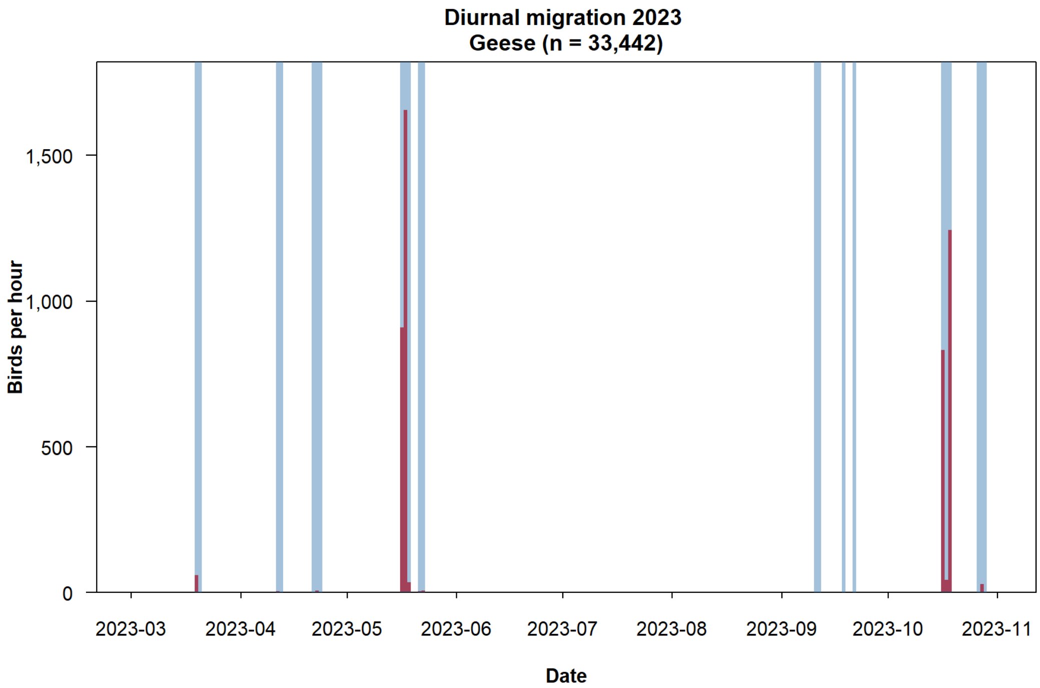


Figure 5-71 Diurnal migration intensity of geese in 2023 at the pre-investigation area KF II OWF S. See Figure 5-32 for details.

Especially in the northern area, most geese were observed flying at very low altitudes (below 5 m), with about 78% and 52% of all migrating geese in spring and autumn, respectively, found at that altitude range. In the southern area, there were about 40% of all migrating geese flying at this low altitude in autumn, but only 10% of the geese were flying that low in spring. Then, geese flew mainly between 20 and 50 m of altitude (48%, Figure 5-72, Figure 5-73). Geese flew comparatively at lower altitudes in the northern area with no geese flying above 100 m of altitude while in the southern area, 18% of the geese flew above this altitude in autumn (Figure 5-73).

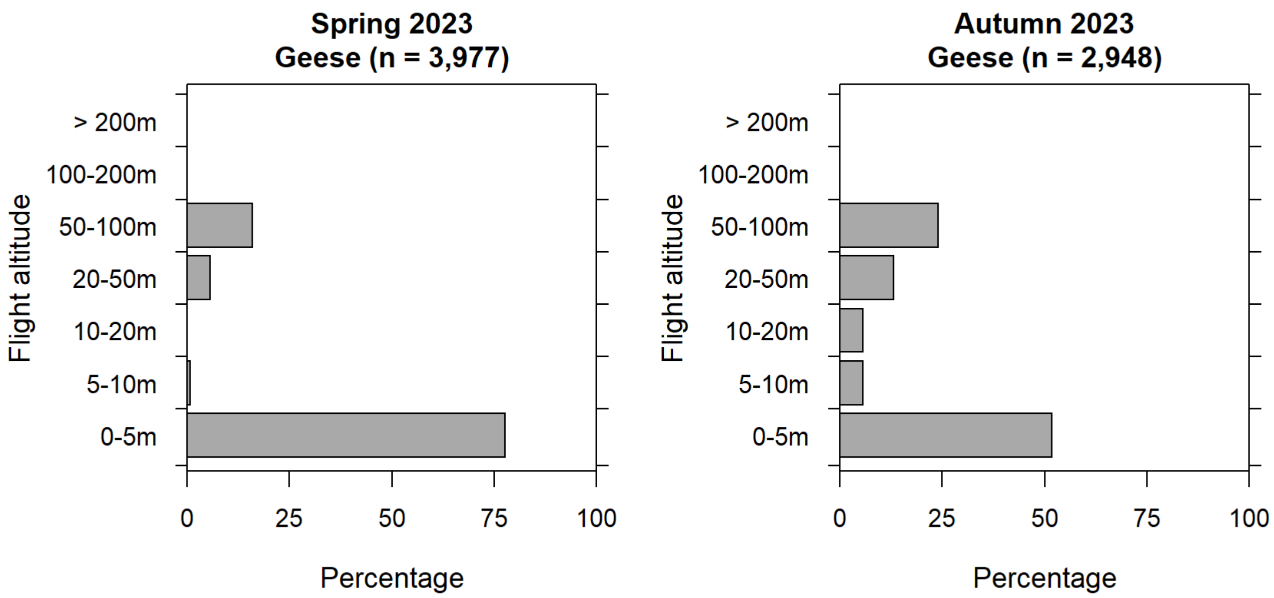


Figure 5-72 Flight altitude distribution of geese during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-35 for details.

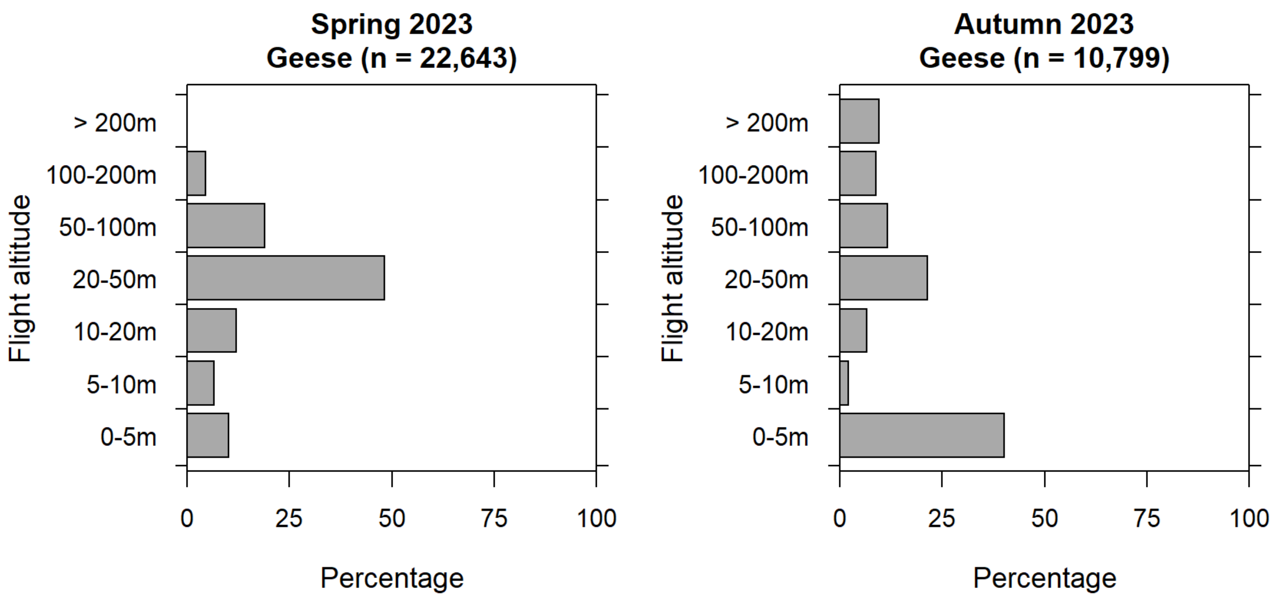


Figure 5-73 Flight altitude distribution of geese during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-35 for details.

In spring, most geese flew in a NE direction: 68% and 95% of all registered geese were migrating in that direction in the northern and southern area respectively. In addition, about 19% of all migrating geese flew in a NW direction in the northern area. In autumn, geese flew mainly in a SW direction (46% and 60% in the northern and southern area respectively, Figure 5-74 and Figure 5-75), but also in a W direction (26% and 38%, respectively). In addition, 20% of all geese flew in a S direction, but only in the most northern area.

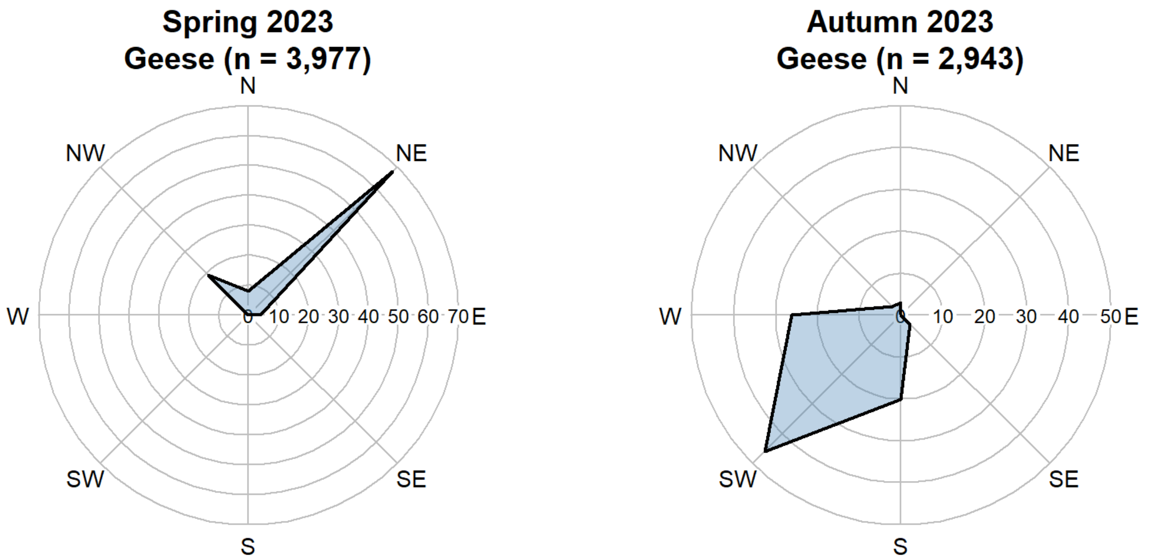


Figure 5-74 Flight direction of geese during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-36 for details.

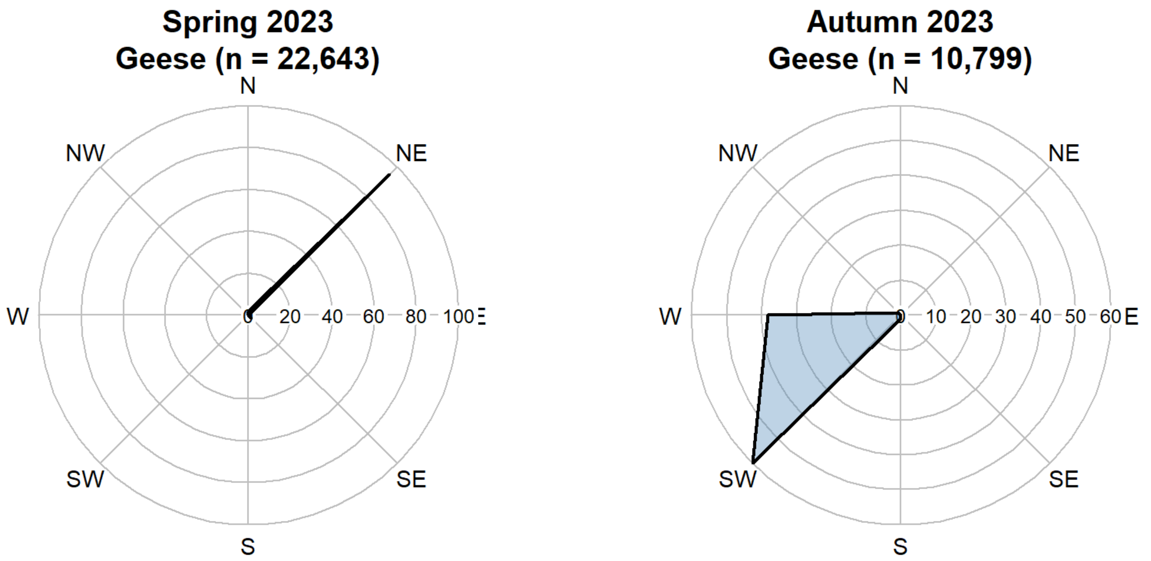


Figure 5-75 Flight direction of geese during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-36 for details.

In spring, geese flew more often in the first six hours of the day, with peaks at the middle of the day (4 and 5 hours after the civil morning twilight, in the northern area and 5th and 6th hours in the southern area, Figure 5-76 and Figure 5-77). Very few geese were observed flying after the 8th hour after civil morning twilight. In autumn, the patterns differed for both areas with a major peak at two hours after civil morning twilight in the northern area, and a peak at 12 hours after civil morning twilight, just before the sunset during autumn in the southern area. Here most geese flew more frequently in the latter part of the day.

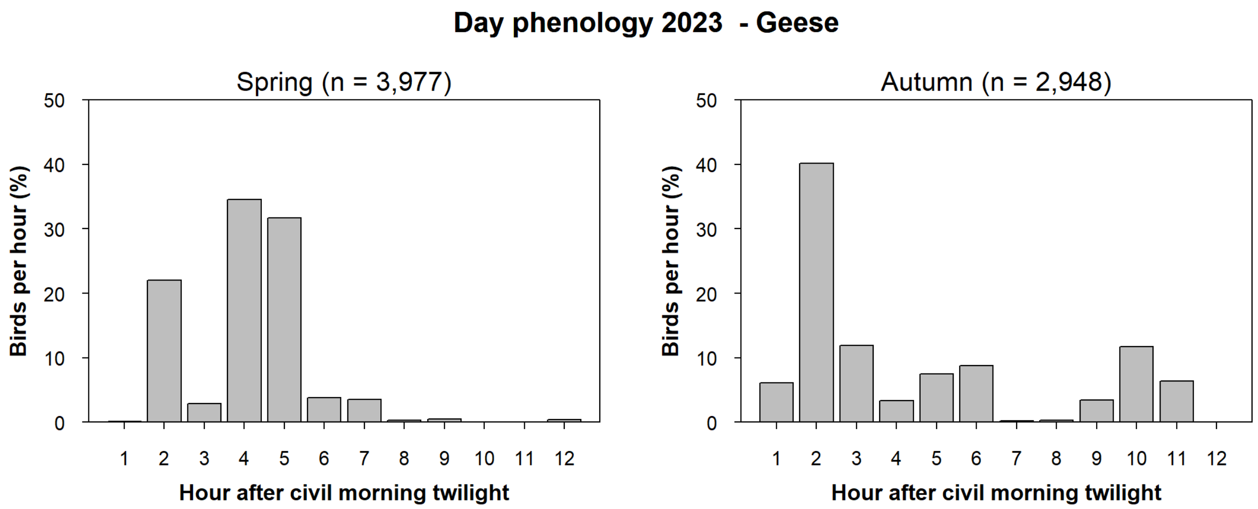


Figure 5-76 Diurnal phenology of geese in spring and autumn 2023 at the pre-investigation area KF II OWF N. See Figure 5-38 for details.

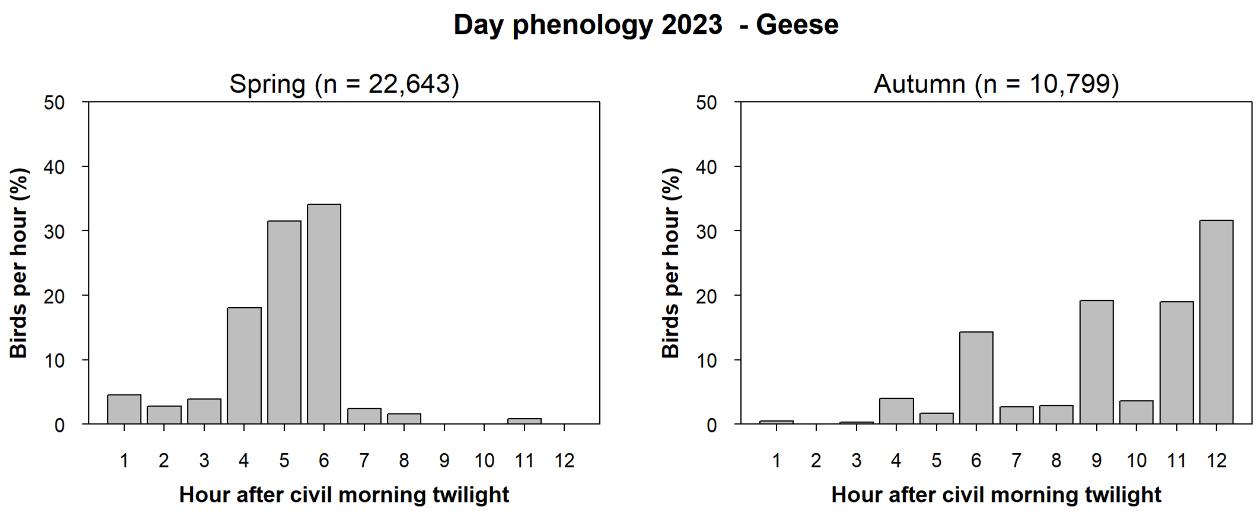


Figure 5-77 Diurnal phenology of geese in spring and autumn 2023 at the pre-investigation area KF II OWF S. See Figure 5-38 for details.

DUCKS

Ducks were the second most abundant group of migrating birds in both areas during both seasons. There were about the same number of ducks observed in both seasons at the northern area: 2,347 in spring and 2430 in autumn. Here, common scoter was the most common species, appearing with very similar numbers in both seasons and representing 11.4 – 11.5% of all migrating birds in spring and autumn, respectively, in the northern area. Common eider was the second most common species, with about 5.2% of all species in autumn, and 13.6% in spring, and thus the most commonly seen duck in that season in the northern area. Other relatively common ducks were the red-breasted merganser (1.3%) and the long-tailed duck (1%) in spring; and the Eurasian wigeon (2.6%) and the velvet scoter (1.2%) in autumn.

In the southern area, there were more ducks found in autumn than in spring (4,591 vs 3,495). Since geese were comparatively less abundant in autumn than in spring ducks represented about 25% of all migrating birds in that season, while roughly the half as many in spring (12.8%, Figure 5-31). In terms of species, common eiders were more common representing 4.6% of all migrating birds in spring and 18.1% of all birds in autumn. common scoter was the most common sea duck in spring in the southern area, representing 7.3% of all migrating birds, but only 1.7% in autumn. With the exception of the Eurasian wigeon (2.1% of all migrating birds) in autumn, no other duck species was common in the southern area in any season.

Mean migration intensity was very similar in both seasons in the northern area with 23 and 22.5 ind./h in spring and autumn respectively. The maxima were also at similar levels and occurred at the middle of the seasons in both cases: 99 ind./h on the 09th of September and 104.1 ind./h on the 9th of September (Figure 5-78).

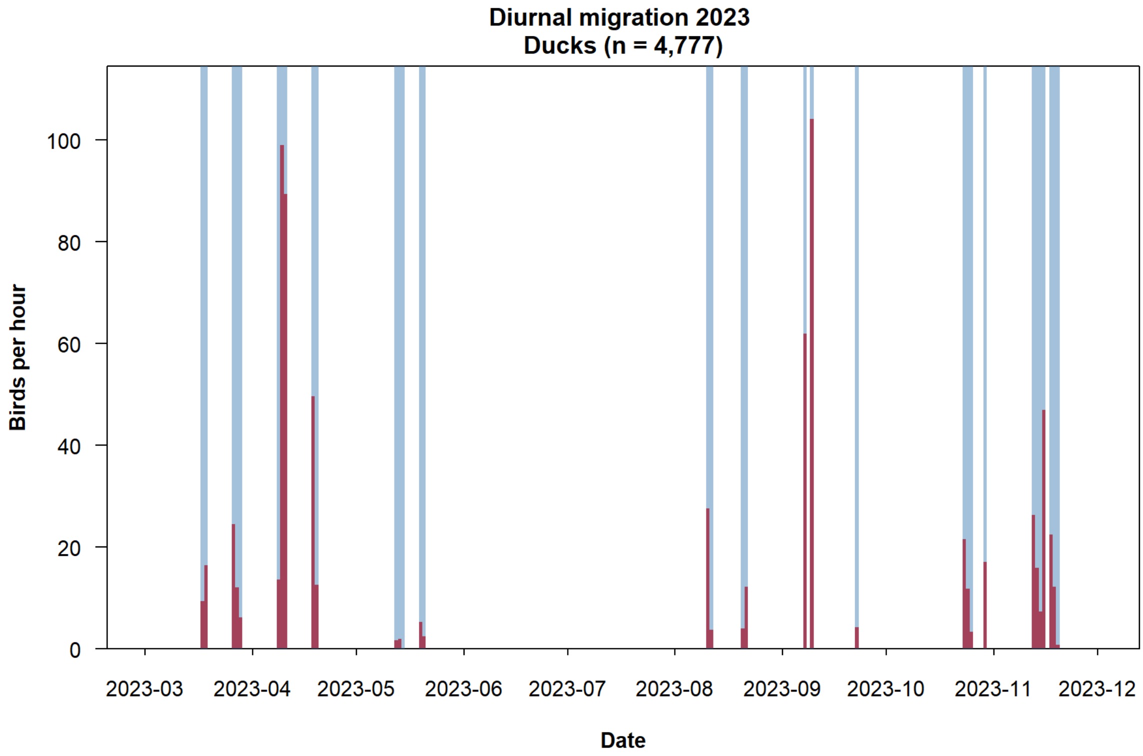


Figure 5-78 Diurnal migration intensity of ducks in 2023 at the pre-investigation area KF II OWF N. See Figure 5-32 for details.

In the southern area, migration intensity was higher, with higher maximum peaks, especially in autumn. Mean migration intensity was 42.3 ind./h and 85.6 ind./h in spring and autumn respectively. Peaks occurred also in the middle of the season, but were higher: 166.3 and 357.6 ind./h on April 11th and October 18th in spring and autumn respectively (Figure 5-79).

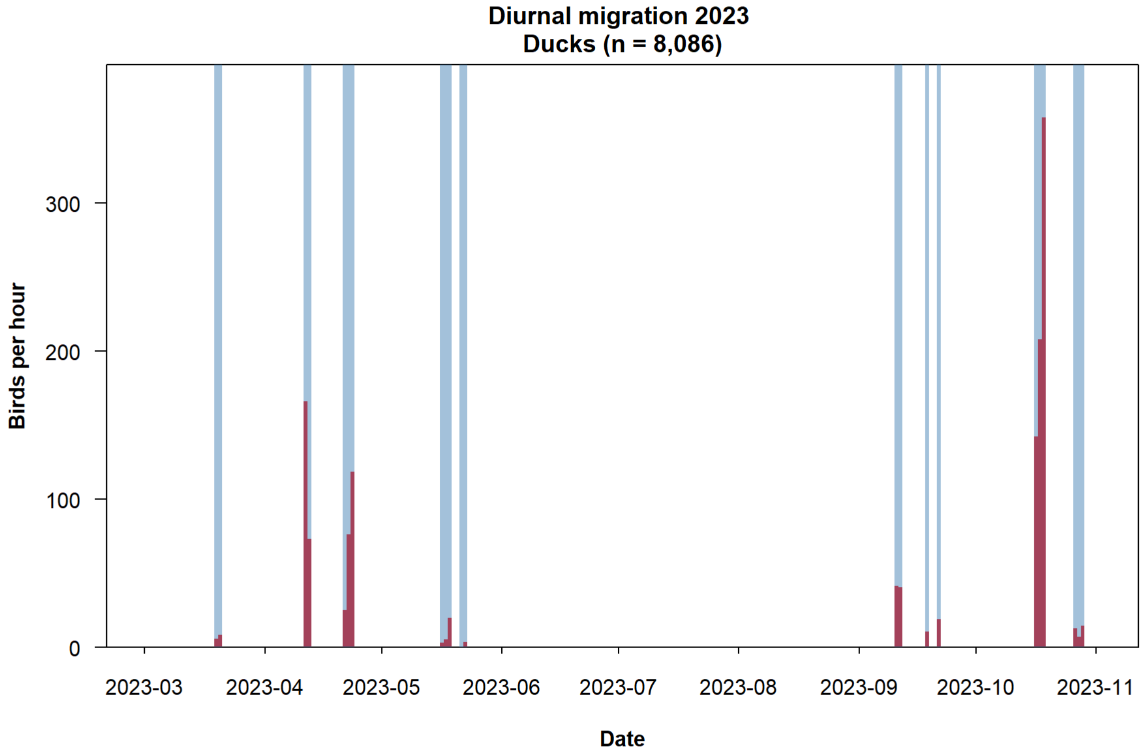


Figure 5-79 Diurnal migration intensity of ducks in 2023 at the pre-investigation area KF II OWF S. See Figure 5-32 for details.

In general, ducks flew at low altitudes. Most of them flew at altitudes up to 20 m height (varying percentages between 83% and 95% of all ducks in the different seasons and locations, see Figure 5-80 and Figure 5-81). Only few of them were observed at higher altitudes (>50 m).

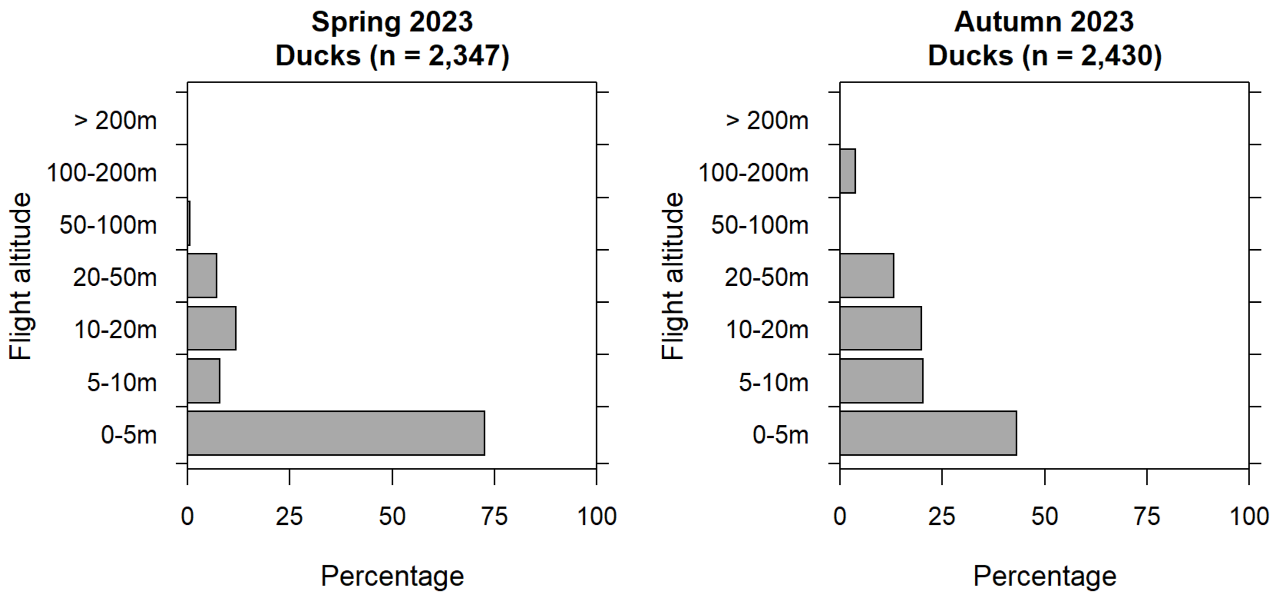


Figure 5-80 Flight altitude distribution of ducks during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-35 for details.

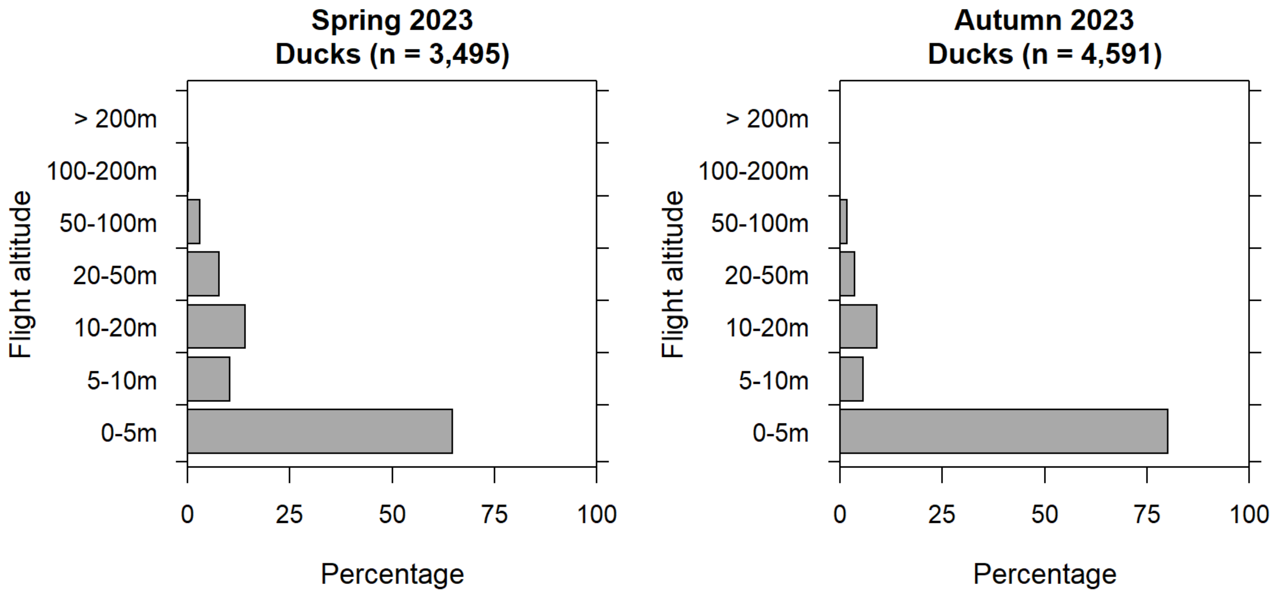


Figure 5-81 Flight altitude distribution of ducks during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-35 for details.

In spring, 45% and 66% of all migrating ducks were observed flying at a NE direction in the northern and southern area respectively. In addition, 14.4% and 12.6% of all ducks migrated in a E and N direction in the northern area whereas 14.5% in an E direction in the southern area (Figure 5-82 and Figure 5-83).

In autumn, the migrating directions differed between the northern and southern area: most ducks migrated in a western direction in the northern area (52.1%), with fewer in a SW direction (26.9%). In the southern area, the great majority was seen with a clear SW direction (63.3%) and only few of them were migrating to the west (25%, Figure 5-82 and Figure 5-83).

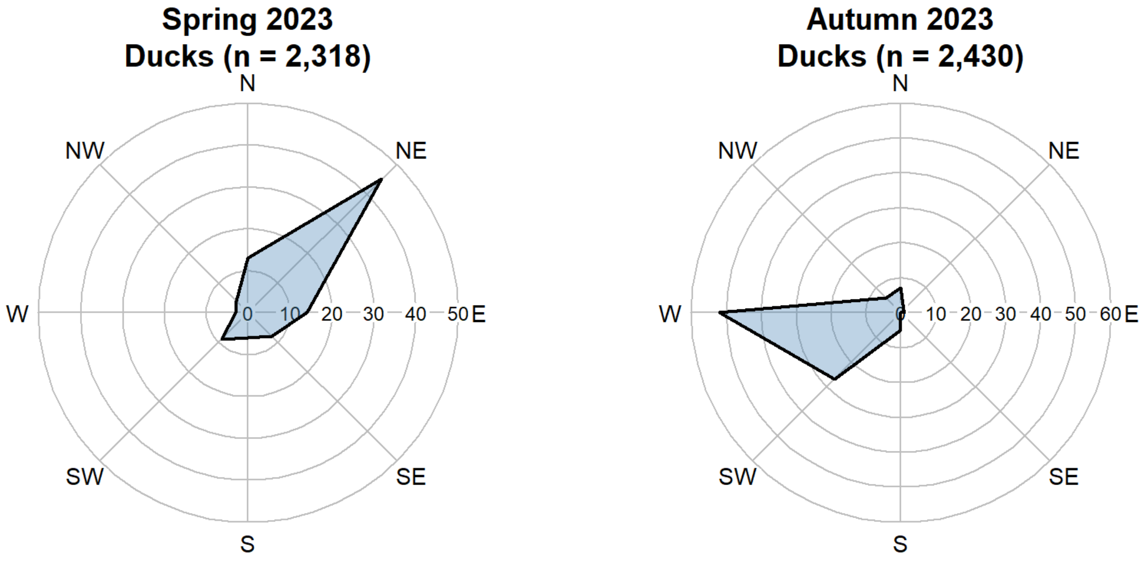


Figure 5-82 Flight direction of ducks during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-36 for details.

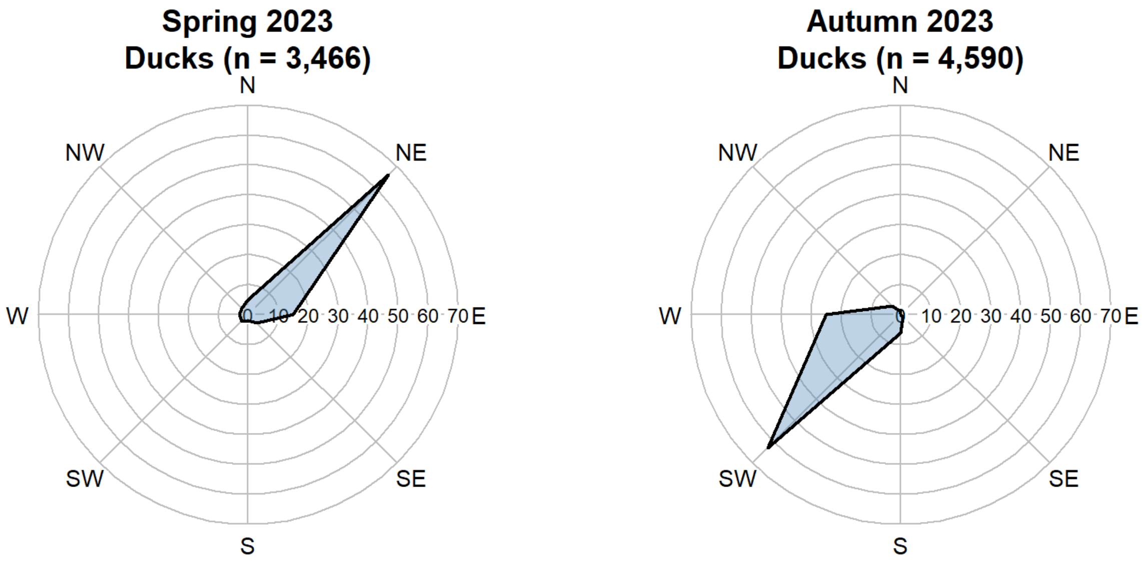


Figure 5-83 Flight direction of ducks during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-36 for details.

Ducks flew during all hours of the day but were observed in larger numbers during the first three hours of the morning in which the major peaks of migration occurred in all seasons. There was an exception in autumn in the southern area, where the highest peak was observed at 9 hours after civil morning twilight (Figure 5-84, Figure 5-85).

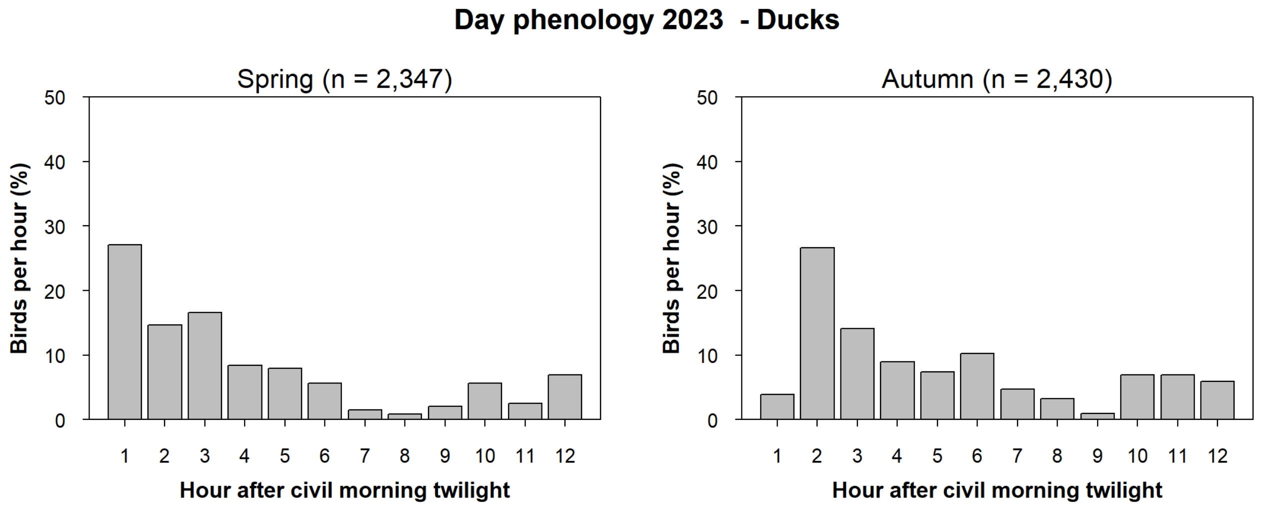


Figure 5-84 Diurnal phenology of ducks in spring and autumn 2023 at the pre-investigation area KF II OWF N. See Figure 5-38 for details.

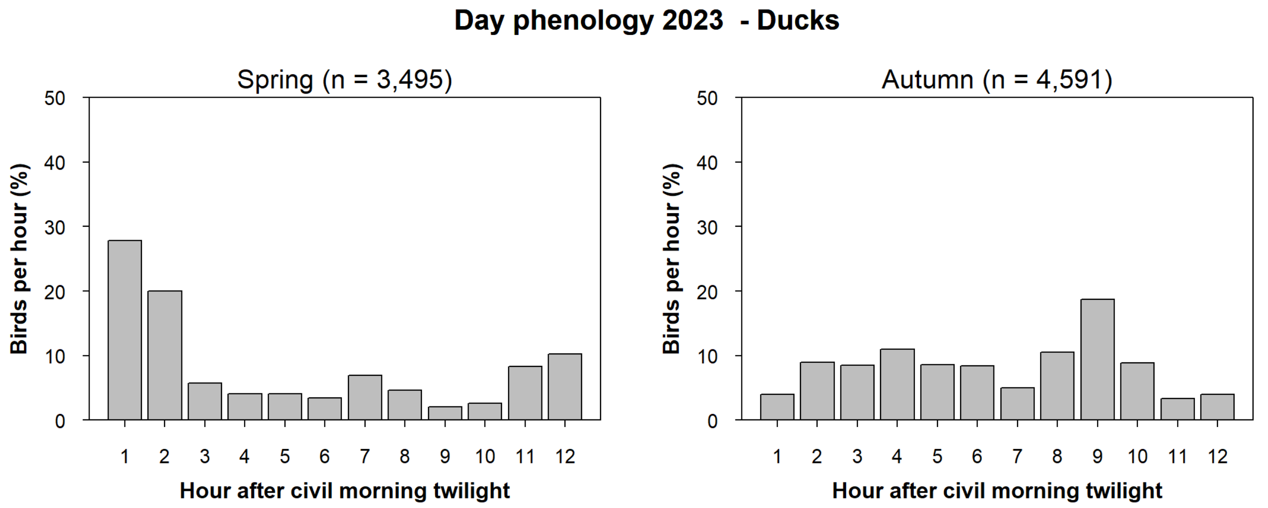


Figure 5-85 Diurnal phenology of ducks in spring and autumn 2023 at the pre-investigation area KF II OWF N. See Figure 5-38 for details.

BIRDS OF PREY

Not many birds of prey were observed. However, a total of 95 and 119 birds of prey were seen in the northern and southern area respectively (please note less observation days in the southern area), with more species and individuals being observed during the autumn migration in both areas. During spring migration in both areas, very few individuals and species were observed. Since there were many other migrating birds, especially geese, in the southern area, the 105 birds of prey observed in autumn represented a very small percentage of all. Nevertheless, the 89 birds of prey spotted during the autumn migration at the northern area represented roughly 1.1% of all migrating birds. In terms of species, in the northern area, two species were most common: red kites and Eurasian sparrowhawks represented 0.45% and 0.41% of all migrating birds in autumn and constitute together about 77% of all birds of prey in that area. In the southern area, the latter species represented 2/3 of all birds of prey in that season (and 0.38% of all migrating birds in that area).

In terms of migration intensity, very low intensities were observed in both areas during spring (< 0.2 ind./h). In autumn, mean intensities were higher with 0.88 ind./h and 2.1 ind./h in the northern and southern area respectively. The maximum peaks were 5.1 and 10.3 ind./h in the northern and southern area respectively. The maximum peak in the northern area was observed in mid November, a month later than in the southern area but there was another peak (4.6 ind./h) taking place on October 24th in the northern area as well (Figure 5-86, Figure 5-87).

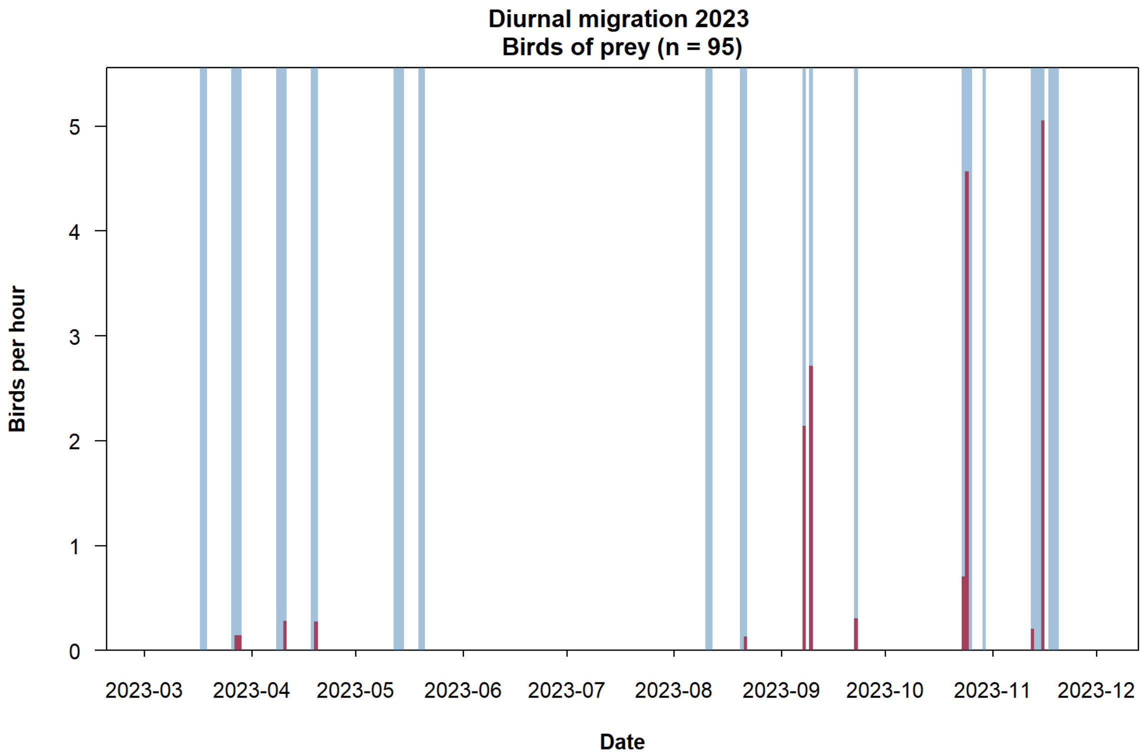


Figure 5-86 Diurnal migration intensity of birds of prey in 2023 at the pre-investigation area KF II OWF N. See Figure 5-32 for details.

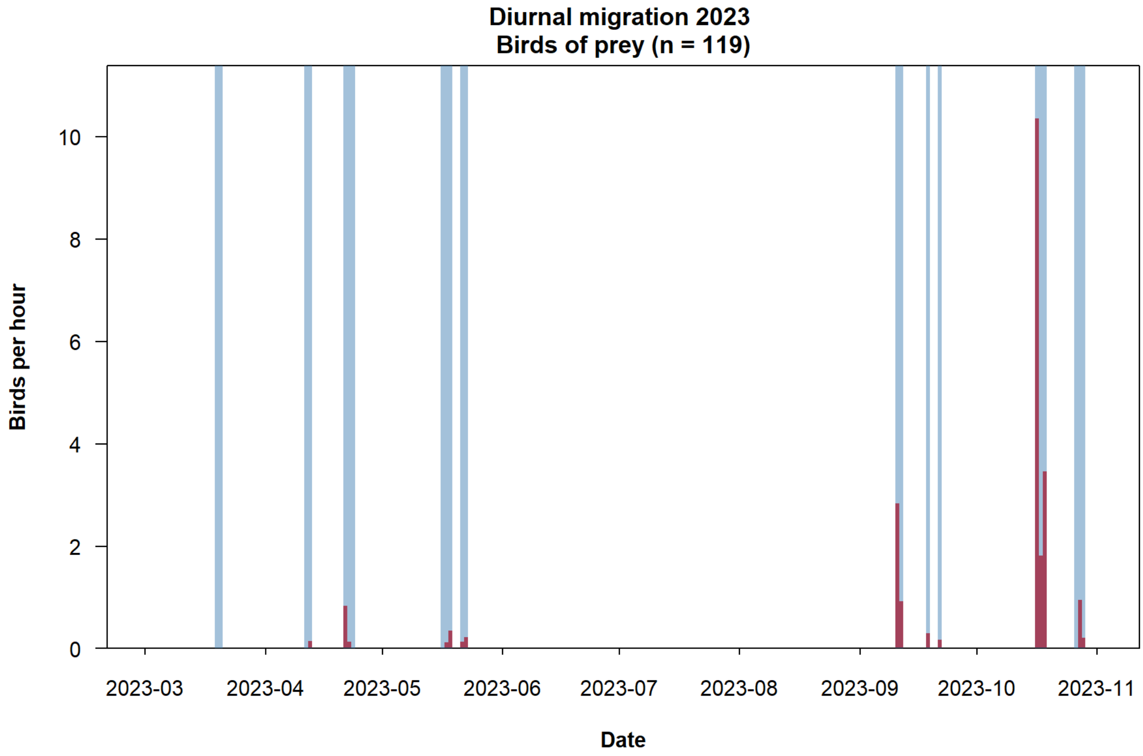


Figure 5-87 Diurnal migration intensity of birds of prey in 2023 at the pre-investigation area KF II OWF S. See Figure 5-32 for details.

In the northern area, half of the 6 individuals observed in spring flew at very low altitudes (up to 5 m), whereas only two flew above 20 m of altitude. In spring at the southern area, the proportion of birds flying at higher altitudes (> 20m) was higher, but very few individuals were observed then too.

In autumn in the northern area, almost half of the birds flew at altitudes below 20 m with approximately 25% of the birds flying at very low altitudes, and 25% also flying at altitudes above 200 m. In the southern area, the altitude distribution was different, with most birds (> 50%) flying at very low altitudes (< 5 m), and comparatively few (21%) flew above 20 m, but no bird was observed flying above 100 m (Figure 5-88, Figure 5-89).

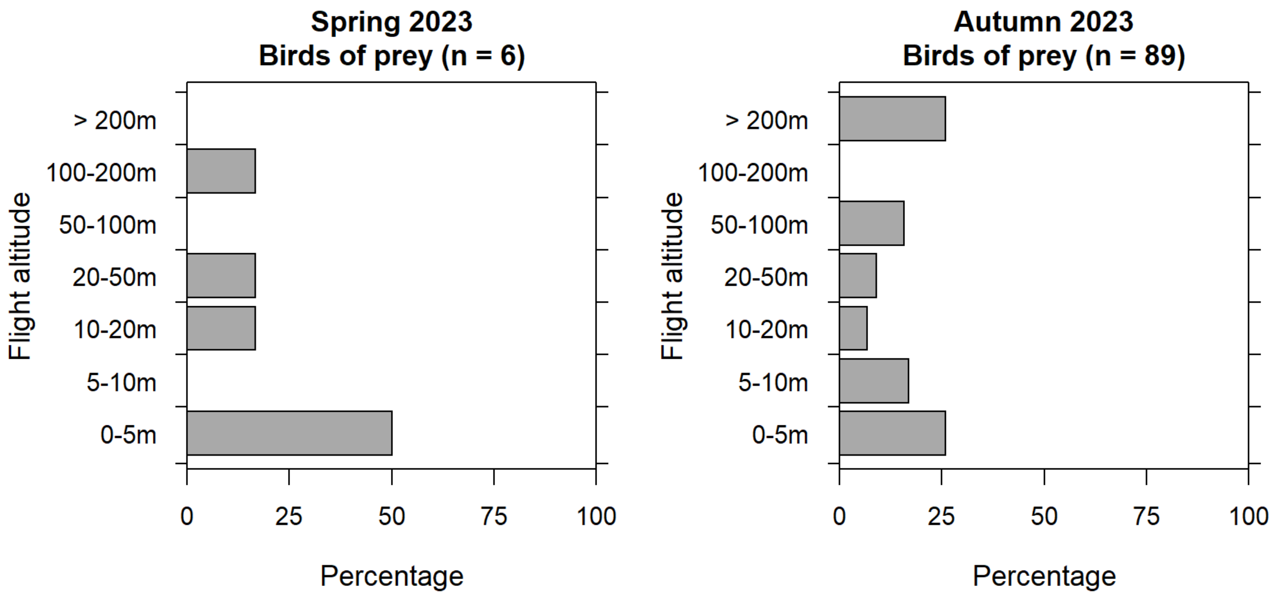


Figure 5-88 Flight altitude distribution of birds of prey during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-35 for details.

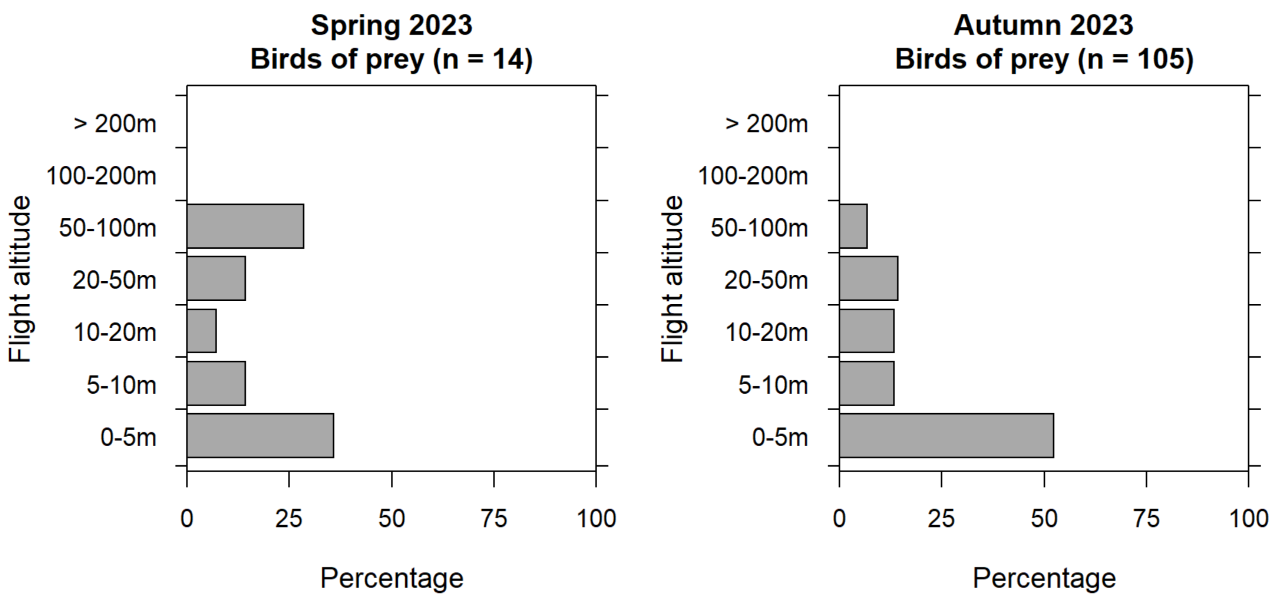


Figure 5-89 Flight altitude distribution of birds of prey during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-35 for details.

In spring at the northern area, half of the birds flew to the NE and half to the N, whereas in the southern area > 60% of the birds flew in a NE direction with about 20% flying directly to the N. In autumn, most birds flew towards the SW (43% and 53.3% in the northern and southern area respectively). Other directions observed were the W and S in similar proportions in the northern area (28.4% and 27.2%) and the W, representing 38.1% of all directions in the southern area (Figure 5-90 and Figure 5-91).

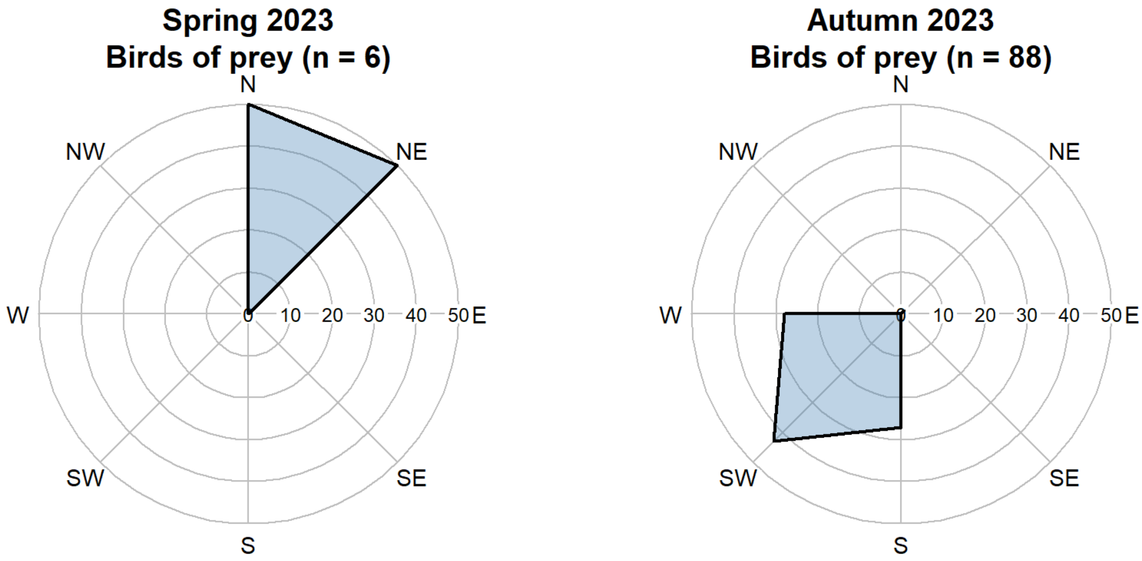


Figure 5-90 Flight direction of birds of prey during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-36 for details.

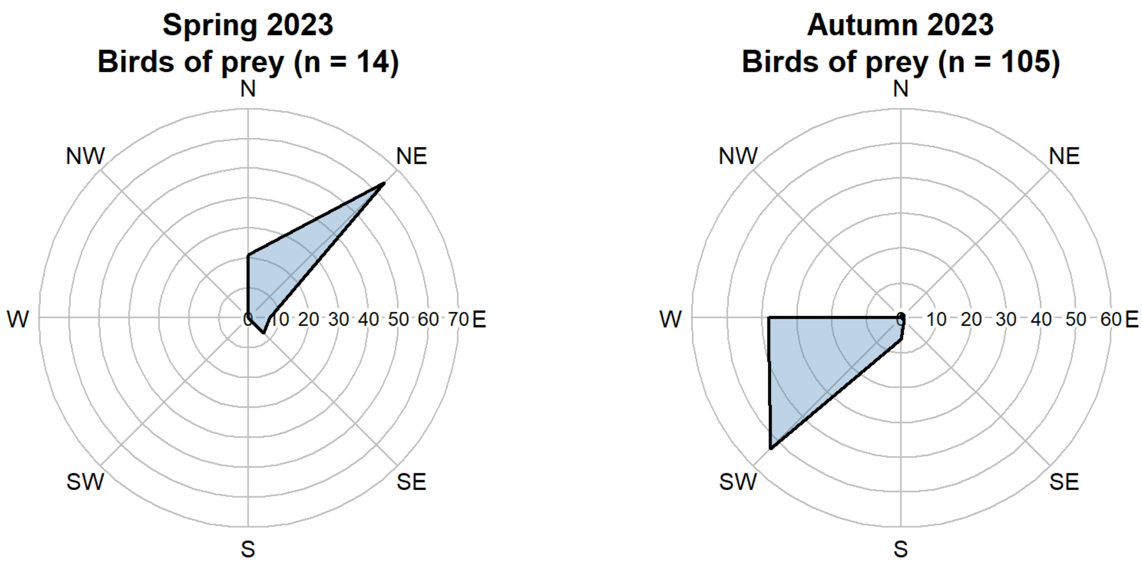


Figure 5-91 Flight direction of birds of prey during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-36 for details.

In spring, the few individuals observed flew mainly at the mid hours of the day (between 2 and 9 hours) after the civil morning twilight. In autumn, a similar pattern was observed with most birds being observed between the 2nd and the 8th hour, with peaks at 4th and 8th hour after civil morning twilight in the northern area, whereas in the southern area most birds were observed between the 3rd and 7th hour with peaks at 4th and 5th hours after morning civil twilight. Observations decreased progressively towards the later part of the day, but there was a small increase of observations at 12 hours after civil morning twilight (Figure 5-92 and Figure 5-93).

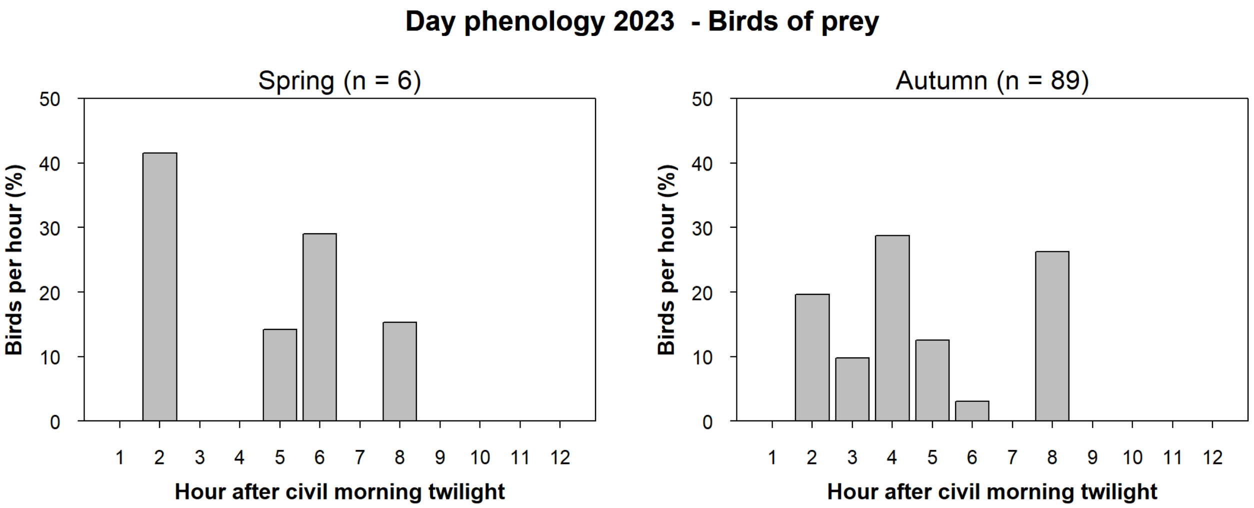


Figure 5-92 Diurnal phenology of birds of prey in spring and autumn 2023 at the pre-investigation area KF II OWF N. See Figure 5-38 for details.

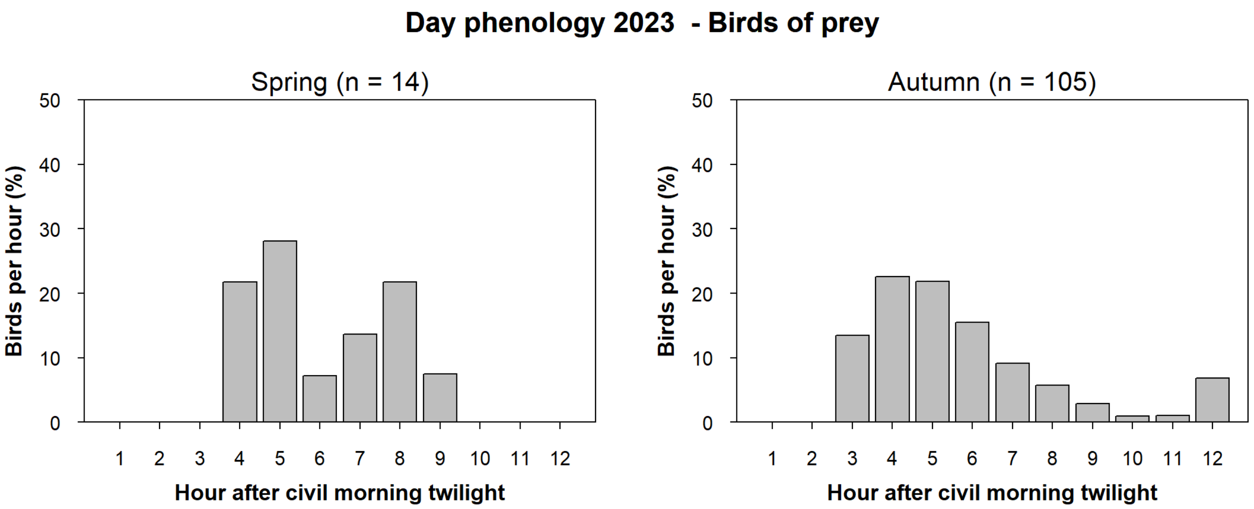


Figure 5-93 Diurnal phenology of birds of prey in spring and autumn 2023 at the pre-investigation area KF II OWF S. See Figure 5-38 for details.

WADERS

Waders were more numerous and diverse in the northern area, than in the southern area. In total there were 418 individuals in the northern area, vs. 123 individuals of waders in the southern area. At KF II OWF N, the 149 individuals and 269 individuals in spring and autumn, represented 1.9% and 3.4% respectively of all migrating birds. In the southern area, the fewer individuals did not make more than 0.6% of all migrating birds in any of the seasons. In spring, one species dominated the waders community at both areas: Eurasian curlews represented 81% of all waders registered at the northern area and 1.54% of all migrating birds. With 89 individuals, this species was the most common wader in the southern area, but represented only 0.3% of all migrating birds in spring in the southern area. In autumn, there were more species of waders seen in both areas, but comparatively many more species and individuals in the northern area. Here, dunlins were the dominant species representing over half of all waders registered and 1.54% of all migrating birds. Other species that were relatively common were the Eurasian oystercatcher (0.44%) and the ringed plover (0.25%).

Mean migration intensity ranged between 0.5 ind./h (in autumn in the southern area) and 2.1 ind./h (in autumn in the northern area). Maximum peaks were at the same level in spring and autumn at the northern area (15.4 ind. and 17.9 ind./h, respectively) and took place at the middle of the season (April, 9th and September, 9th respectively). In the southern area, there was a peak of 8 ind./h on April 23rd. In autumn, not a similar peak was observed and the maximum value was 1.7 ind./h on September 11th (Figure 5-94, Figure 5-95).

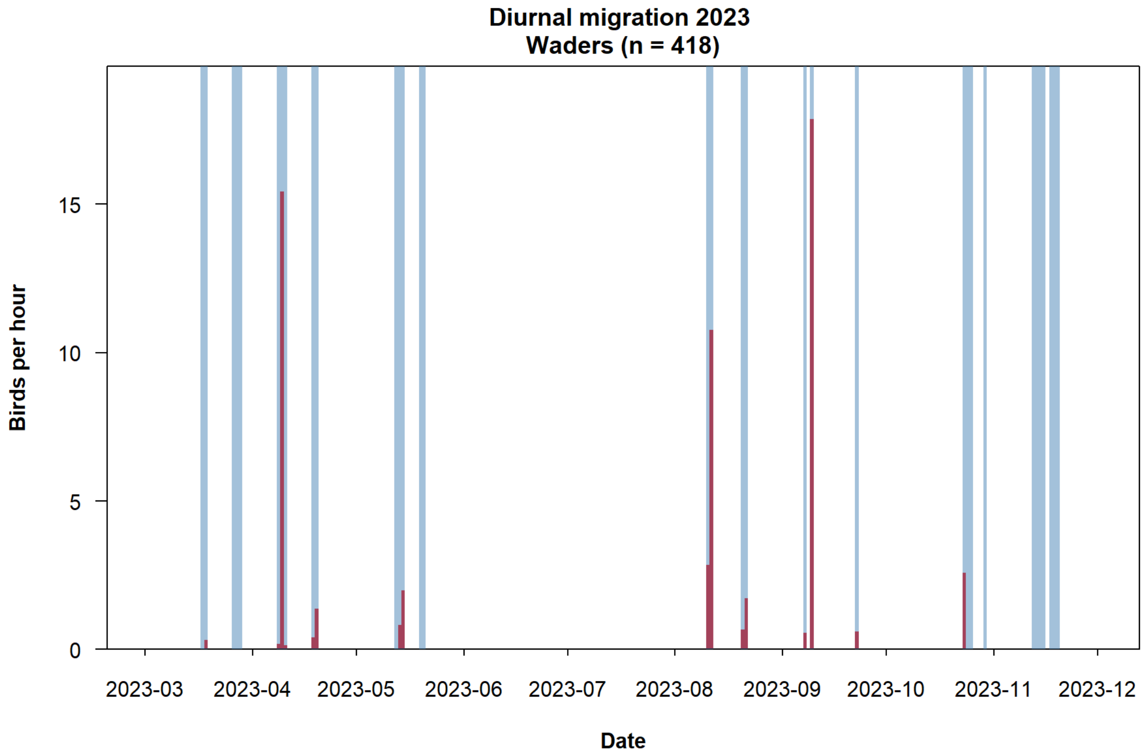


Figure 5-94 Diurnal migration intensity of waders in 2023 at the pre-investigation area KF II OWF N. See Figure 5-32 for details.

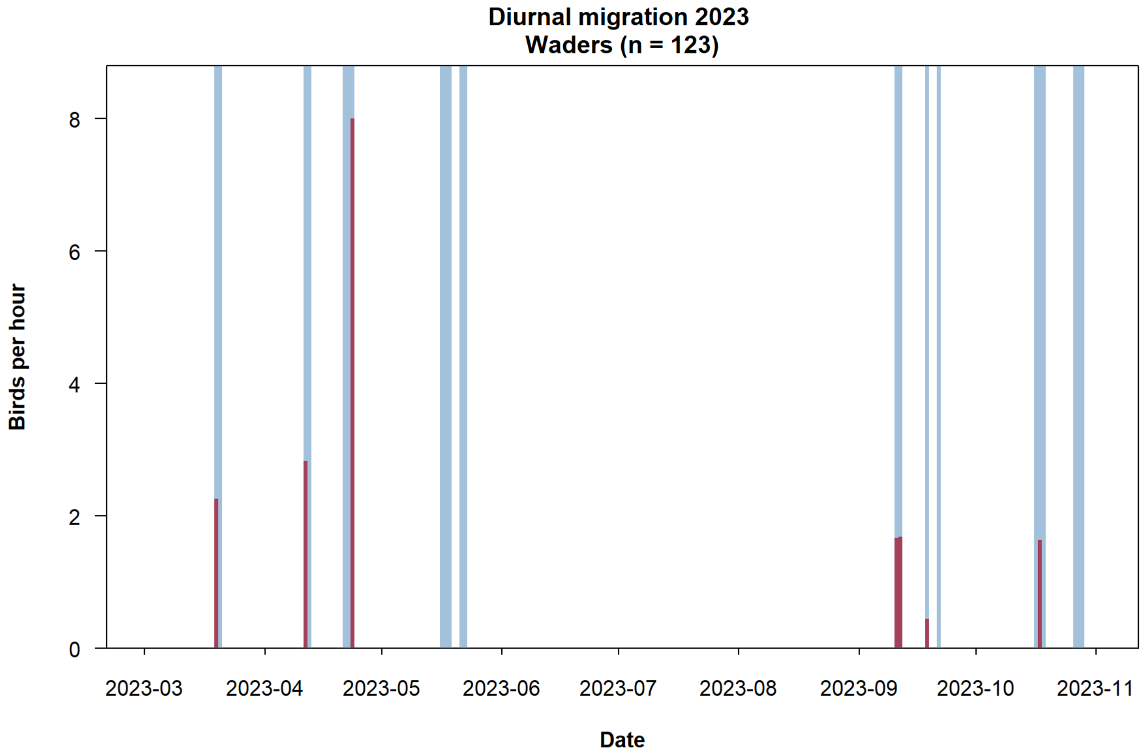


Figure 5-95 Diurnal migration intensity of waders in 2023 at the pre-investigation area KF II OWF S. See Figure 5-32 for details.

During nocturnal migration, waders represented the second most abundant group after songbirds. They represented between 6-8% of all flight calls heard during spring and autumn in the northern area whereas they were not heard during spring and represented just about 3% of all calls in autumn at the southern area.

In general, similar patterns were observed during nights as during days, with more individuals and more species having been observed during autumn than during spring at both areas. In spring at the northern area, Snipes were the most common waders heard, with only 11 individuals, they made up 3.4% of all calls during that season. Only one (1) Eurasian oystercatcher was in contrast heard during spring at the southern area. In autumn, dunlin was the most common species at the northern area. It represented 5.9% of all migrating birds heard in that season and >76% of all waders heard. Other common species were snipe, common sandpiper and the ringed plover (0.6%, 0.4% and 0.4% of all migrating birds respectively). In the southern area, common sandpipers represented over 76% of all waders heard and 2.3% of all migrating birds in that season. The second most common species was the Dunlin (0.5% of all migrating birds).

Overall, mean migration intensity was very low (0.02 ind./h) to low (0.35 calls/h) in spring at the southern and northern area respectively. In autumn, mean migration intensity was much larger, whichwas due to major migration events taking place at the middle of the season: 55.2 calls/h and 28.2 calls/h on September 7th and 10th and the northern and southern area respectively (Figure 5-96, Figure 5-97).

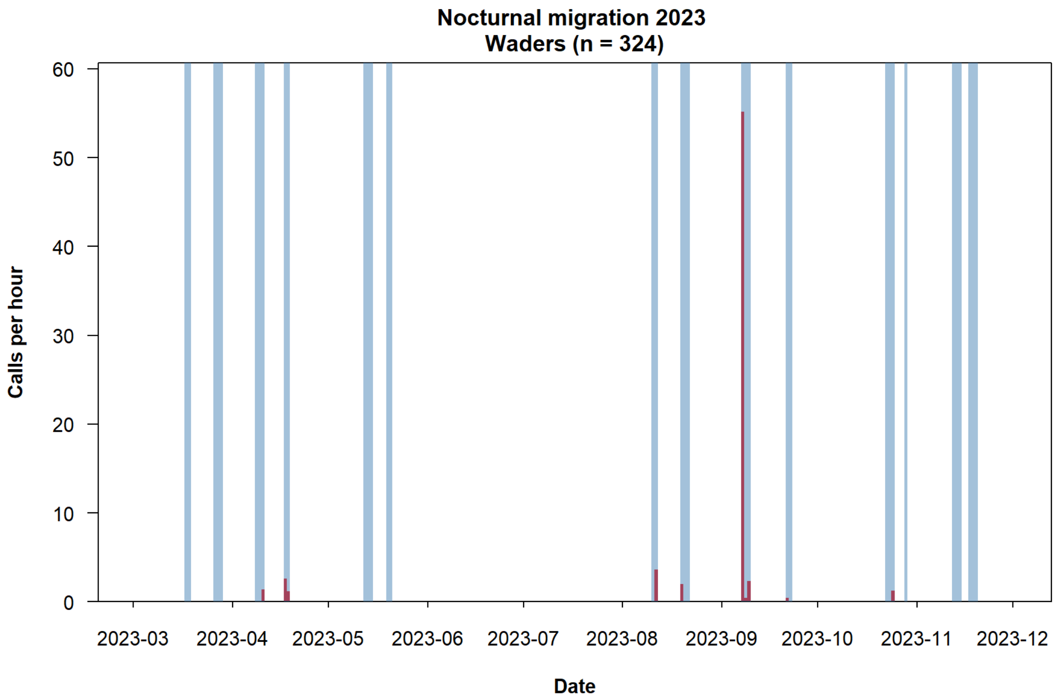


Figure 5-96 Nocturnal migration intensity of waders in 2023 at the pre-investigation area KF II OWF N. See Figure 5-42 for details.

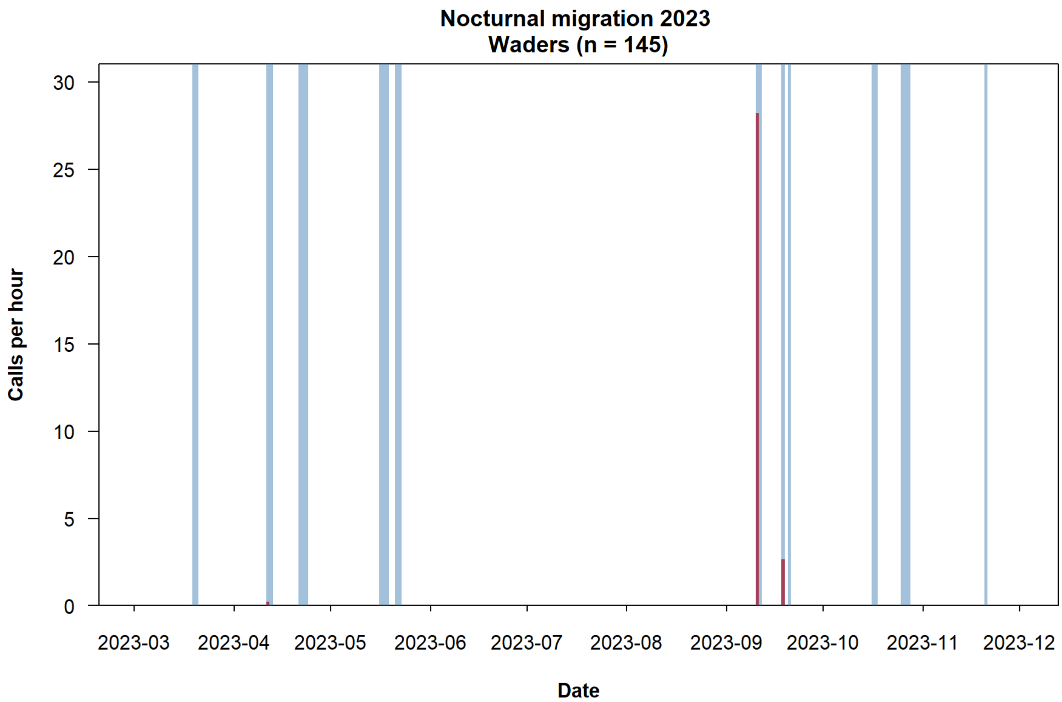


Figure 5-97 Nocturnal migration intensity of waders in 2023 at the pre-investigation area KF II OWF S. See Figure 5-42 for details.

Despite the fact that most waders observed during the day in spring were Eurasian curlews, very different patterns were found in both areas, with more than 98% flying below 20 m in the southern area and almost all of the waders (98.9%) flying above this limit at the northern area (Figure 5-98, Figure 5-99).

In autumn, most waders flew at very low altitudes (up to 5 m): 54% in the northern area and 91% in the southern area. In the northern area 41.4% flew above 20 m and 9% of all waders flew above this altitude range in the southern area (Figure 5-98, Figure 5-99).

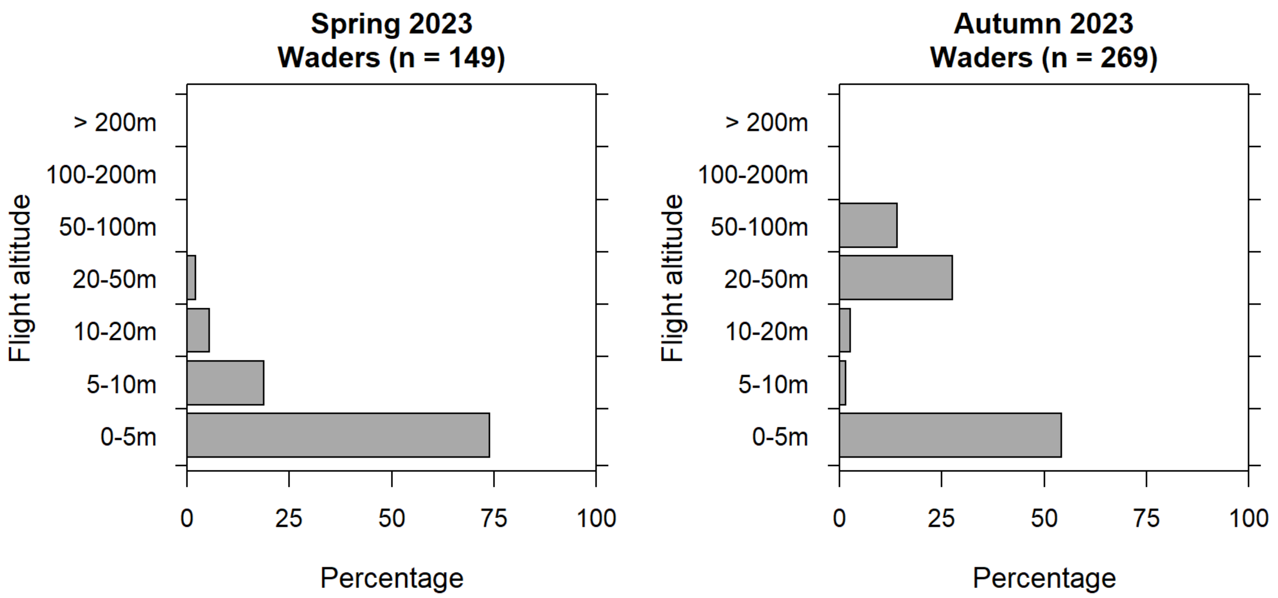


Figure 5-98 Flight altitude distribution of waders during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-35 for details.

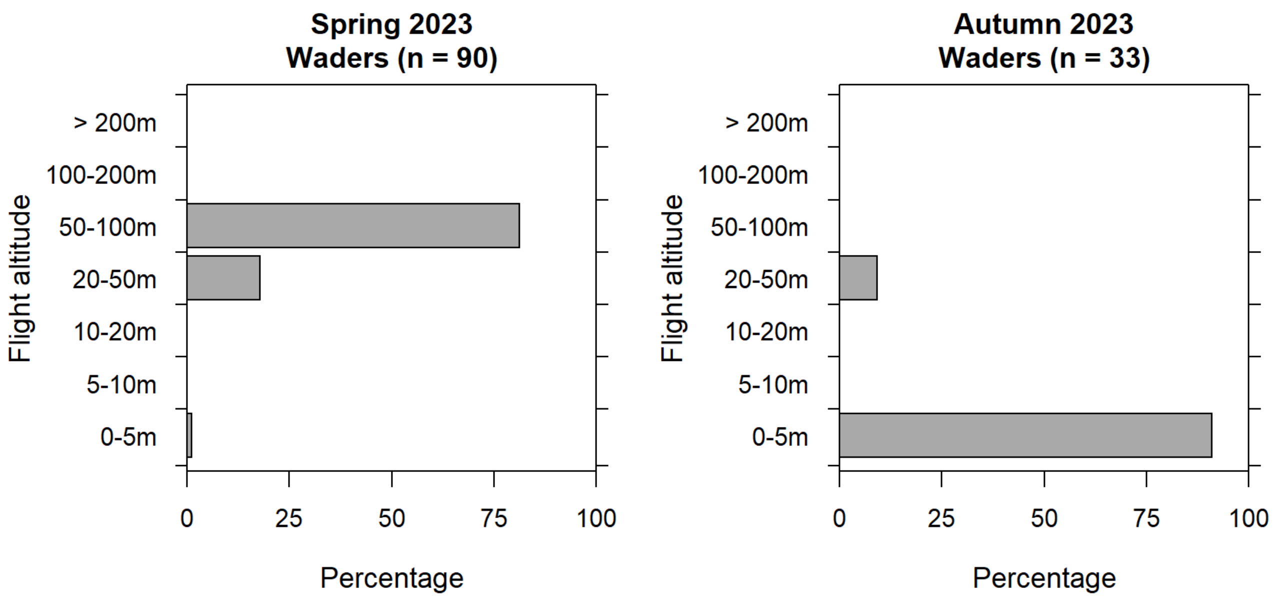


Figure 5-99 Flight altitude distribution of waders during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-35 for details.

Flying directions of waders differed between the northern and southern area. In spring, most waders in KF II N flew in E direction, whereas those at KF II S flew in NE direction. In autumn, the waders of the KF II N flew mainly to the west (72.5%), some few to the SW (24.1%), whereas in the southern area, most (54.6%) flew to the SW and 36.4% flew to the W (Figure 5-100 and Figure 5-101).

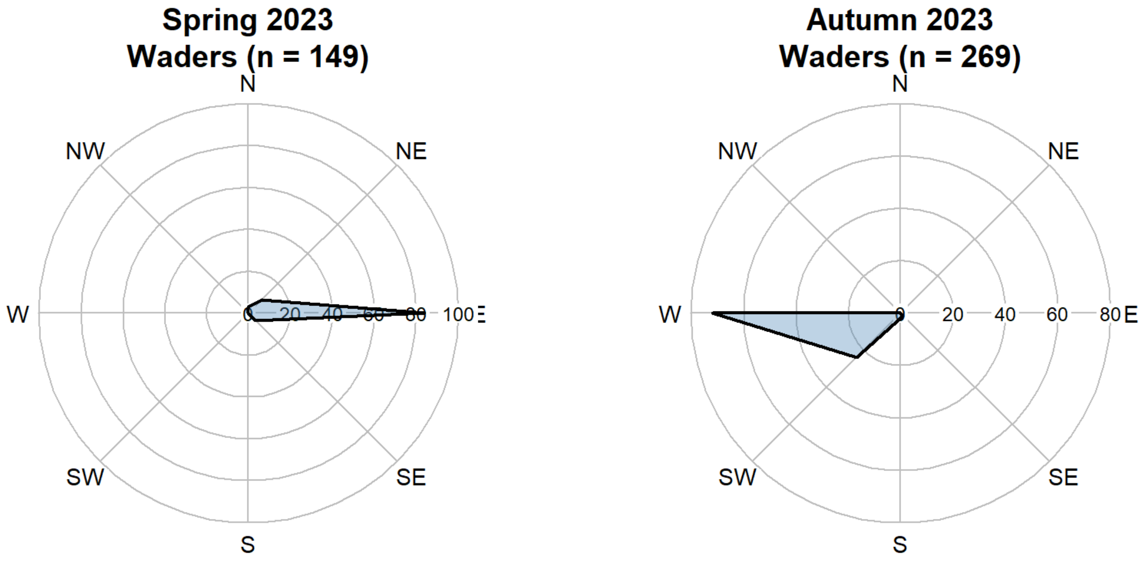


Figure 5-100 Flight direction of waders during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-36 for details.

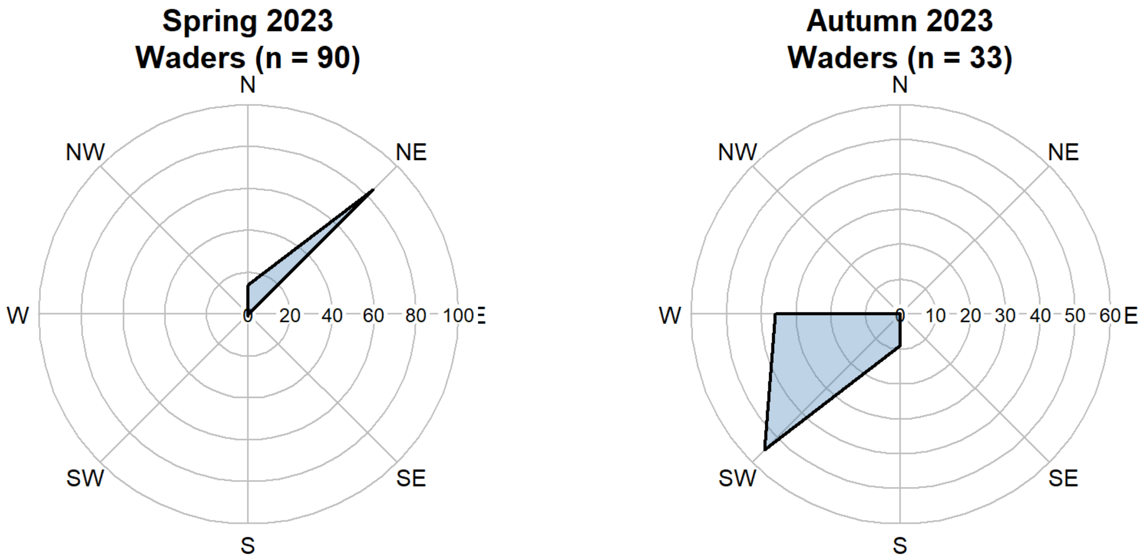


Figure 5-101 Flight direction of waders during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-36 for details.

During the day, waders were observed during the day, but since they fly in flocks, there were some peaks occurring at some specific hours. For example, in spring, there was an important peak at 11 hours after civil morning twilight at the northern area. This was due to several observations of Eurasian curlews, whereas the same species peaked at different hours in spring at the southern area. In autumn, similar patterns were observed in both areas with many observations between the 2nd and 5th hour after the morning civil twilight, and a peak at 3 hours after in both areas. During nights, the great majority of the individuals were heard at about 5 hours after civil evening twilight. In the northern area, a second peak was observed at 11 hours after civil morning twilight, which were all oystercatchers.

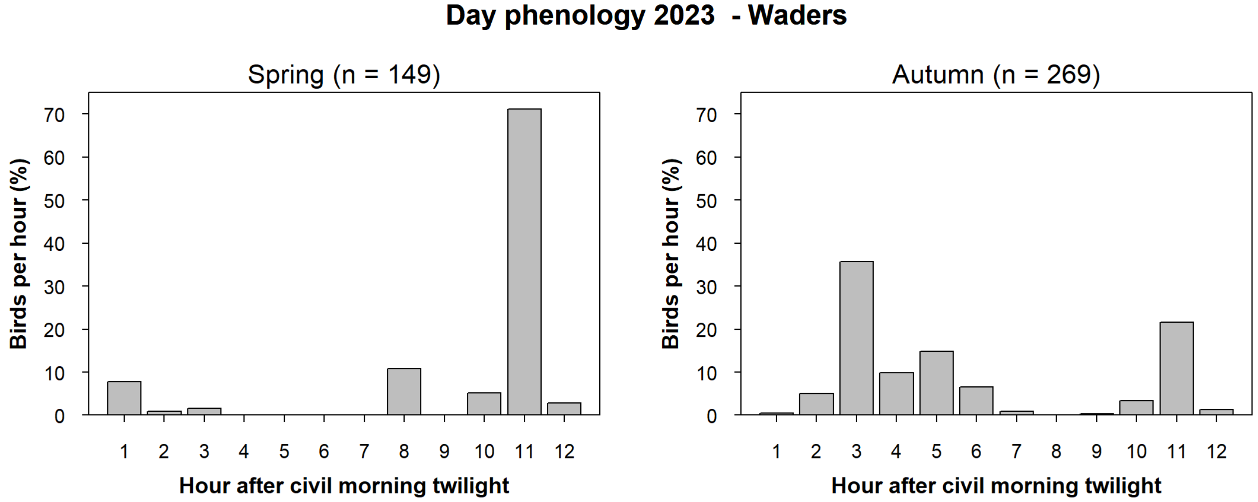


Figure 5-102 Diurnal phenology of waders in spring and autumn 2023 at the pre-investigation area KF II OWF N. See Figure 5-38 for details.

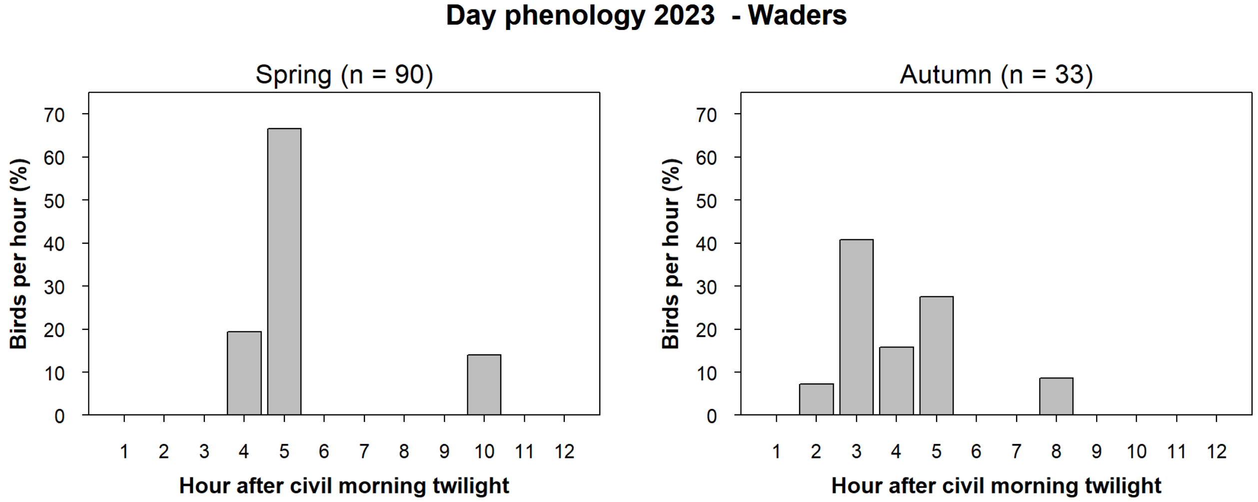


Figure 5-103 Diurnal phenology of waders in spring and autumn 2023 at the pre-investigation area KF II OWF S. See Figure 5-38 for details.

There was no particular phenological pattern at night, as waders flew in flocks and the peaks correspond to peaks observed of the most important species: dunlins in autumn at the northern area were mostly heard at three hours after the civil evening twilight and common sandpipers were mainly heard at 12 hours after civil evening twilight (Figure 5-104 and Figure 5-105).

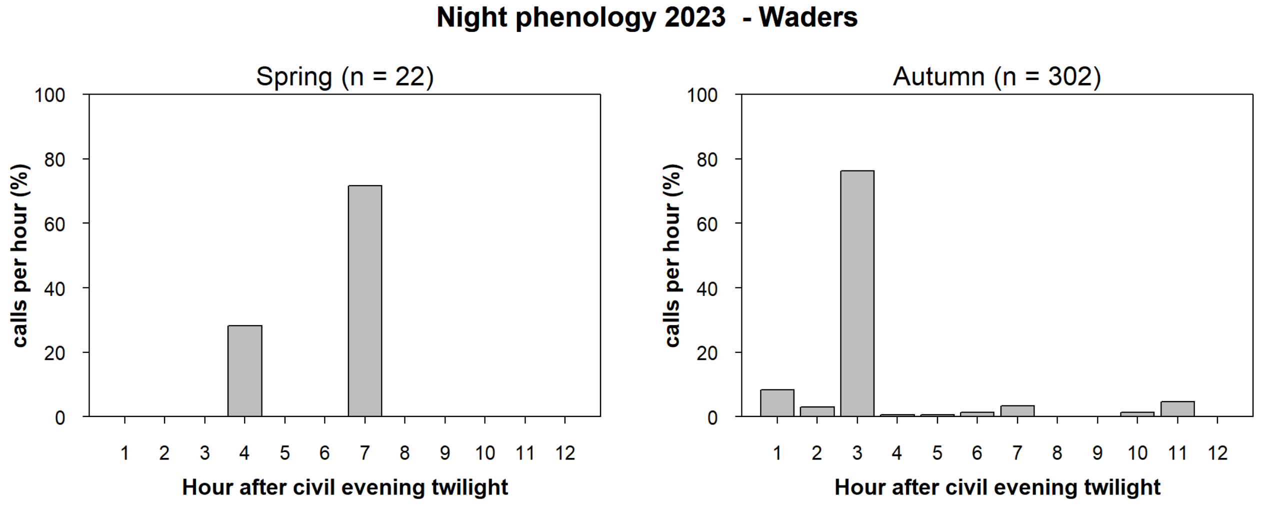


Figure 5-104 Nocturnal phenology of waders in spring and autumn 2023 at the pre-investigation area KF II OWF N. See Figure 5-38 for details.

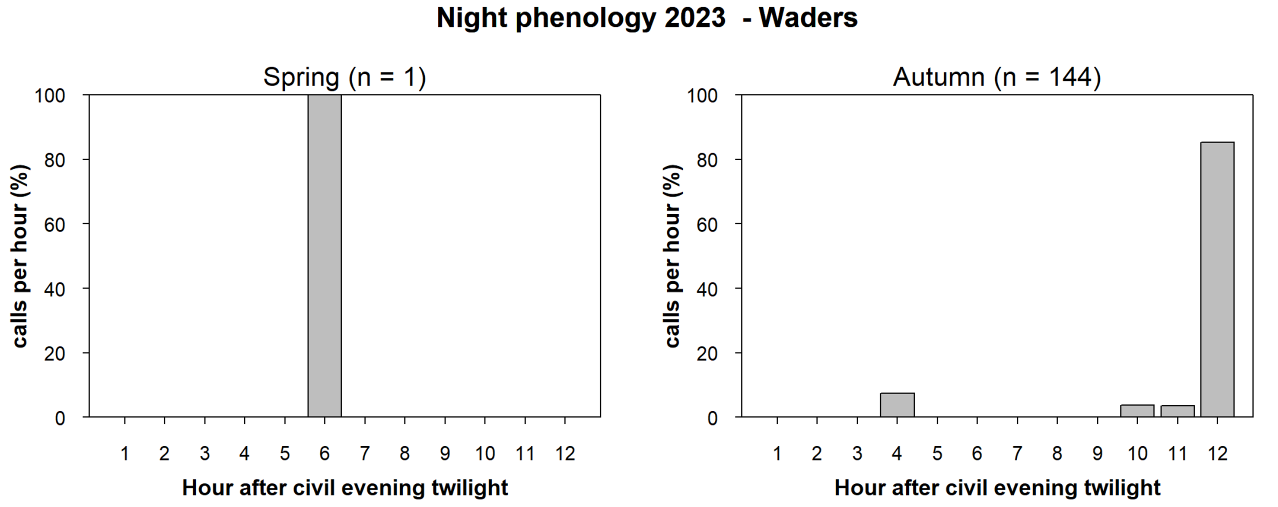


Figure 5-105 Nocturnal phenology of waders in spring and autumn 2023 at the pre-investigation area KF II OWF S. See Figure 5-38 for details.

GULLS

Gulls were a frequently occurring group during diurnal migration in both areas and both seasons. In the northern area, with 396 individuals they made up 5% of all migrating birds in spring. In autumn, they made up 2.9% of all migrating birds. In the southern area, slightly fewer individuals of gulls were seen in spring and autumn (201 and

236, respectively) but they made up for less than 1% of all migrating birds in spring and only 1.3% of all migrating birds in autumn.

In terms of species, common gull and herring gull were the most common species in spring in both areas. Common gulls represented 2.65% of all migrating birds in the northern area, but only 0.23% of all migrating birds at the southern area, whereas herring gulls represented 0.98% of all migrating birds and 0.28% of all migrating birds in the southern area and thus were more frequent than common gulls there. In the northern area, other species that occurred relatively frequent were black-headed gull, little gull and Lesser black-backed gull (0.43, 0.34 and 0.33% of all migrating birds, respectively). In autumn, little gull was more dominant in the northern area representing 1% of all migrating birds, while common gulls and herring gulls represented 0.63 and 0.54% of all migrating birds in that season. In the southern area, common gulls were more common (0.3% of all migrating birds) but three other species followed closely in abundance: herring gull, little gull and great black-backed gull (0.22%, 0.20% and 0.19%, respectively).

Mean migration intensity was at similar levels at both areas and seasons varying between 2.4 and 4.5 ind./h (see Table 5-7 and Table 5-8). Maximum values varied between 5 and 15.5 ind/h (in spring and autumn of the southern area, respectively).

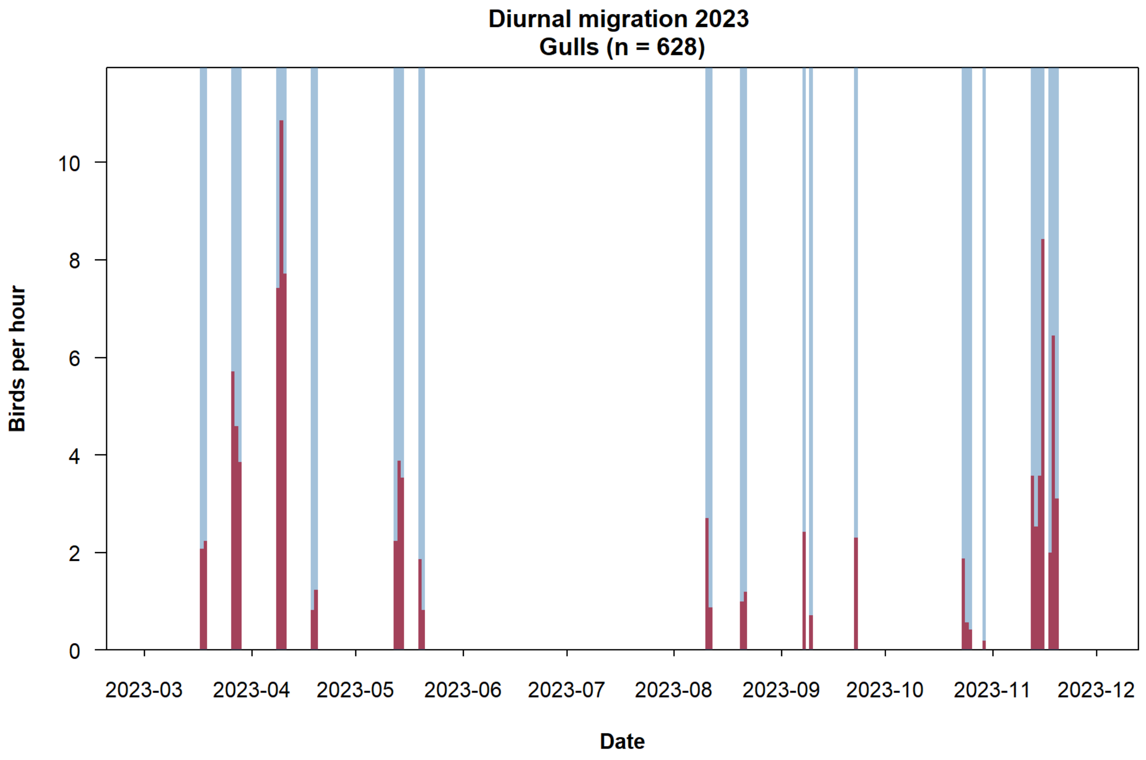


Figure 5-106 Diurnal migration intensity of gulls in 2023 at the pre-investigation area KF II OWF N. See Figure 5-32 for details.

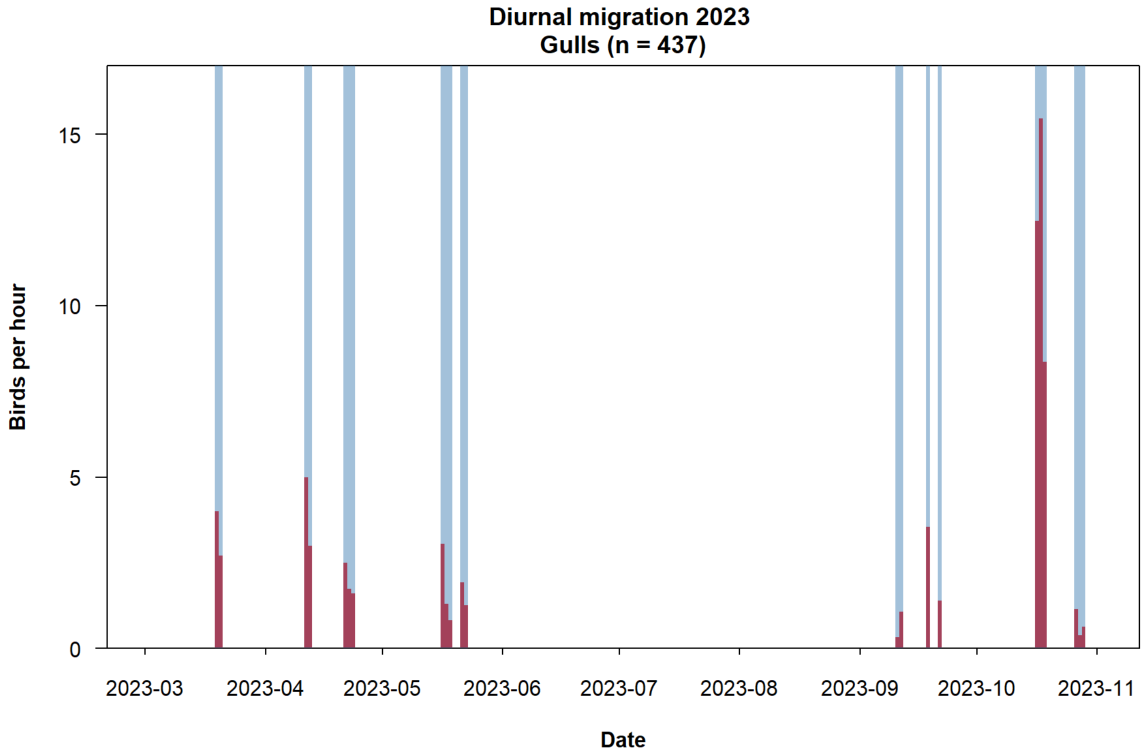


Figure 5-107 Diurnal migration intensity of gulls in 2023 at the pre-investigation area KF II OWF S. See Figure 5-32 for details.

During nocturnal migration, gulls were only heard in spring.The 92 flight calls in the northern area represented over 25% of all calls. In the southern area were fewer calls recorded and they represented just 1.9% of all calls. In the northern area, the majority of calls belonged to common gulls (24.2%), the rest were herring gulls. In the southern area, most calls belonged to black-headed gulls (1.4%) and the remaining calls were from common gulls. In both areas, calls were infrequent and heard only on few dates. Mean migration intensity and maximum peaks were larger in the northern area (see Table 5-9, Table 5-10 and Figure 5-108, Figure 5-109).

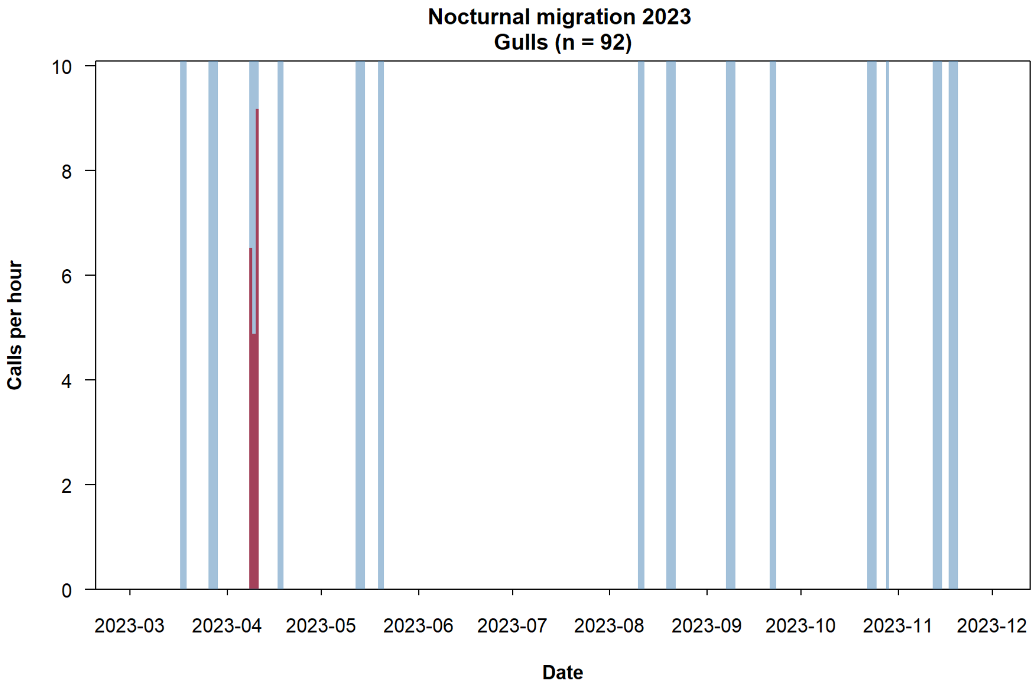


Figure 5-108 Nocturnal migration intensity of gulls in 2023 at the pre-investigation area KF II OWF N. See Figure 5-42 for details.

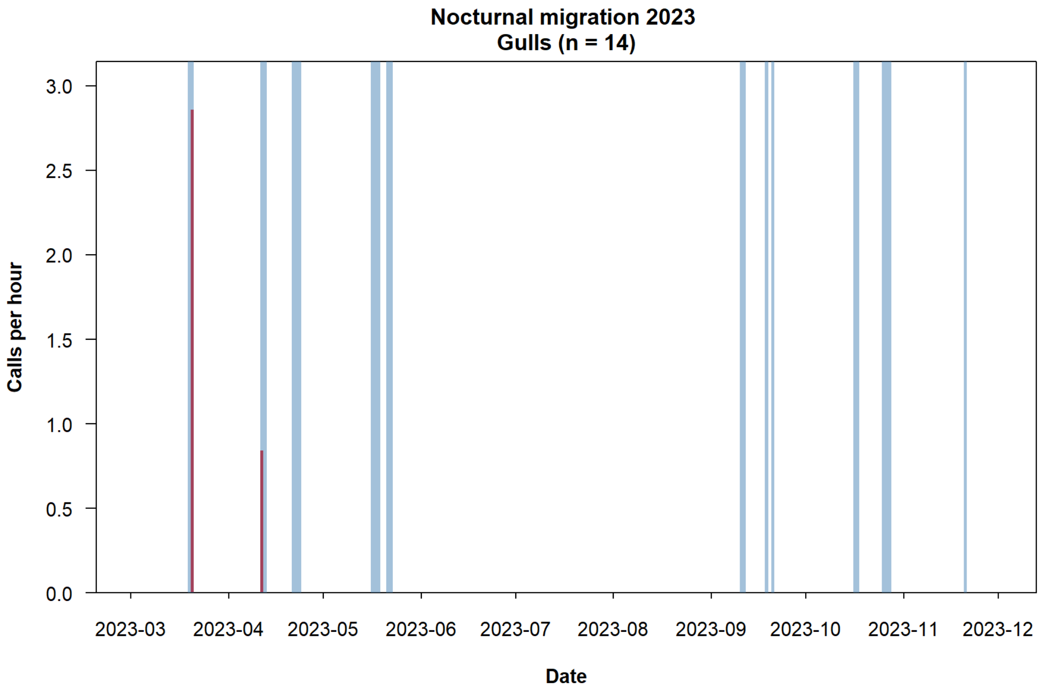


Figure 5-109 Nocturnal migration intensity of gulls in 2023 at the pre-investigation area KF II OWF S. See Figure 5-42 for details.

Gulls flew mainly at mid-range altitudes (between 10 and 50 m). In general, in the northern area, most gulls flew at 20-50 m altitude range (30% in spring and 40% in autumn), whereas in the southern area, most gulls flew at the 10-20 m altitude range (approximately 36% in both seasons). Few gulls flew above 50 m (Figure 5-110, Figure 5-111).

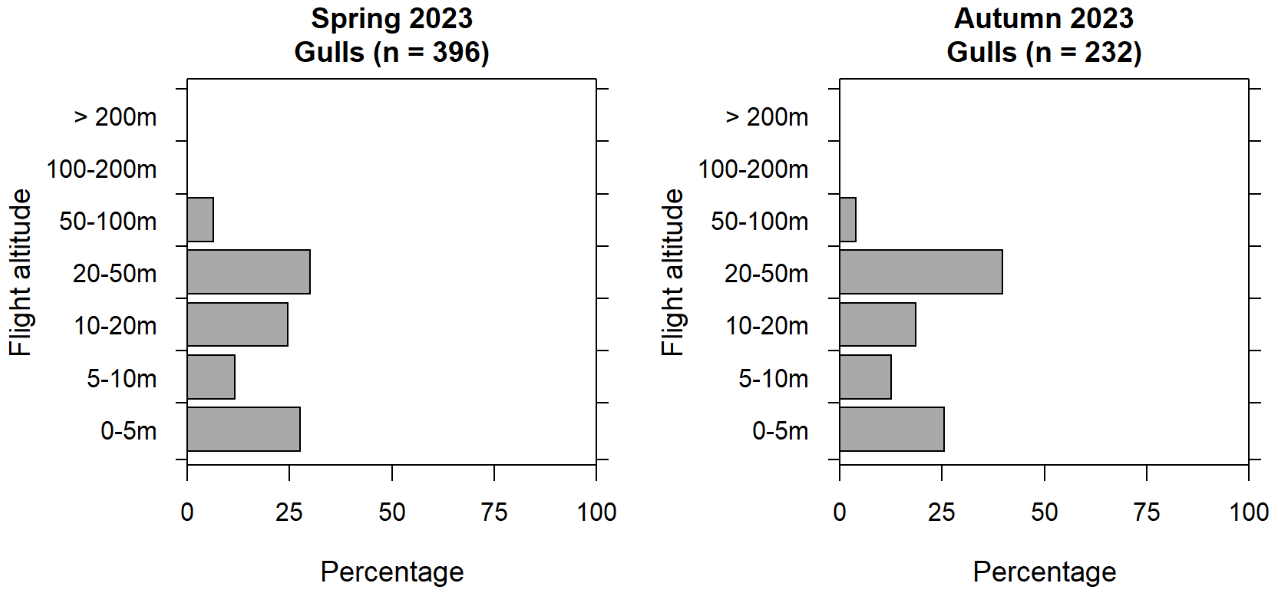


Figure 5-110 Flight altitude distribution of gulls during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-35 for details.

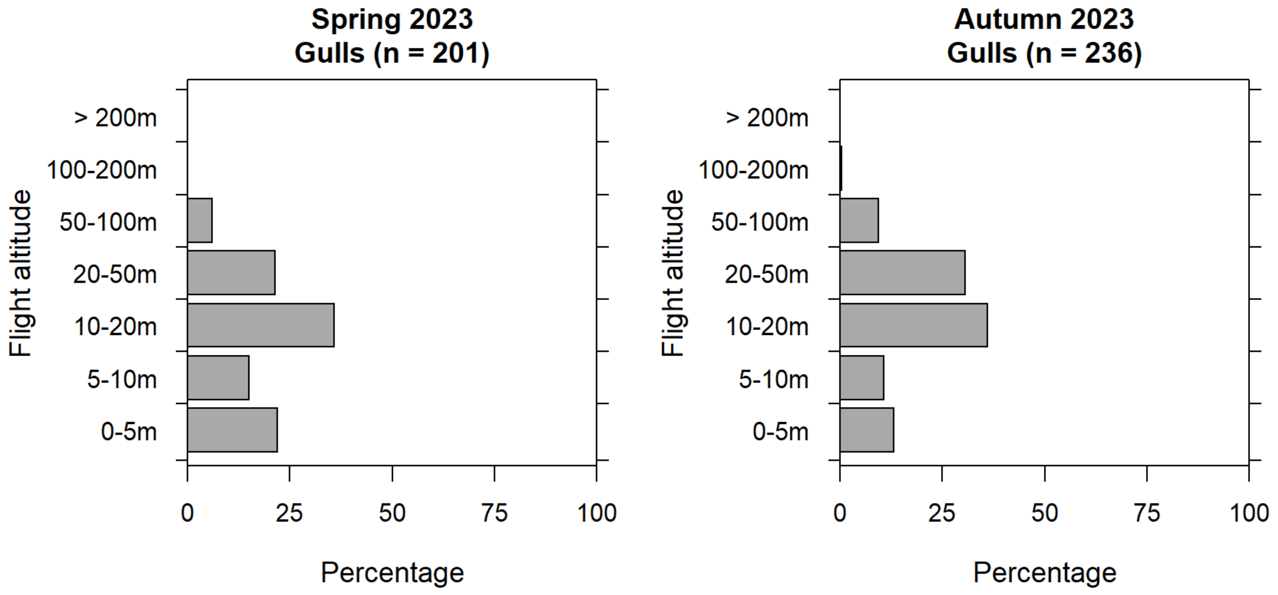


Figure 5-111 Flight altitude distribution of gulls during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-35 for details.

Gulls were seen flying in different directions. Only during spring at the northern area was the majority flying towards the NE. In the southern area, gulls were flying in different directions, most flew to the NE and E, but there were also several flying to the NW, SE and SW indicating that a lot of birds were not migrating but moving between feeding or resting areas. In autumn, they were seen flying at all directions in the northern area, most flew to the E, and then SW, N and NW followed. In the southern area, most flew to the W and SW (Figure 5-112, Figure 5-113).

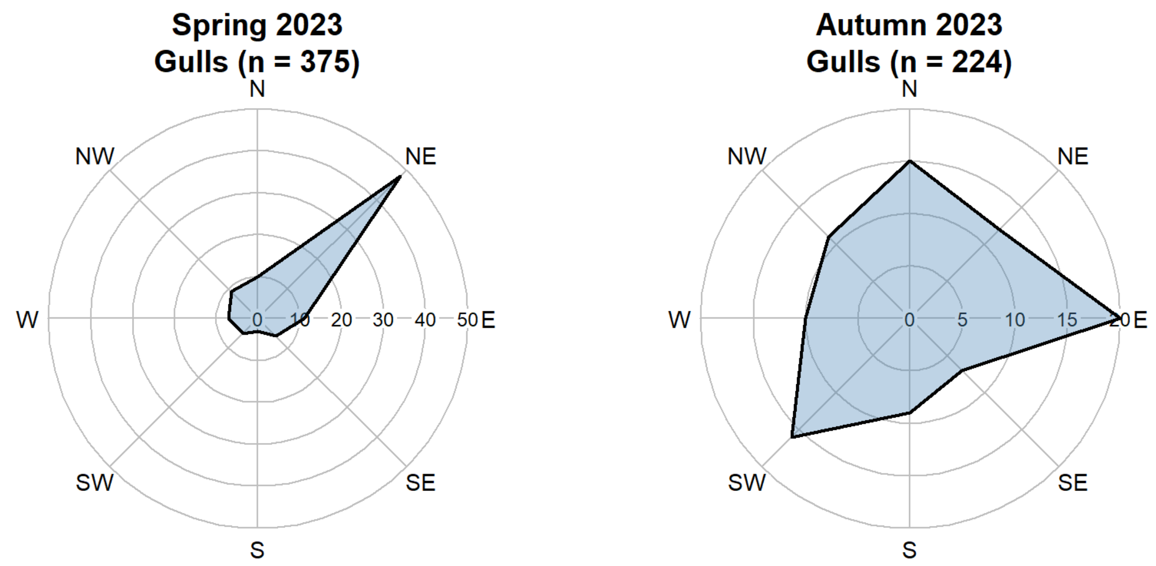


Figure 5-112 Flight direction of gulls during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-36 for details.

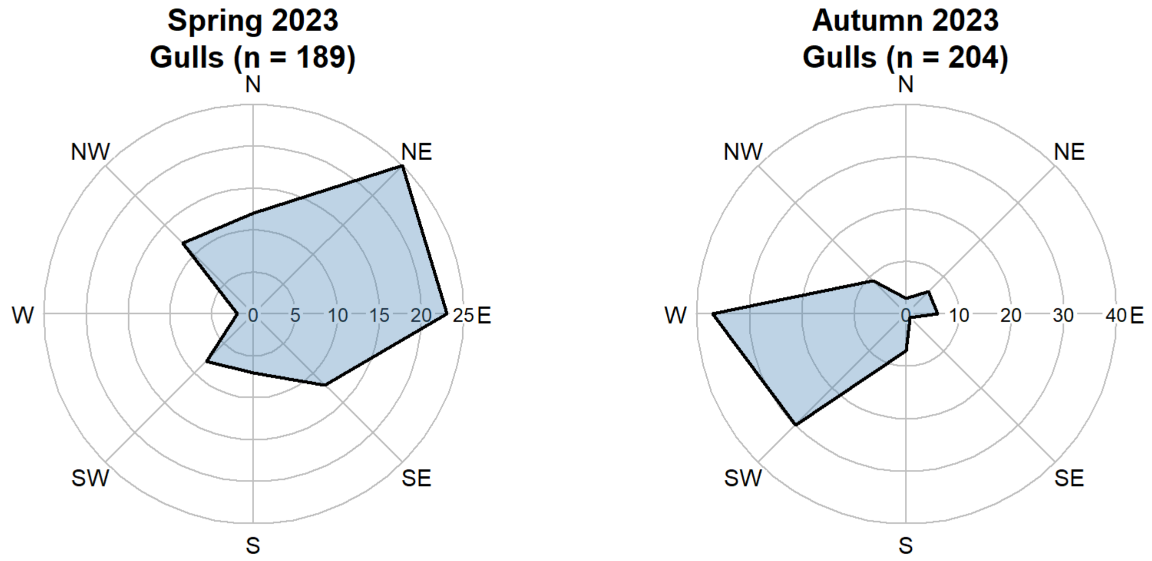


Figure 5-113 Flight direction of gulls during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-36 for details.

During the day, gulls were observed flying all day long and no specific pattern can be inferred in any season or any area (Figure 5-114 and Figure 5-115).

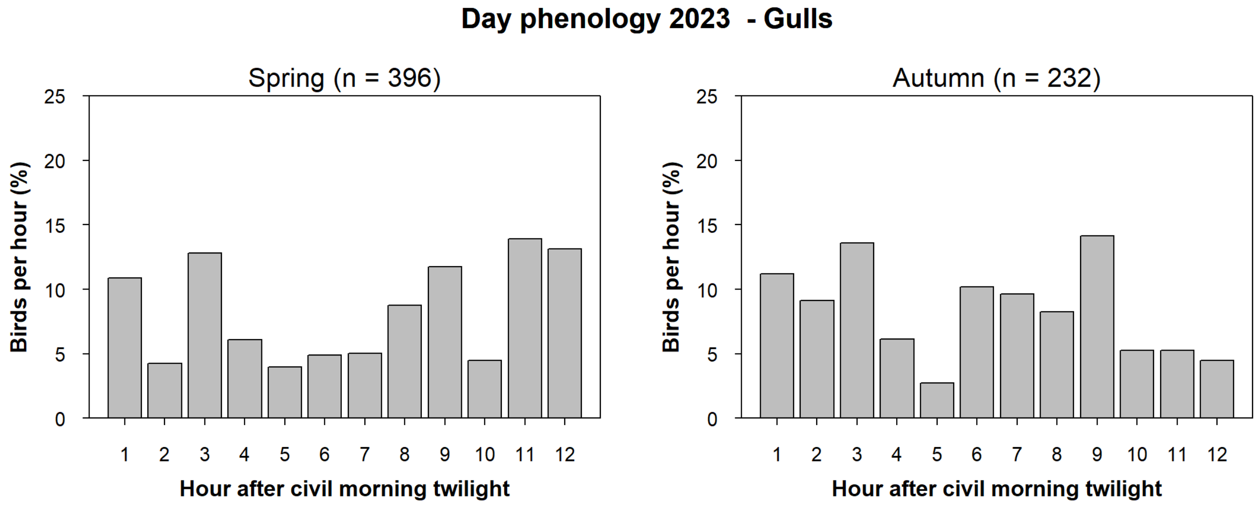


Figure 5-114 Diurnal phenology of gulls in spring and autumn 2023 at the pre-investigation area KF II OWF N. See Figure 5-38 for details.

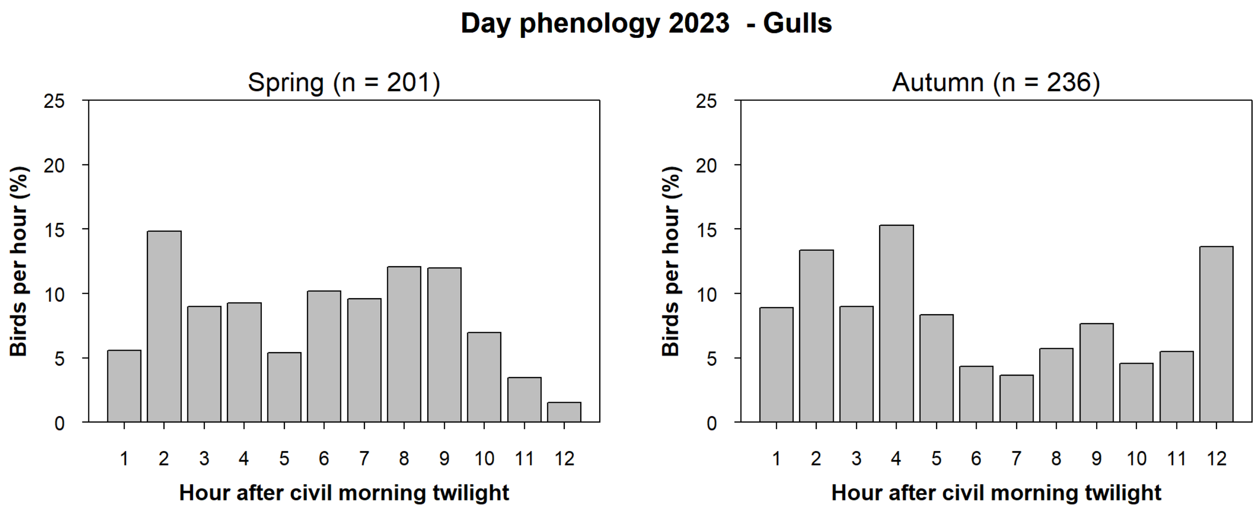


Figure 5-115 Diurnal phenology of gulls in spring and autumn 2023 at the pre-investigation area KF II OWF S. See Figure 5-38 for details.

During nights, most gulls were heard in the middle of the night (Figure 5-116 and Figure 5-117).

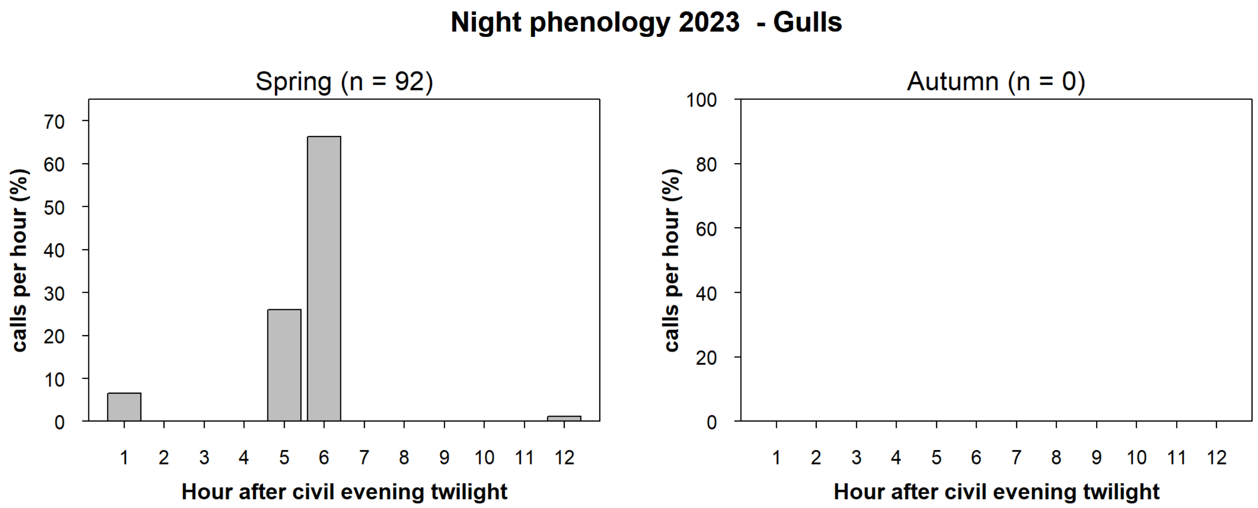


Figure 5-116 Nocturnal phenology of gulls in spring and autumn 2023 at the pre-investigation area KF II OWF N. See Figure 5-38 for details.

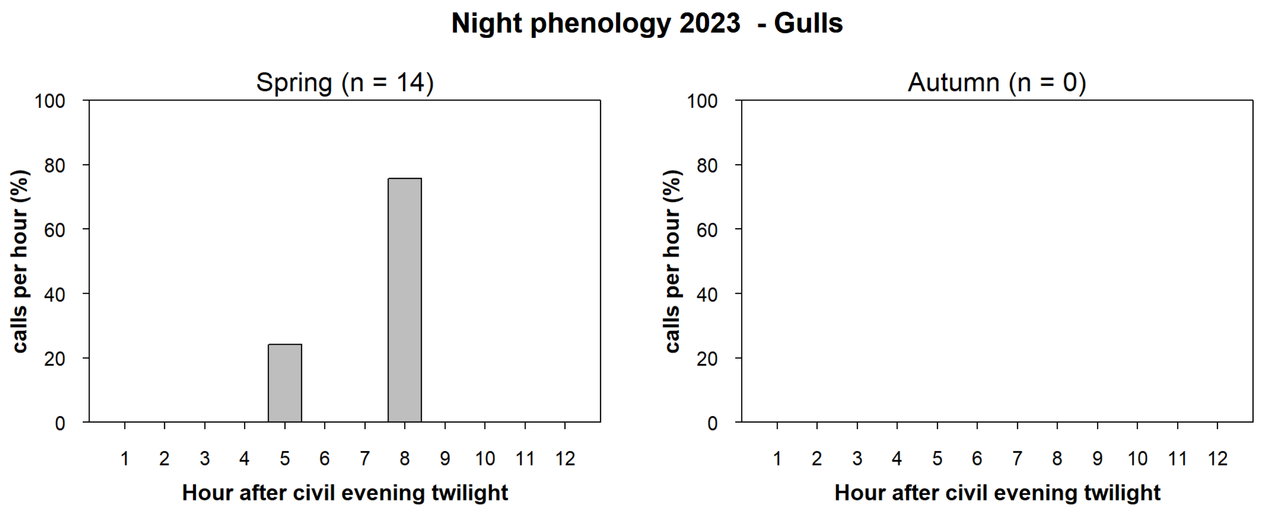


Figure 5-117 Nocturnal phenology of gulls in 2023 at the pre-investigation area KF II OWF S. See Figure 5-38 for details.

TERNS

A total of 306 individuals of terns were sighted in the northern area, most of them in autumn, whereas only 5 individuals were seen in the southern area and only in spring (Figure 5-118 and Figure 5-119). Terns were mainly observed in the northern area in autumn (251 individuals), representing 3.1% of all migrating birds in this season. In spring, 33 individuals (60%) were identified as Sandwich tern, all other terns sighted remained unidentified. In autumn, most terns observed were common terns and common terns/arctic terns (2.1% and 0.6% of all migrating birds). All 5 individuals seen in the southern area during spring were sandwich terns.

Mean migration intensity varied between 0 ind./h (in the southern area) and 1.8 ind./h in autumn at the northern area. The maximum peak value was 23.4 ind./h in autumn at the beginning of the autumn (August, 11th 2023, Figure 5-118 and Figure 5-119).

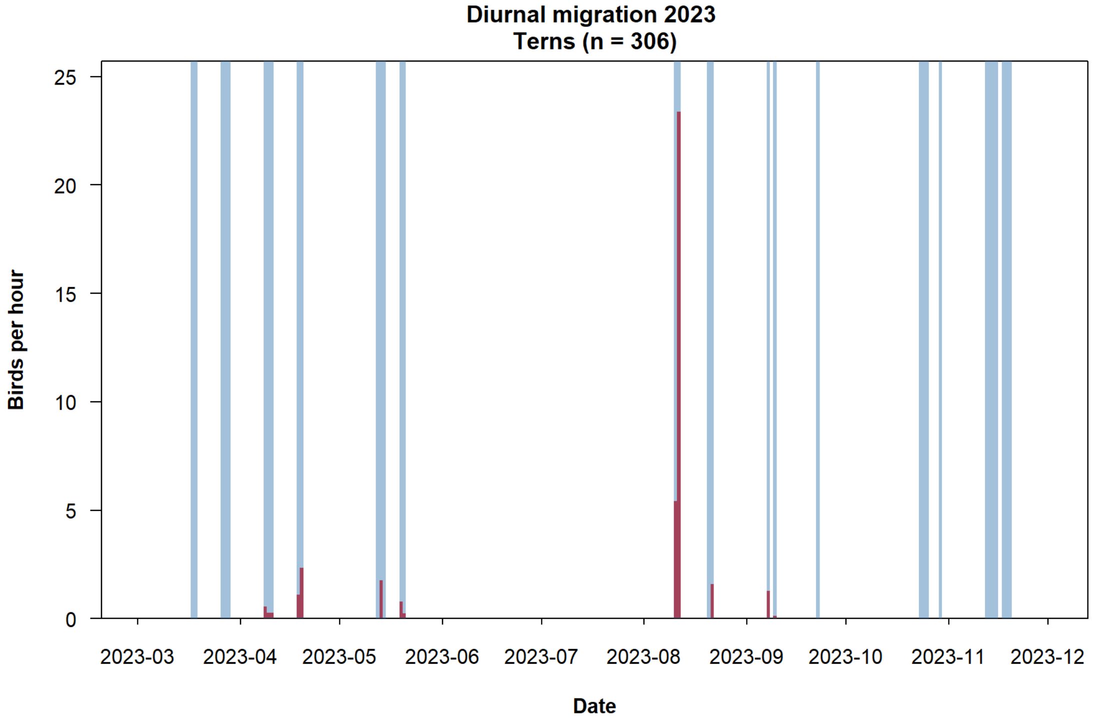


Figure 5-118 Diurnal migration intensity of terns in 2023 at the pre-investigation area KF II OWF N. See Figure 5-32 for details.

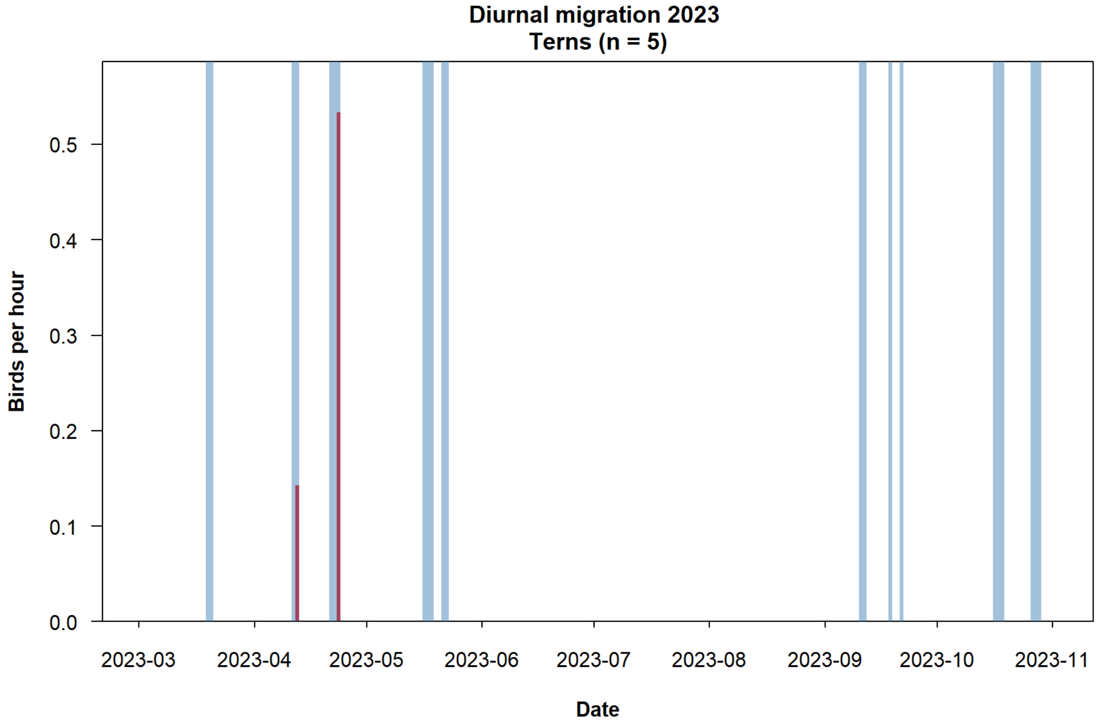


Figure 5-119 Diurnal migration intensity of terns in 2023 at the pre-investigation area KF II OWF S. See Figure 5-32 for details.

Terns flew mostly at altittudes between 0 and 20 m. Only in spring at the northern area more than 10% flew at altitudes above 20 m (Figure 5-120 and Figure 5-121).

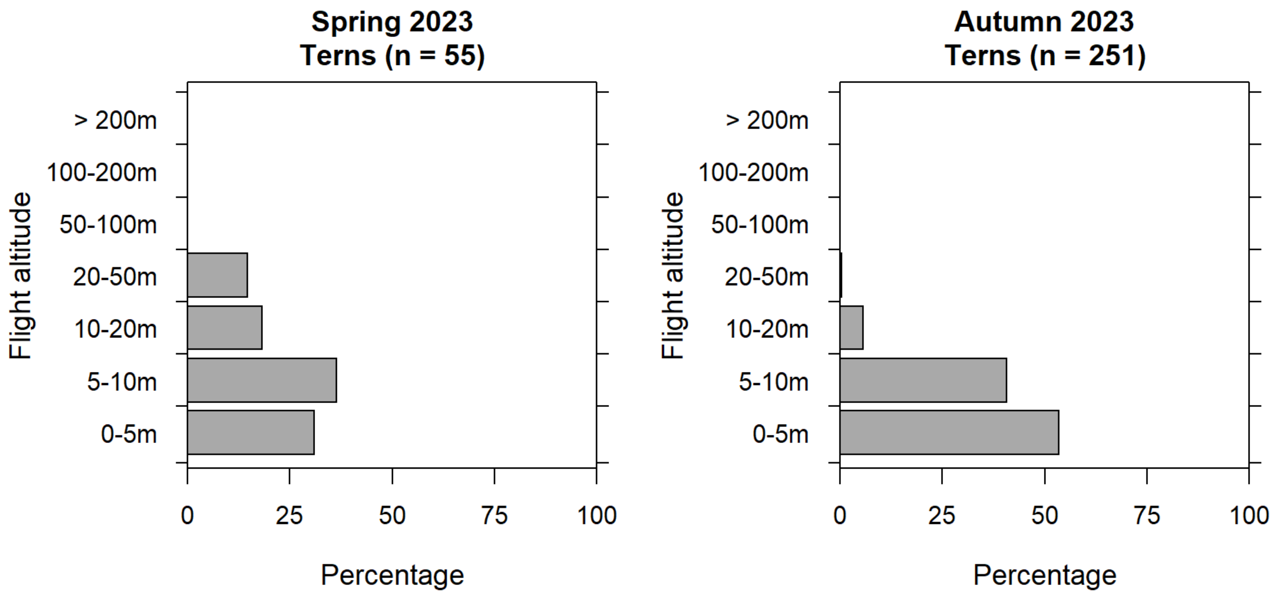


Figure 5-120 Flight altitude distribution of terns during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-35 for details.

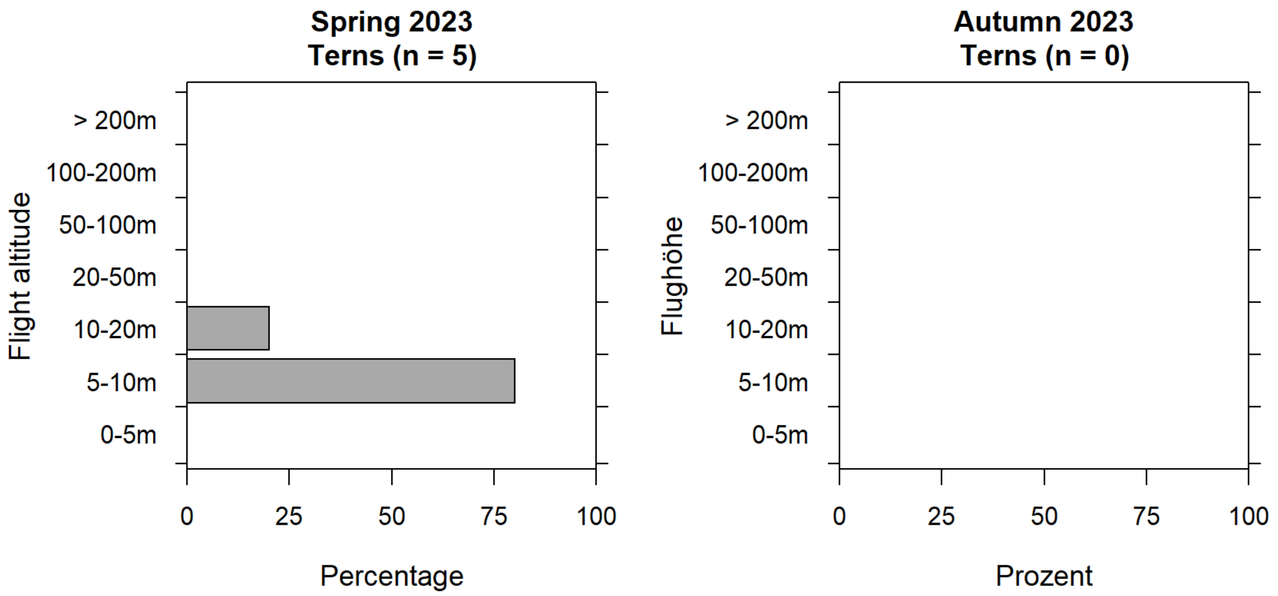


Figure 5-121 Flight altitude distribution of terns during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-35 for details.

In spring, most individuals flew towards the NE (65.4% in the northern area, 80% in the southern area). In autumn, the majority flew to the W (55.4%) and 32.7% to the SW (Figure 5-122 and Figure 5-123).

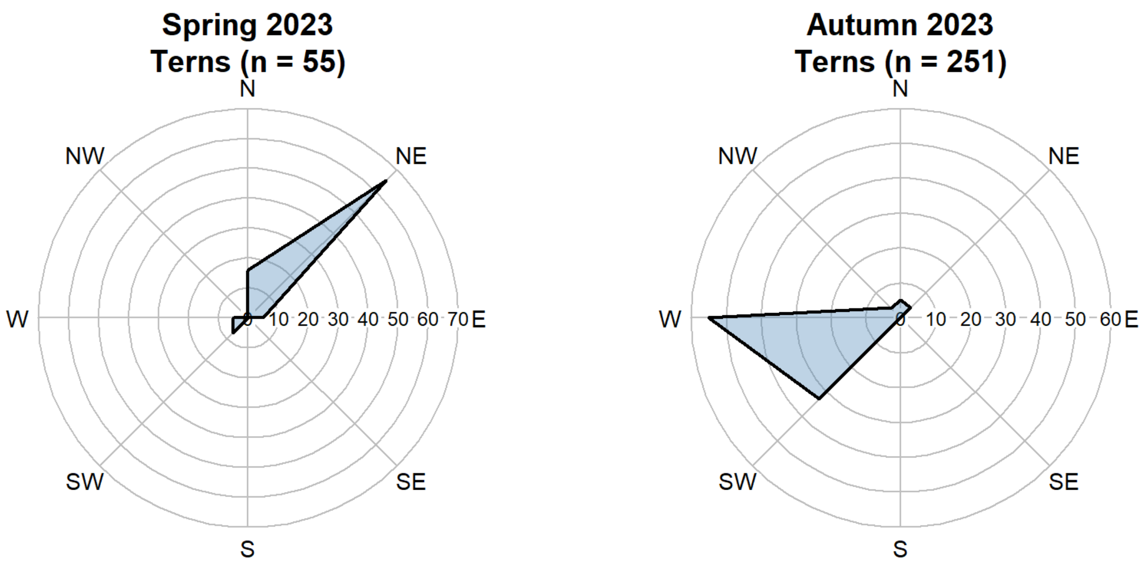


Figure 5-122 Flight direction of terns during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-36 for details.

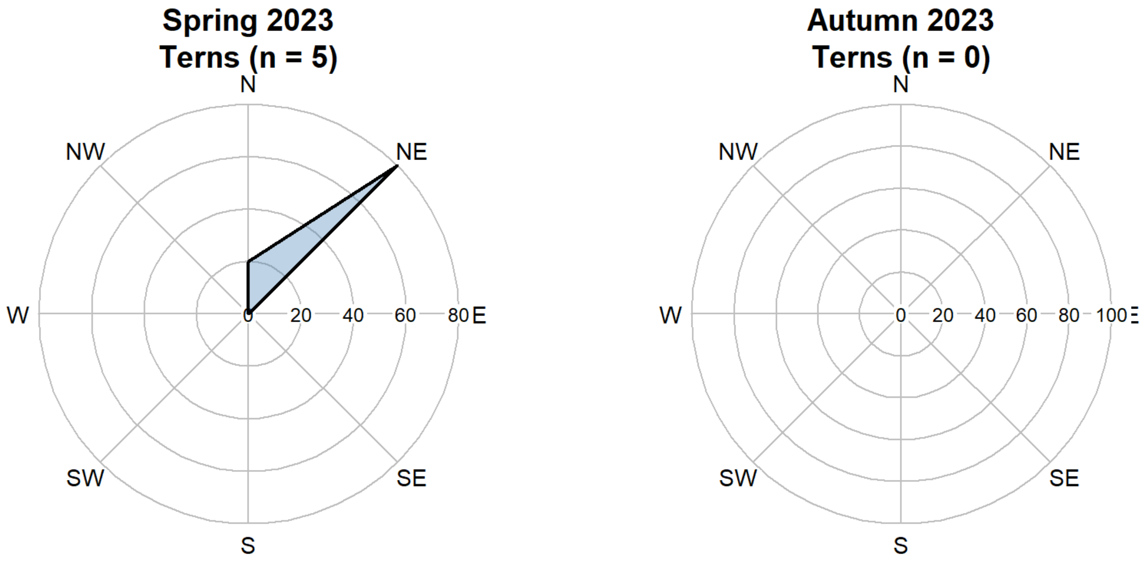


Figure 5-123 Flight direction of terns during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-36 for details.

Terns were observed flying all day long, but in spring at the northern area highest numbers were seen flying in the first six hours after civil morning twilight (Figure 5-124, and Figure 5-125).

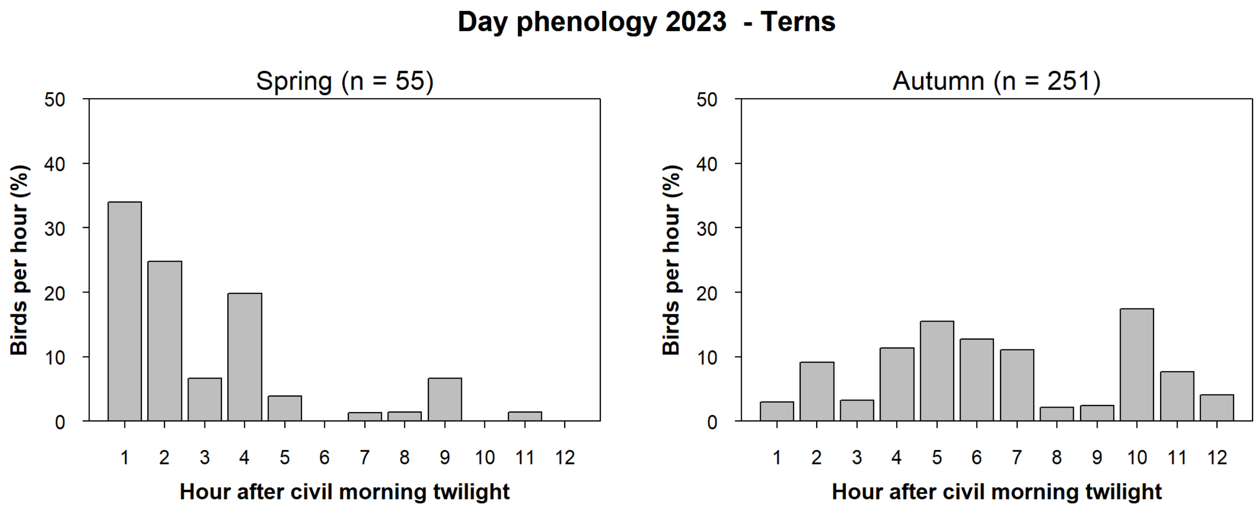


Figure 5-124 Diurnal phenology of terns in spring and autumn 2023 at the pre-investigation area KF II OWF N. See Figure 5-38 for details.

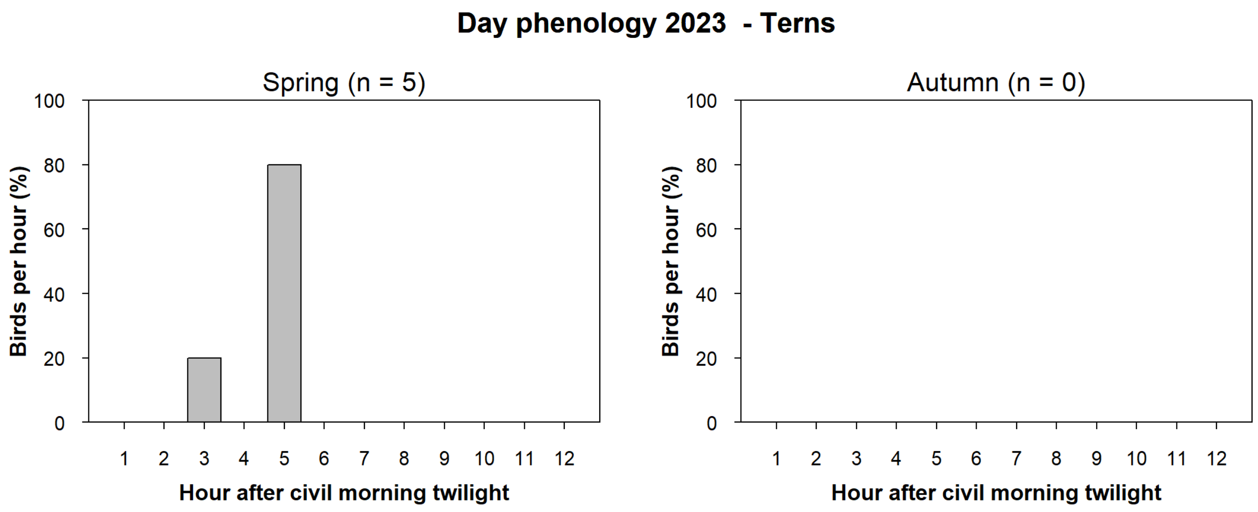


Figure 5-125 Diurnal phenology of terns in spring and autumn 2023 at the pre-investigation area KF II OWF S. See Figure 5-38 for details.

AUKS

Two species of auks are often present in the Baltic Sea: the common guillemot (*Uria aalge*) and the razorbill (*Alca torda*). These are similar in morphology and often difficult to tell apart so often species are classified as common guillemots/razorbills. In both areas, these species were dominant. In general, there were more auks in the northern area (almost twice as many) compared to the southern area. Auks represented 1.83% of all migrating birds in spring and 0.94% of all migrating birds in autumn at the northern area. They represented less than 0.3% of all migrating birds in spring and in autumn in the southern area. . In addition, a third species was present in low numbers in the northern area: the black guillemot that represented 0.27% of all migrating birds in spring.

Auks were frequently occurring and were present in similar mean intensities (mean intensities varied between 0.83 and 1.33 ind./h. The maximum values varied between 2.5 and 5.3 ind./h (see Table 5-7 and Table 5-8, Figure 5-126 and Figure 5-127).

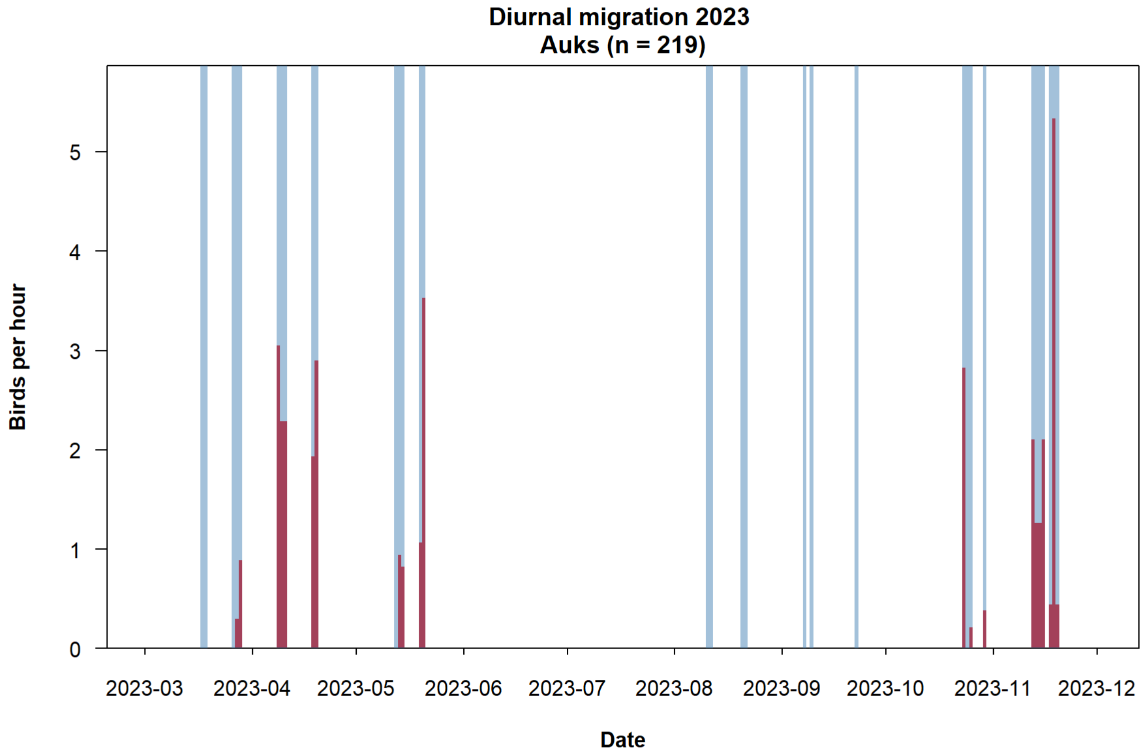


Figure 5-126 Diurnal migration intensity of auks in 2023 at the pre-investigation area KF II OWF N. See Figure 5-32 for details.

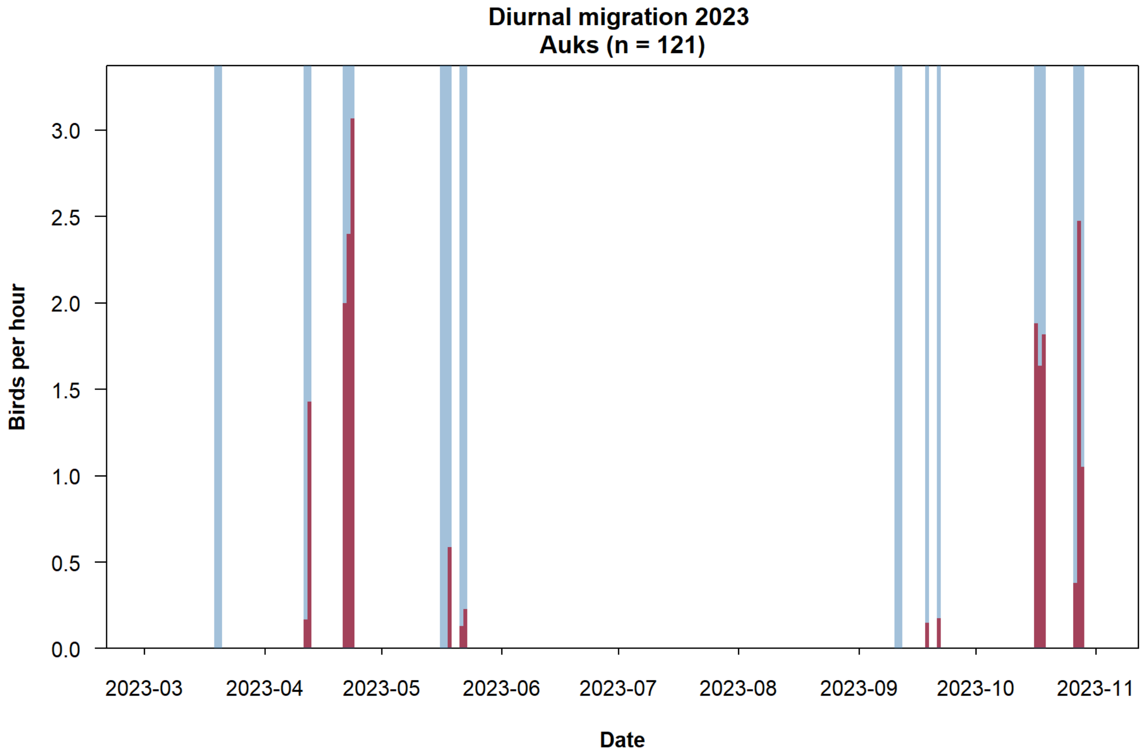


Figure 5-127 Diurnal migration intensity of auks in 2023 at the pre-investigation area KF II OWF S. See Figure 5-32 for details.

Most auks flew at very low flying altitudes (< 5 m). Only in autumn, few of them were observed flying above 5 m up to 20 m altitude (Figure 5-128, Figure 5-129).

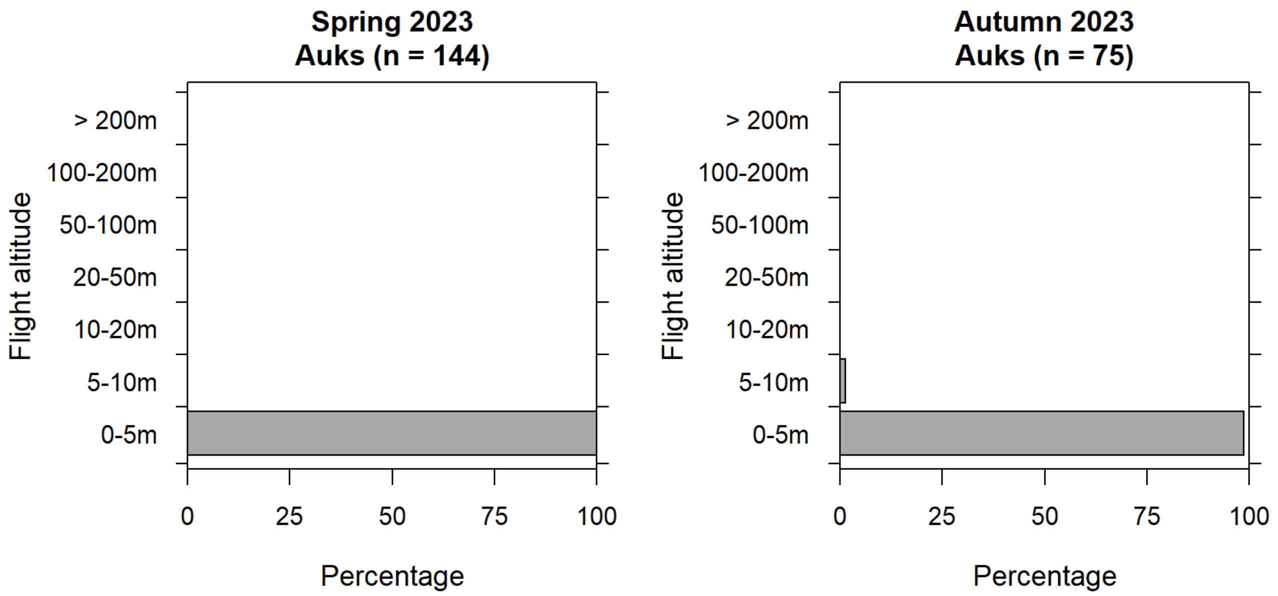


Figure 5-128 Flight altitude distribution of auks during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-35 for details.

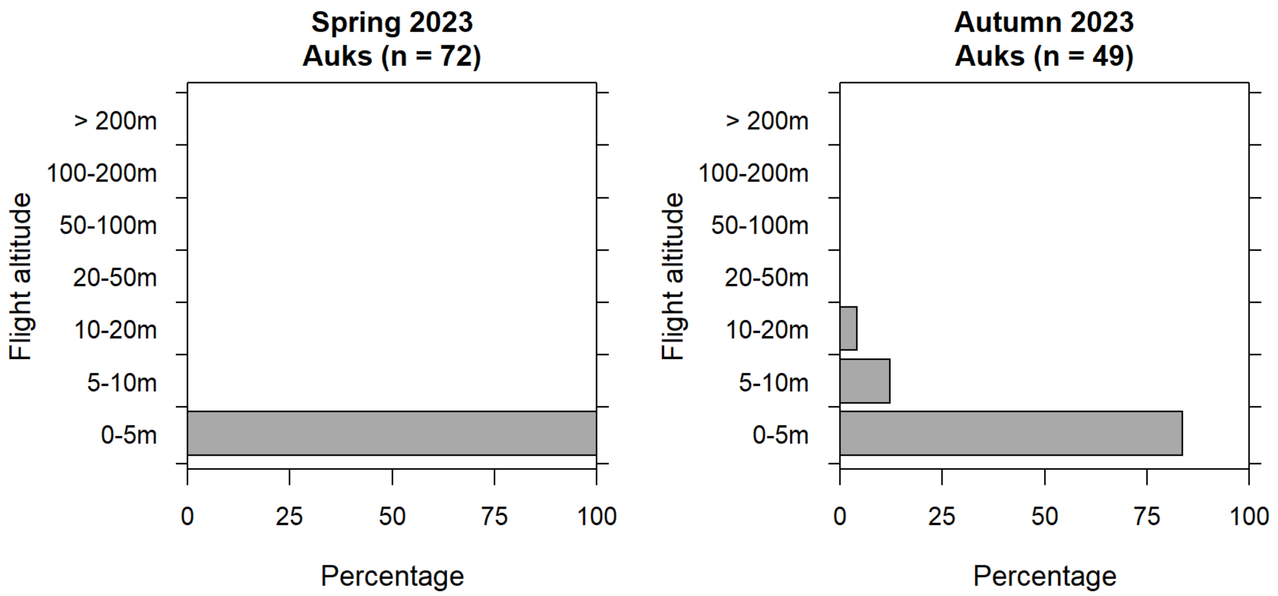


Figure 5-129 Flight altitude distribution of auks during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-35 for details.

Auks were observed flying at multiple directions. In spring, at the northern area, they were observed flying in basically all directions at relatively large proportions (except N and S). In the southern area, most flew in the typical direction for spring migration: NE, but relatively few flew to the N, NW, E, W and S. In autumn, similarly many directions were seen with the W, NW, E, NE being the most common ones at the northern area and the NW, W, NE and SW being common in the southern area (Figure 5-130 and Figure 5-131).

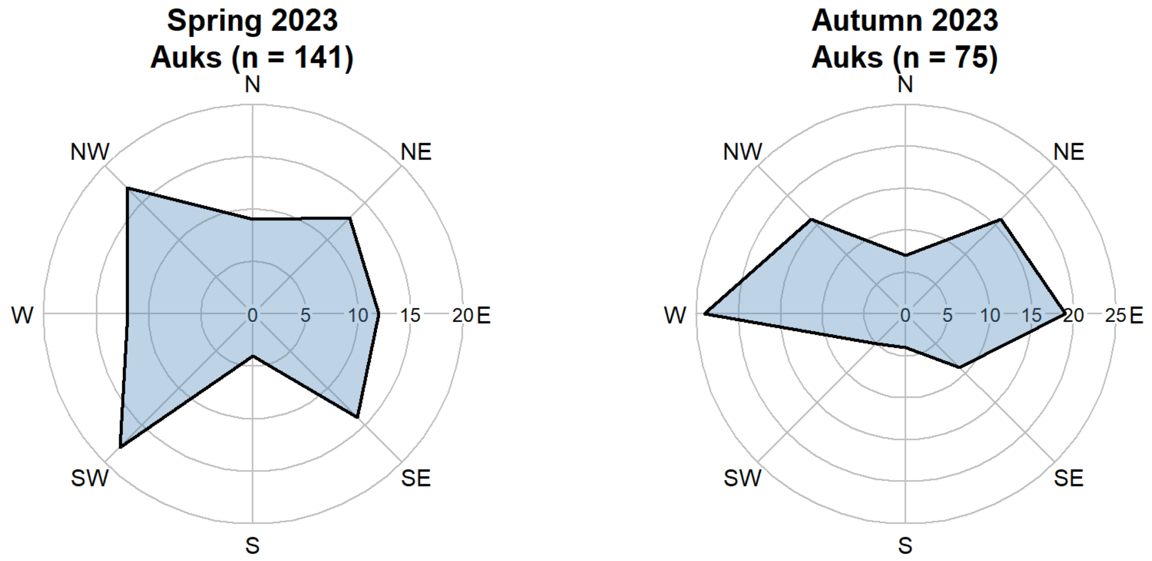


Figure 5-130 Flight direction of auks during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-36 for details.

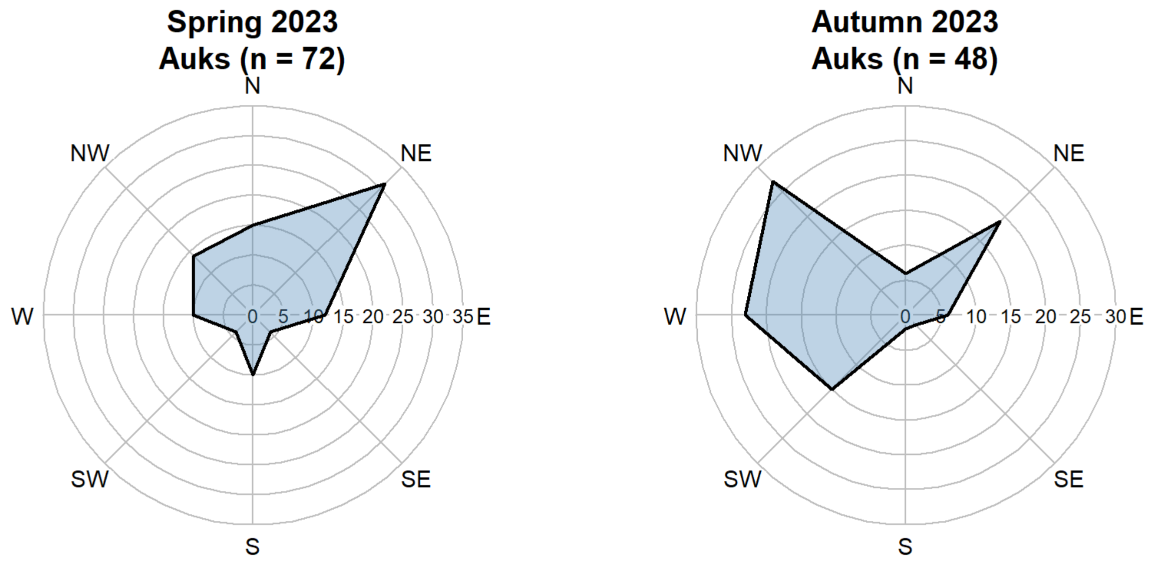


Figure 5-131 Flight direction of auks during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-36 for details.

Auks were observed migrating all day long. In spring, they seemed to prefer the first hours of the day or as second option the later hours of the day. Fewer individuals were observed flying in the middle of the day. In autumn, the largest peak was exactly at the middle of the day in the northern area and at three hours after civil morning twilight in the southern area (Figure 5-132, Figure 5-133).

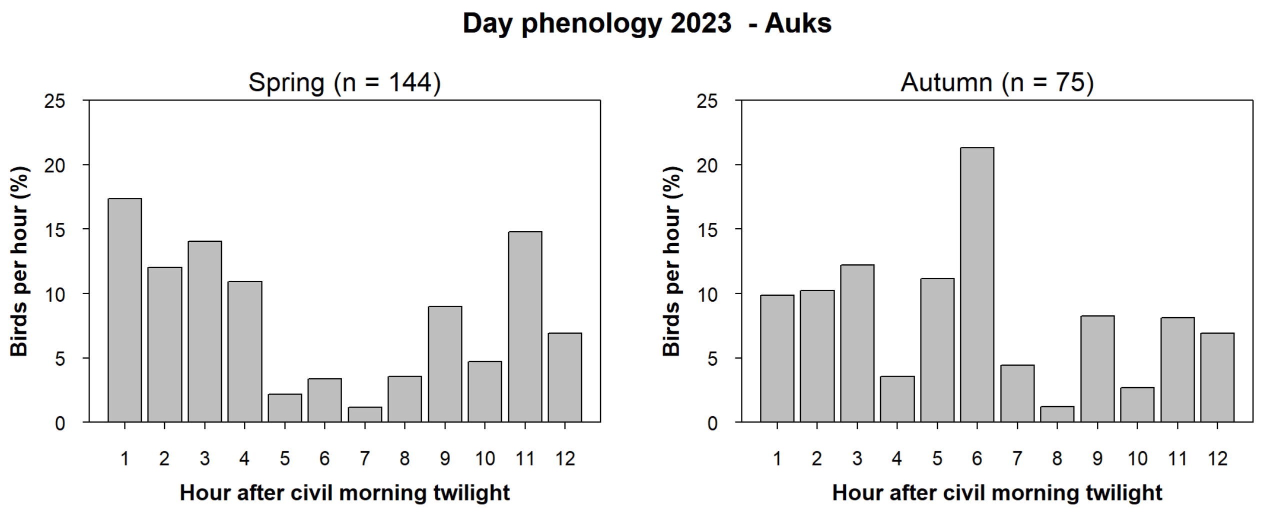


Figure 5-132 Diurnal phenology of auks in spring and autumn 2023 at the pre-investigation area KF II OWF N. See Figure 5-38 for details.

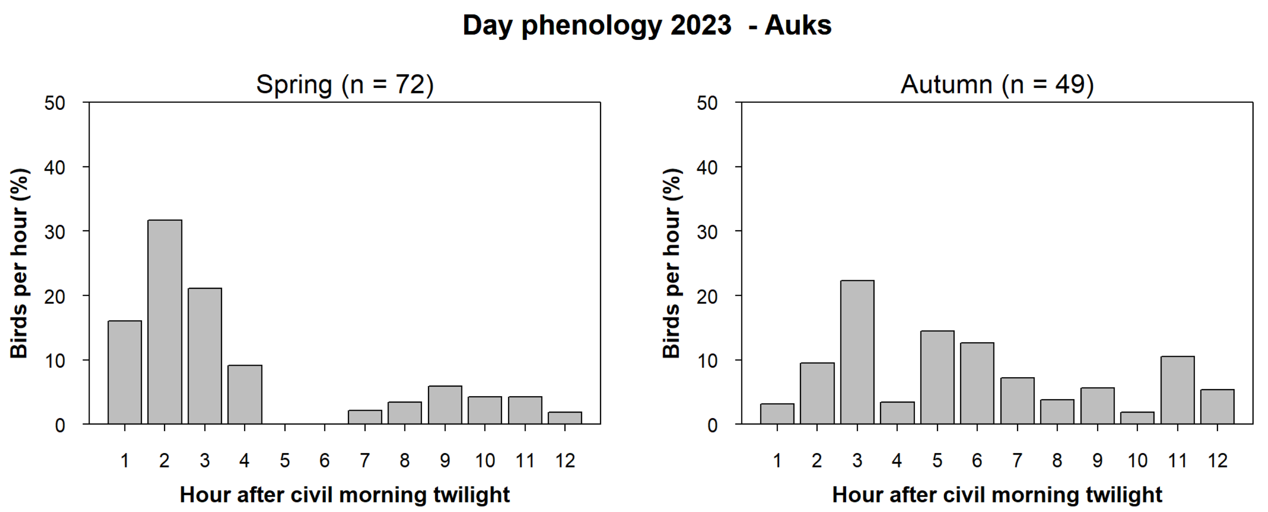


Figure 5-133 Diurnal phenology of auks in spring and autumn 2023 at the pre-investigation area KF II OWF S. See Figure 5-38 for details.

SONGBIRDS

Songbirds were more abundant in the southern area than in the northern area. In the northern area, songbirds made up for 3.3% and 12.4% of all migrating birds in spring and autumn respectively. In the southern area, they made up for 1.5% and 12.4% of all migrating birds in spring and autumn.

Similar numbers of species were found at both areas, with slightly more in the southern area (36 species for the two seasons vs. 30 species in both seasons at the northern area). A relatively large proportion of the species could not be determined to species level and this proportion was larger for spring (45% and 38% of all individuals at the northern and southern area respectively) than in autumn (30% and 24% in the northern and southern area respectively).

During the spring migration, not a single species was particularly abundant or dominant. In the northern area, the most common species were: the white wagtail / pied wagtail, the Eurasian siskin, the sky lark and the barn swallow (0.34%, 0.24%, 0.23% and 0.23% of all migrating birds), whereas in the southern area two species were more common but also not dominant: the barn swallow and the meadow pipit (0.17% and 0.15% of all migrating birds).

In autumn, these species were much more abundant and thus contributed with a higher proportion to the total of songbirds observed: sky larks represented 3.7%, barn swallows and Eurasian siskin 1.4% and 1.3% of all migrating birds in the northern area respectively. In the southern area, common starlings were the most abundant species in autumn and represented 3.1% of all migrating birds while Eurasian siskin and sky larks represented 2.5% and 1.7% of all migrating birds respectively.

Mean migration intensity was at similar ranges in spring at both areas. Slightly higher values were seen though in the southern area, but values remained at the same order of magnitude, with means being 2.4 and 5.4 ind./h in the northern and southern area, respectively and the maximum peaks taking place during the third week of April, with 19.5 ind./h and 27.7 ind./h in the northern and southern area, respectively (Figure 5-134, Figure 5-135). In autumn, values were much larger, with mean value being 10.7 ind./h and 44 ind./h in the northern and southern area respectively. Then, the peaks were 72.5 ind./h and 120.9 ind./h in those same areas (Figure 5-134, Figure 5-135).

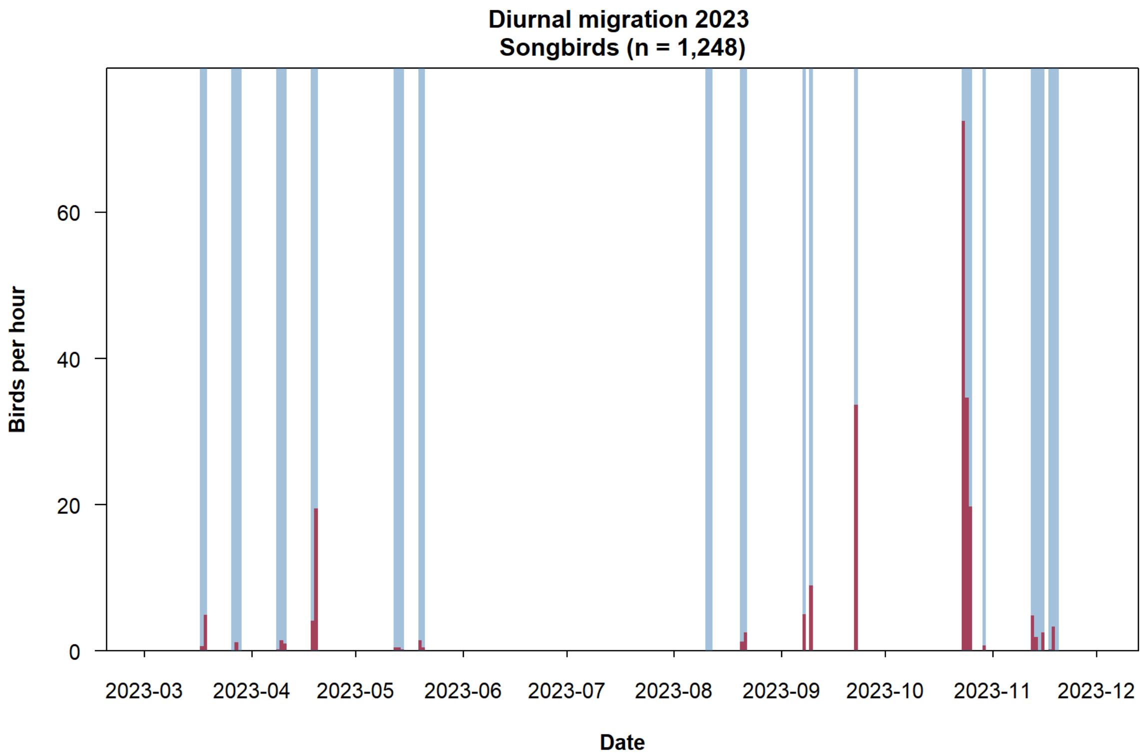


Figure 5-134 Diurnal migration intensity of songbirds in 2023 at the pre-investigation area KF II OWF N. See Figure 5-32 for details.

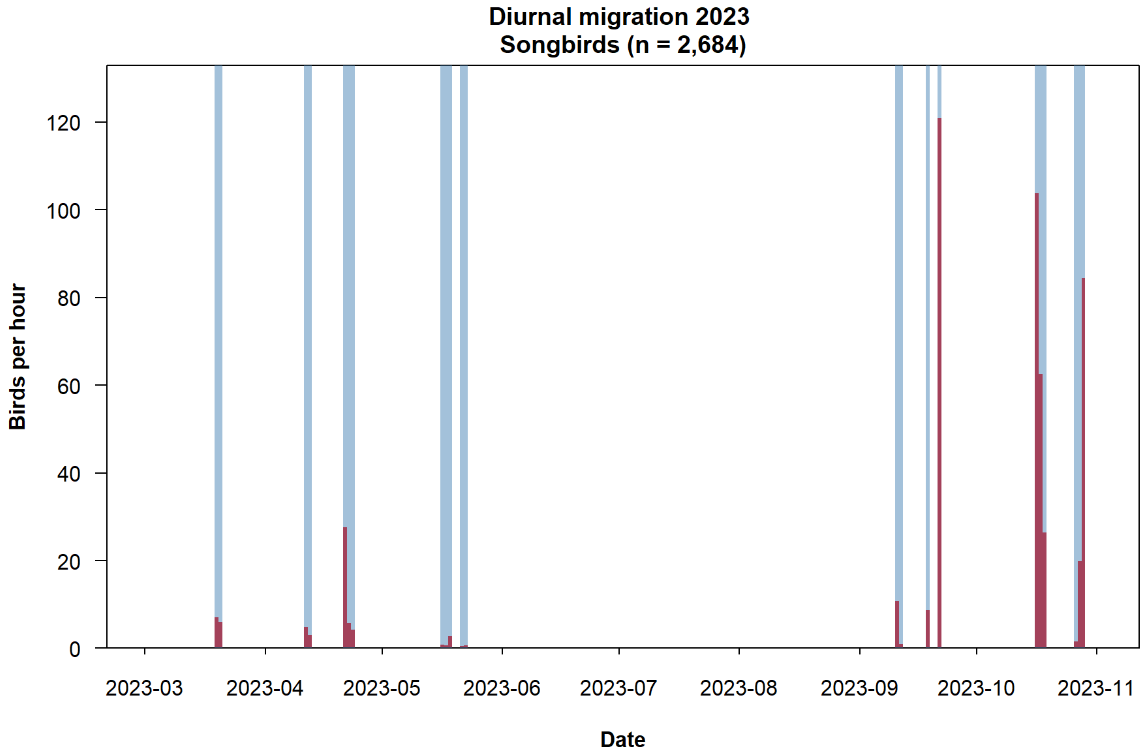


Figure 5-135 Diurnal migration intensity of songbirds in 2023 at the pre-investigation area KF II OWF S. See Figure 5-32 for details.

Songbirds were by far the most abundant group of birds migrating during the night, according to the analysis of nocturnal flight calls. They typically represented over 90% of all night calls, only in spring at the northern area they contributed to only 67.5% of all calls heard (see previous section). During nocturnal migration, songbird calls were divided into two groups: thrushes, *Turdus* spp. and all other songbirds. Thrushes were the most commonly occurring group, except during autumn at the southern area, where all other songbirds made up over 80% of all migrating calls. In general, four species of songbirds dominated at all times, although their abundance varied with season and area. These were the European robin (a non-thrush species) and three thrushes: song thrush, redwing and the common blackbird. In the northern area, the species are listed in terms of abundance during both seasons: redwings were the most commonly occurring species in both seasons (27.2% in spring, and 40.2% in autumn), whereas song thrush the least abundant and at similar levels between seasons (6.9% and 7.4% in spring and autumn respectively). European robins were the second most abundant species in spring (17.2%), but the third most common in autumn (10.2%), whereas calls of common blackbirds made up for the second most common calls in autumn at the (25.2%) and the third most common in spring (15.2%). In the southern area, these species were also common. In spring, however, Song thrush was the most common species representing 30.4% of all calls. Common blackbirds (23.9%), European robins (17.9%) and redwings (16.8%) followed in numbers. In autumn, calls of European robins were dominant (68.5%) followed by those of the redwing (9.4%), song thrush (4.2%) and common blackbird (2.6%). In addition, sky larks were relatively common in this season (3.4%).

Mean migration intensity and maximum peak values were larger in all cases during autumn, when considering songbirds together (Figure 5-136). Thrushes however, had similar peaks in spring and autumn in the southern area. Most songbirds peaked in spring in the third week of March (18. – 20.03). In autumn, when most of the songbirds were heard depended on the group. Thrushes were mostly heard and peaked at the end of the autumn season, whereas the group of other songbirds peaked between September 7th and 10th. The peak of non-thrushes was especially high in the southern area (almost 730 calls/h).

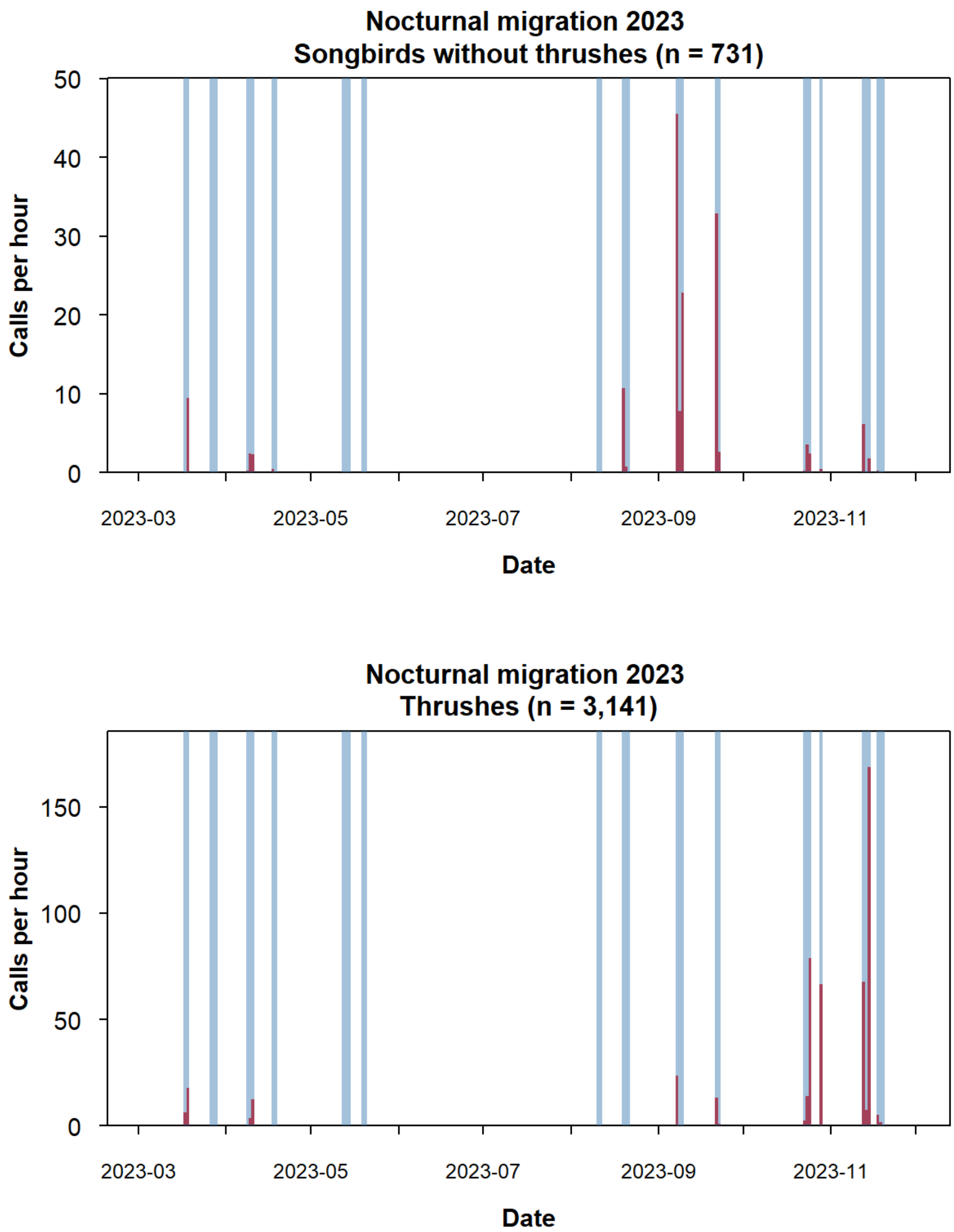
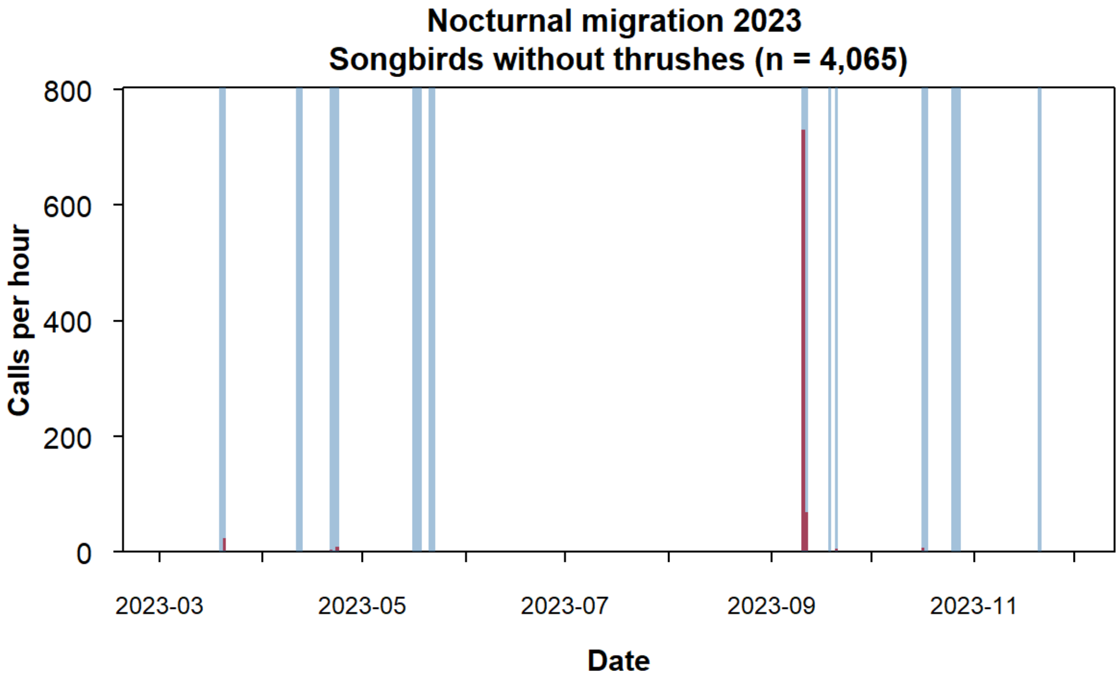


Figure 5-136 Nocturnal migration intensity of songbirds in 2023 at the pre-investigation area KF II OWF N. Calls from the large groups of passerines are often divided into thrushes (*Turdus* spp.) and all other songbirds. See Figure 5-42 for details.



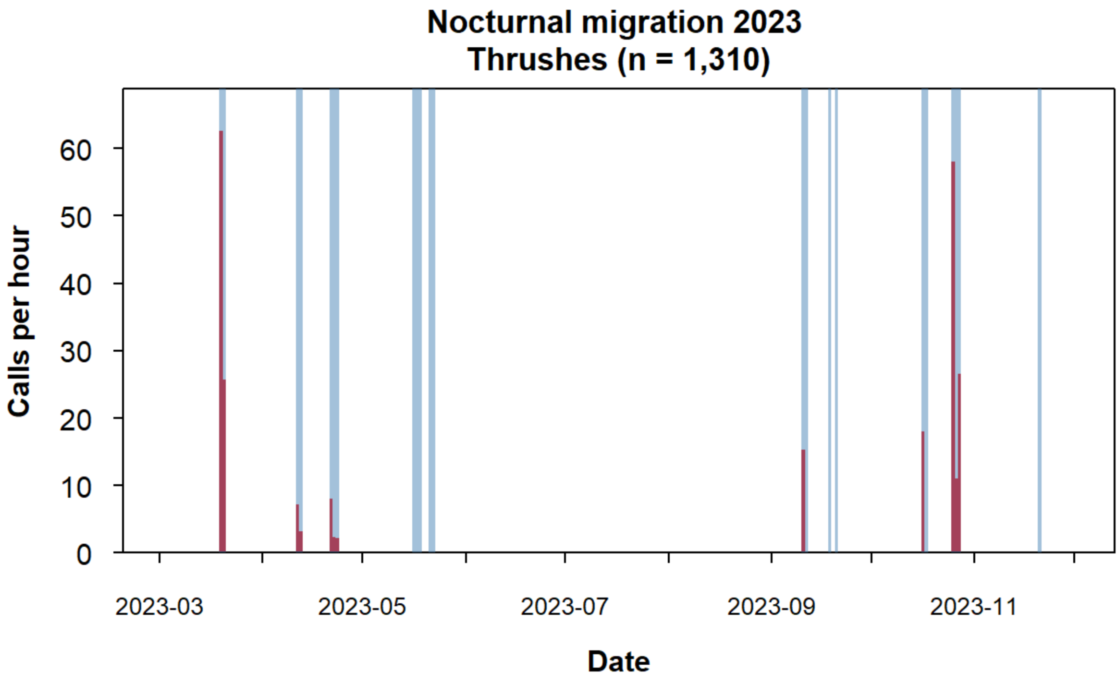


Figure 5-137 Nocturnal migration intensity of songbirds in 2023 at the pre-investigation area KF II OWF S. Calls from the large groups of passerines are often divided into thrushes (*Turdus* spp.) and all other songbirds. See Figure 5-42 for details.

Most diurnally migrating songbirds flew at very low altitudes (0 - 5 m), and still a considerable proportion (varying between 14% and 35%) flew at altitudes up to 50 m (Figure 5-138 and Figure 5-139). Only in autumn in the KF II S, there was a relatively large proportion of songbirds observed flying between 50 and 100 m (20.7%)

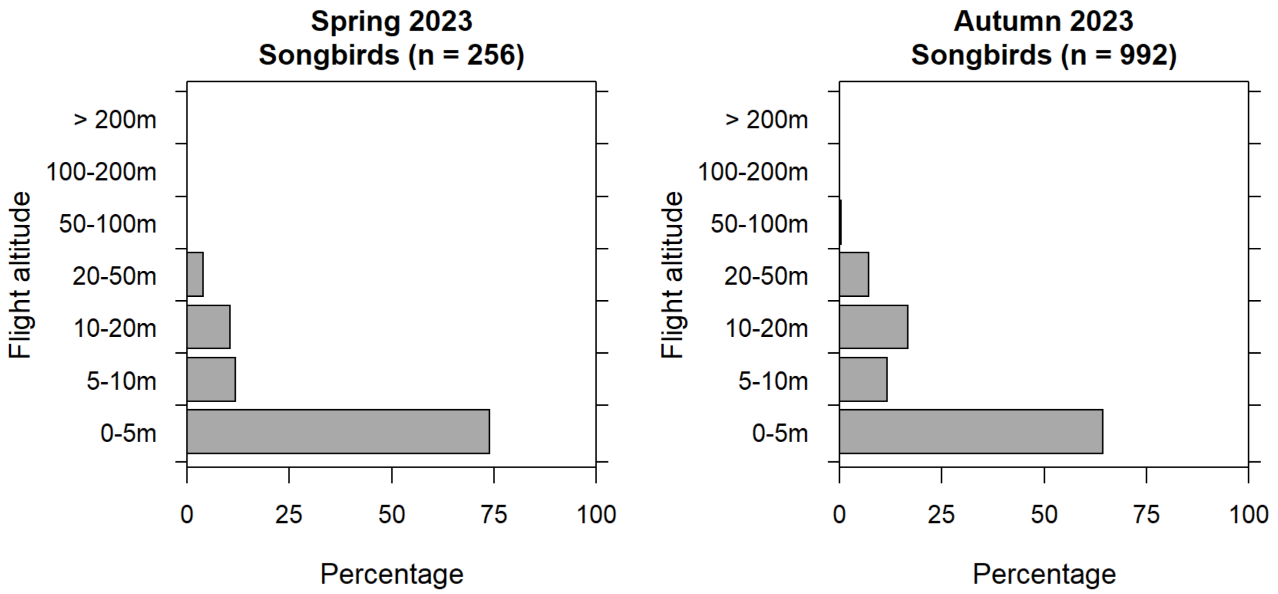


Figure 5-138 Flight altitude distribution of songbirds during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-35 for details.

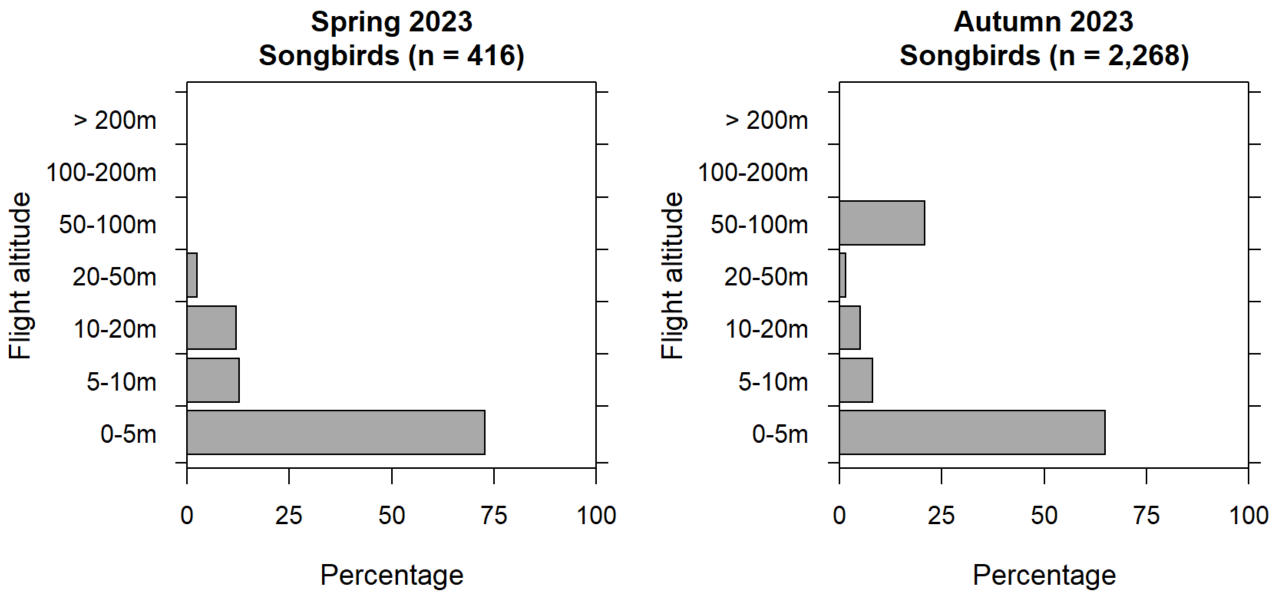


Figure 5-139 Flight altitude distribution of songbirds during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-35 for details.

In spring, flying directions differed between the areas, with the most common direction being the N in the northern area (42.9%) and an additional 24% and 19.3% of the birds flying to the NE and the NW, respectively. In the southern area,almost 60% of all songbirds flew in a NE direction. In autumn, the most common direction was SW followed by the S in both areas (Figure 5-140 and Figure 5-141).

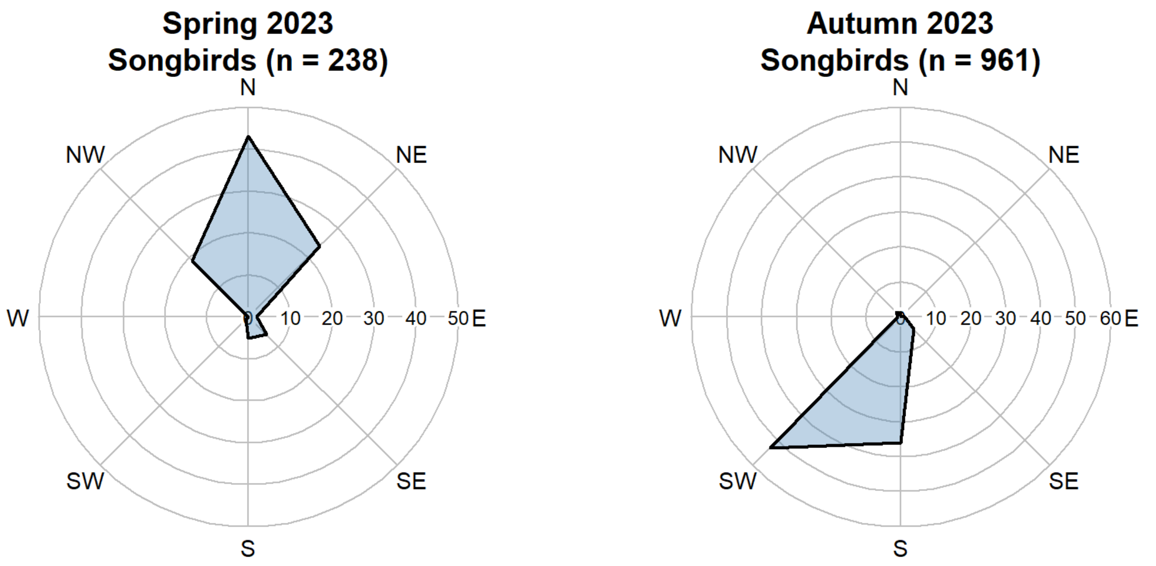


Figure 5-140 Flight direction of songbirds during visual observations in 2023 at the pre-investigation area KF II OWF N. See Figure 5-36 for details.

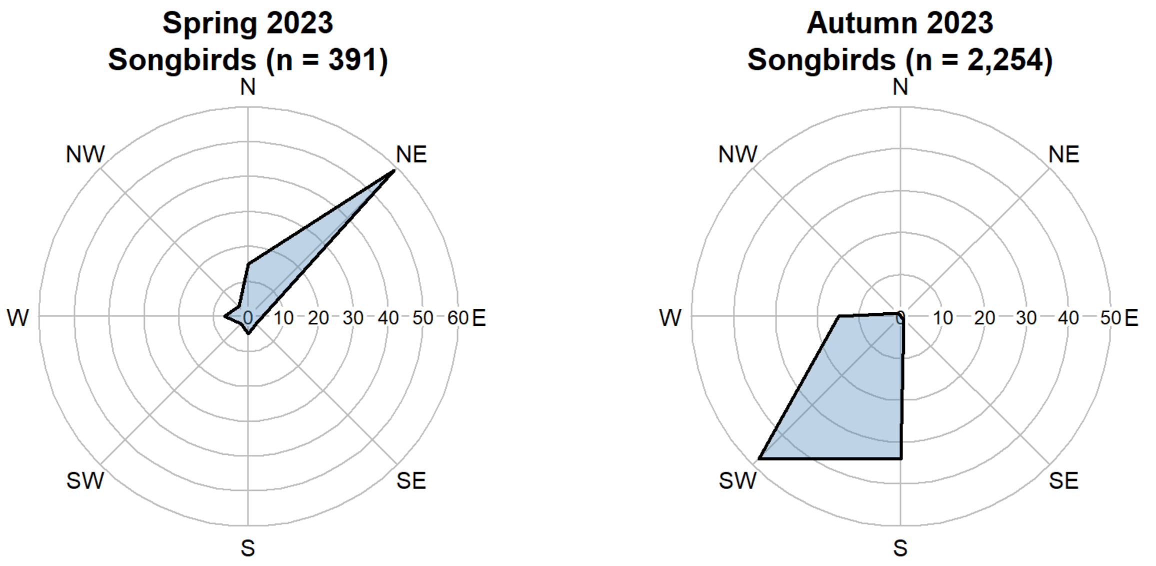


Figure 5-141 Flight direction of songbirds during visual observations in 2023 at the pre-investigation area KF II OWF S. See Figure 5-36 for details.

During diurnal migration, songbirds flew more often during the first six hours of the day, and this pattern was true for both seasons at both areas. Most songbirds flew between 3 and 5 hours after civil morning twilight in spring and autumn of the northern area as well as spring of the southern area. In autumn, at the southern area, most songbirds flew between 2 and hours after civil morning twilight. Very few songbirds flew after the 7th hour of the day (Figure 5-142, Figure 5-143).

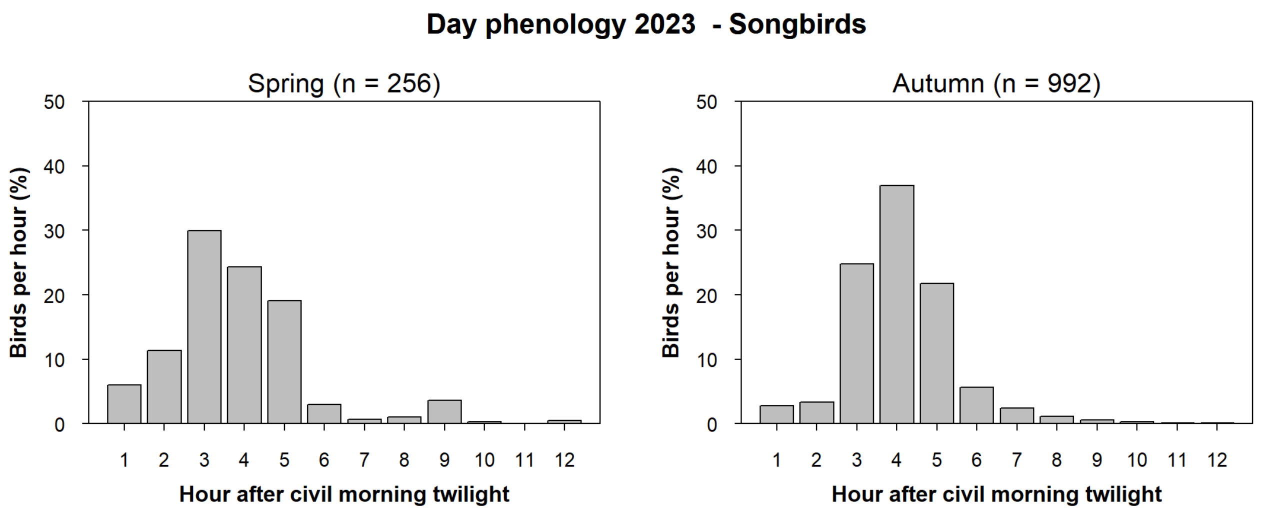


Figure 5-142 Diurnal phenology of songbirds in spriing autumn 2023 at the pre-investigation area KF II OWF N. See Figure 5-38 for details.

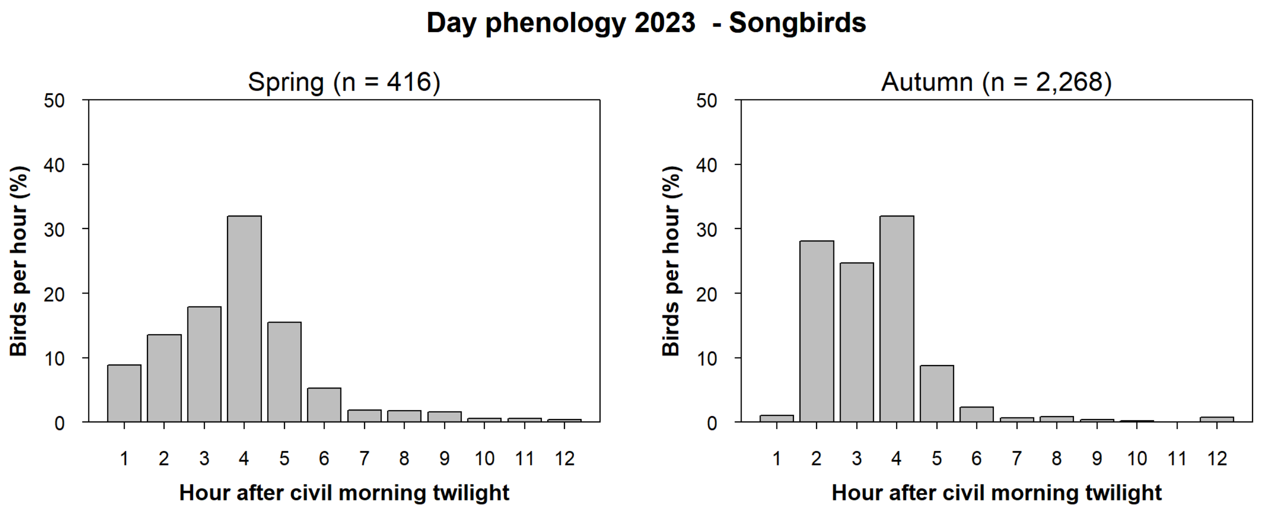


Figure 5-143 Diurnal phenology of songbirds in spring autumn 2023 at the pre-investigation area KF II OWF S. See Figure 5-38 for details.

In spring, both groups of songbirds tended to fly more often towards the middle of the night with peaks observed at 6 hours after civil evening twilight in all areas and both groups. Also, almost no birds were heard in the very first hours of the night. In autumn, the migration pattern of songbirds was different for the group of thrushes and the other songbirds. Although songbirds were heard during all night, thrushes appeared to fly more often during the first six hours of the night in both areas. The other songbirds either do not show a pattern (the northern area) or appeared to progressively be flying more often towards the late night in the southern area (Figure 5-144 and Figure 5-145).

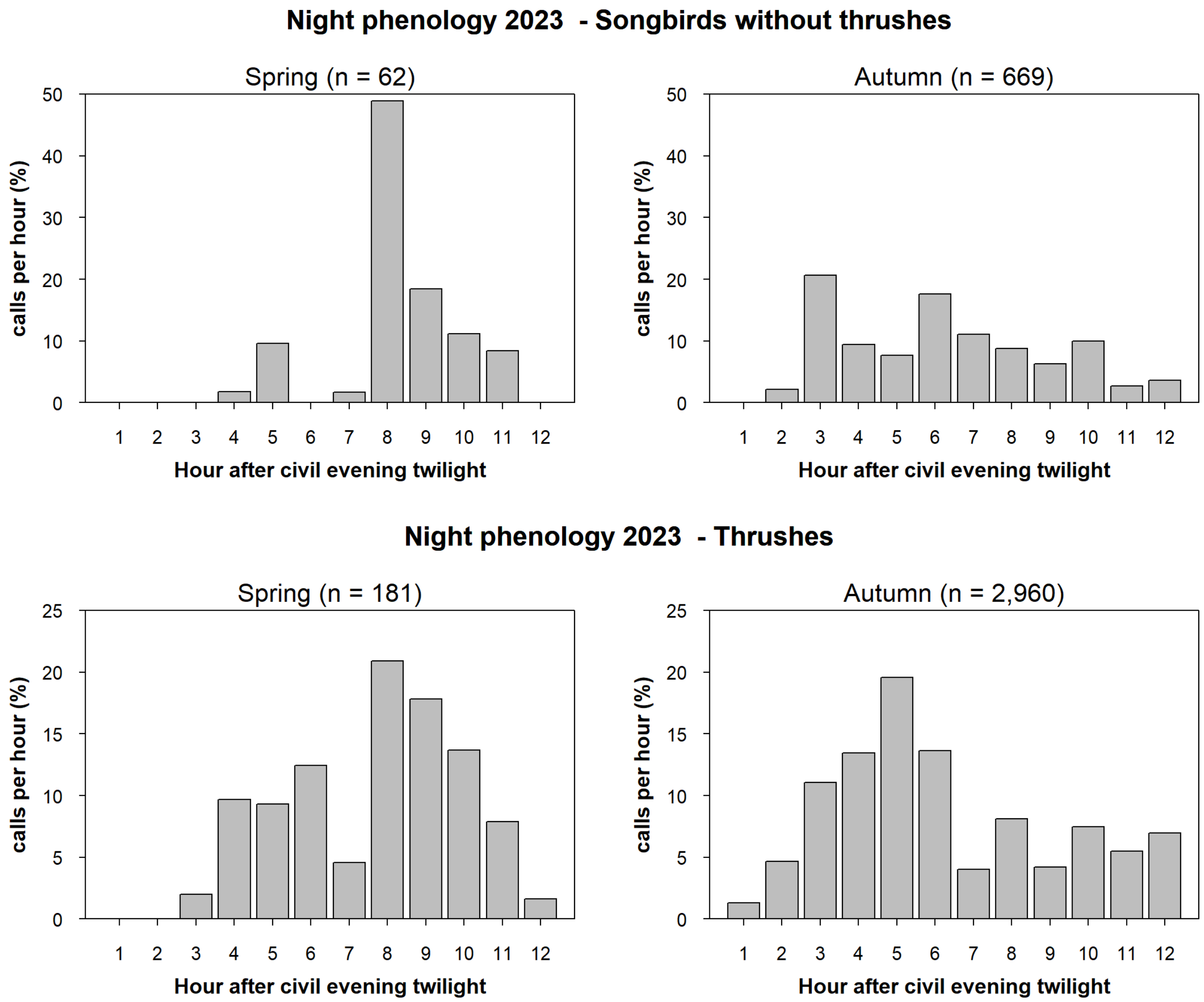


Figure 5-144 Nocturnal phenology of songbirds (separated into two groups: only thrushes, Turdus spp., and all other songbirds) in spring autumn 2023 at the pre-investigation area KF II OWF N. See Figure 5-38 for details.

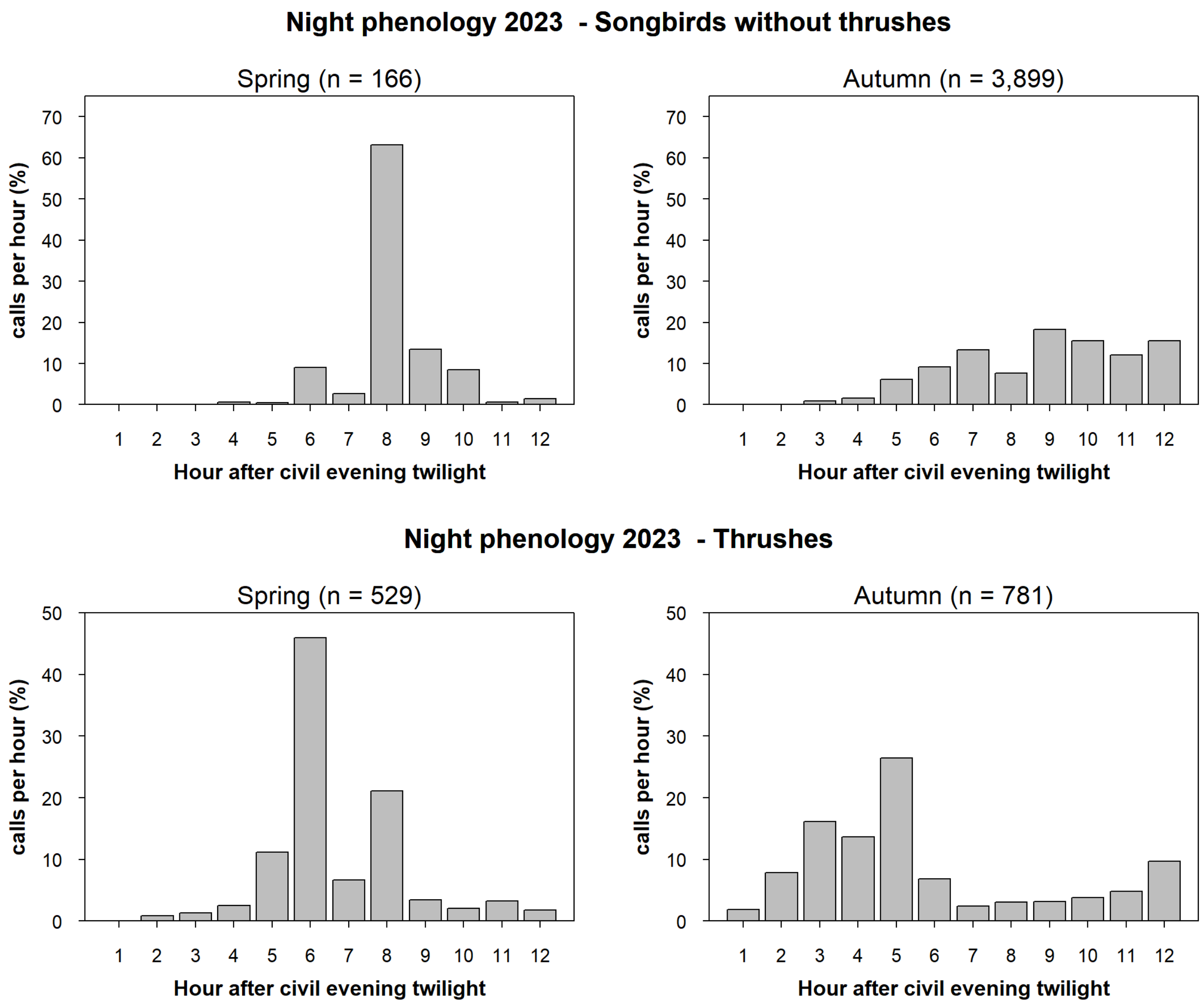


Figure 5-145 Nocturnal phenology of songbirds (separated into two groups: only thrushes, Turdus spp., and all other songbirds) in spring autumn 2023 at the pre-investigation area KF II OWF S. See Figure 5-38 for details.

5.2.2 HORIZONTAL AND VERTICAL RADAR

MIGRATION INTENSITY

KF II OWF N

In the KF II OWF N pre-investigation area, 35 observation days were carried out in accordance with the planned scope. A total of 31 days and 30 nights with analysable vertical radar signals (without interference from rain or excessive swell) could be used to calculate the average migration intensities (see Table 5-11), which corresponds to a proportion of >85% analysable data and is therefore above the expected 75% threshold (see also StUK 4, BSH 2013). In spring, mean migration intensity during daytime was 54.5 MTR (signals/(km*h) and 348.2 MTR during nights (Table 5-11). Migration intensity was higher in the middle of the spring season with the highest mean migration taking place in April (60.6 MTR and 479.7 MTR, for days and nights, respectively), due to a high migration event on the 10th of April (184.1 MTR, Figure 5-146 for days, 1,102.9 MTR, Figure 5-147 for nights). A second large peak (1,011.8 MTR) occurred just on the previous night (9th of April, Figure 5-147).

In autumn, mean migration intensity during days was on a similar level as in spring: 52.0 MTR with the maximum migration taking place in November (40.1 MTR) when the maximum value occurred on the 27th of November (83.7.3 MTR, Figure 5-146). Mean migration intensity during nights was also larger, but not as large as during spring (187.2 MTR). The highest migration intensity during nights in autumn occurred at the start of the season in August (301.8 MTR) and the maximum peak migration event was 654.5 MTR which occurred on the night of the 20th of August (Figure 5-147).

Table 5-11. Monthly and seasonal diurnal and nocturnal migration rates (MTR) calculated from vertical radar in spring and autumn 2023 at the pre-investigation area KF II OWF N.

2023	Diurnal migration (MTR)				Nocturnal migration (MTR)			
	Mean (± SE)	Median	Maximum	Number of days	Mean (± SE)	Median	Maximum	Number of nights [planned]
March	58.5 (± 20.4)	44.5	137.1	5	206.3 (± 69.8)	65.8	670.6	5
April	60.6 (± 31.1)	33.3	184.1	5	479.7 (± 123.5)	101.3	1102.9	5
May	44.5 (± 12.4)	32.6	80.5	5	358.7 (± 236.3)	259.1	753.2	5
Spring	**54.5 (± 12.3)**	**33.3**	**184.1**	**15**	**348.2 (± 93.4)**	**240.4**	**1102.9**	**15 [15]**
August	35.9 (± 12.7)	43.2	75.3	5	301.8 (± 106.4)	241.6	654.5	5
September	45.0 (± 8.4)	43.8	63.6	4	118.7 (± 21.9)	129.2	186.8	5
October	26.6 (± 9.7)	26.6	36.3	2	102.6 (± 28.2)	102.6	130.8	2
November	83.7 (± 15.4)	95.0	108.6	5	166.7 (± 70.2)	198.1	269.4	3
Autumn	**52.0 (± 8.4)**	**44.0**	**108.6**	**16**	**187.2 (± 42.1)**	**135.3**	**654.5**	**15 [20]**

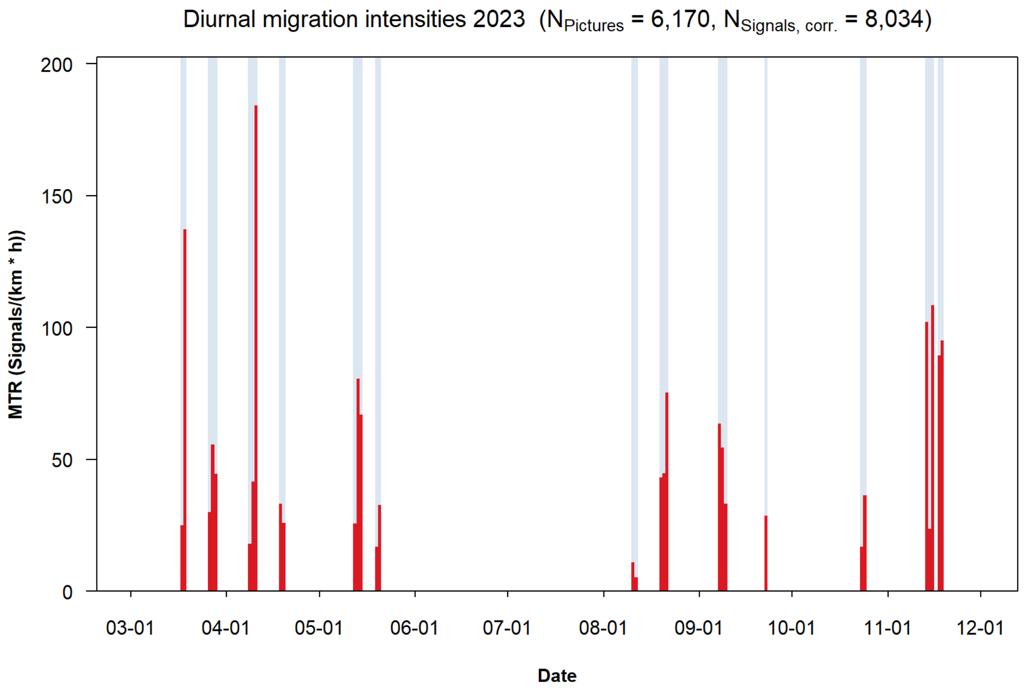


Figure 5-146 Diurnal migration intensity in spring and autumn 2023 based on daily migration traffic rates (MTR) calculated from the vertical radar at the pre-investigation area KF II OWF N. MTR is specified as radar signals per km and hour (up to 1,000 m altitude). Areas highlighted in light grey indicate the survey days.

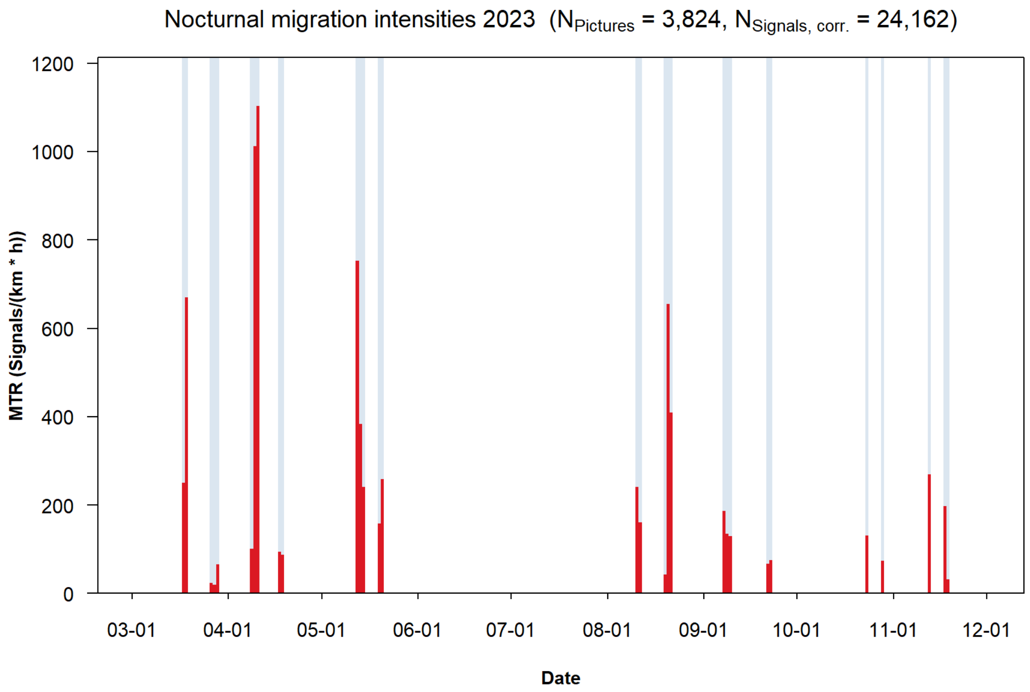


Figure 5-147 Nocturnal migration intensity in spring and autumn 2023 based on daily migration traffic rates (MTR) calculated from the vertical radar at the pre-investigation area KF II OWF N. Note the different y-axis scale, when comparing with diurnal migration intensity.

KF II OWF S

In the KF II OWF N pre-investigation area, 22 full 24h-observation days were planned according to the scope. A total of 23 days and 19 nights with analysable vertical radar signals (without interference from rain or excessive swell) could be used to calculate the average migration intensities (see Table 5-12), which corresponds to a proportion of >85% analysable data. In spring, mean migration intensity during daytime was larger than at KF II OWF N both during days (89.0 MTR, signals/(km*h)) and during nights (636.8 MTR, Table 5-12). Diurnal migration intensity was higher in March (133.1 MTR), due to a high migration event on the 19th of March (254.0 MTR, Figure 5-148). Nocturnal migration was higher in the middle of the spring season (April: 1244.9 MTR) when a very large peak migration took place (2,305.7 MTR) on the night of 22nd of April (Figure 5-149).

In autumn, mean migration intensity during days was half of that in spring and thus similar to the area KF II OWF N: 44.3 MTR with the maximum migration taking place in September (56.3 MTR) when the maximum value occurred on the 10th of September (103.3 MTR, Figure 5-148). Mean migration intensity during nights was also larger compared to days, but significantly lower than during spring and also lower than nocturnal migration at KF II OWF N (112.9 MTR). The highest migration intensity during nights in autumn occurred also at the start of the season in September (153.3 MTR) and the maximum peak migration event was 418.1 MTR which occurred on the night of the same date as the highest diurnal migration (10th of September, Figure 5-149).

Table 5-12. Monthly and seasonal diurnal and nocturnal migration rates (MTR) calculated from vertical radar in spring and autumn 2023 at the pre-investigation area KF II OWF S.

2023	Diurnal migration (MTR)				Nocturnal migration (MTR)			
	Mean (± SE)	Median	Maximum	Number of days	Mean (± SE)	Median	Maximum	Number of nights [planned]
March	133.1 (± 120.9)	133.1	254.0	2	387.2	387.2	387.2	1
April	128.0 (± 31.9)	131.0	237.7	5	1244.9 (± 371.2)	1006.6	2305.7	4
May	32.4 (± 12.3)	21.8	77.9	5	200.2 (± 73.6)	209.5	425.7	5
Spring	**89.0 (± 24.6)**	**64.8**	**254.0**	**12**	**636.8 (± 217.5)**	**406.4**	**2305.7**	**10 [10]**
September	56.3 (± 16.7)	45.0	103.3	4	153.3 (± 88.4)	71.4	418.1	4
October	34.7 (± 8.0)	32.8	64.1	5	96.0 (± 34.3)	70.5	197.3	4
November					18.8	18.8	18.8	1
Autumn	**44.3 (± 8.9)**	**33.3**	**103.3**	**9**	**112.9 (± 41.6)**	**68.2**	**418.1**	**9 [12]**

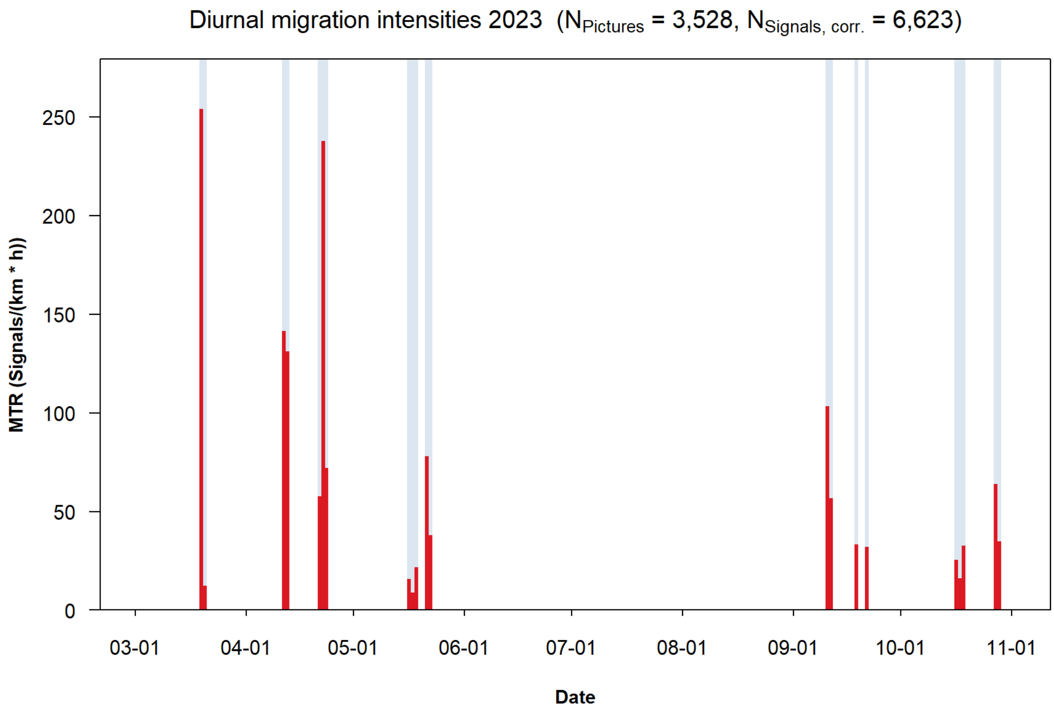


Figure 5-148 Diurnal migration intensity in spring and autumn 2023 based on daily migration traffic rates (MTR) calculated from the vertical radar at the pre-investigation area KF II OWF S. MTR is specified as radar signals per km and hour (up to 1,000 m altitude). Areas highlighted in light grey indicate the survey days.

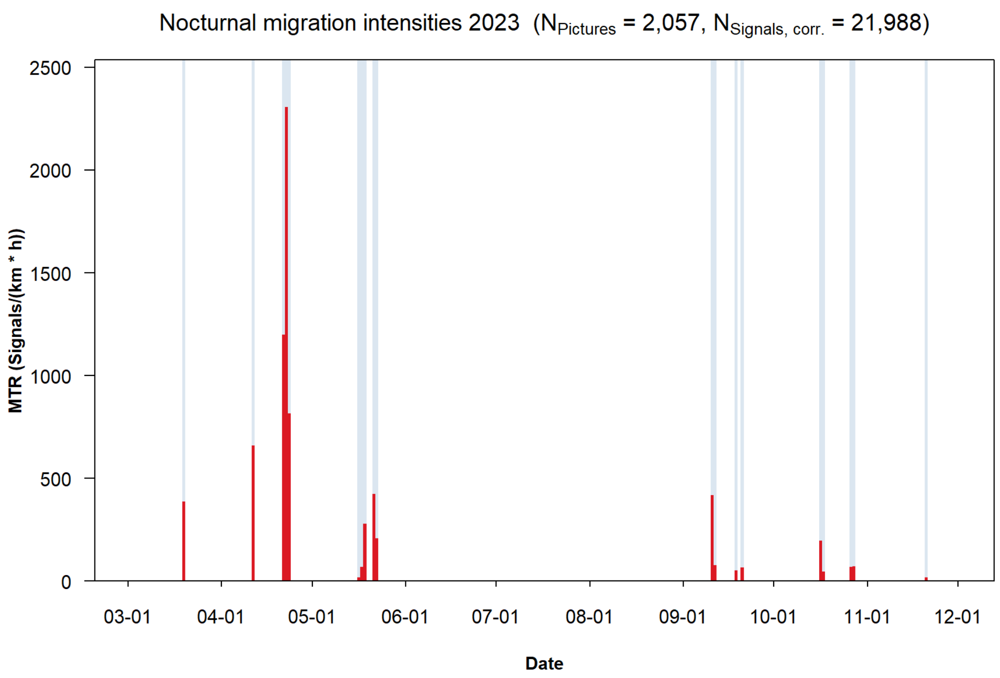


Figure 5-149 Nocturnal migration intensity in spring and autumn 2023 based on daily migration traffic rates (MTR) calculated from the vertical radar at the pre-investigation area KF II OWF S. Note the different y-axis scale, when comparing with diurnal migration intensity.

FLIGHT ALTITUDE

KF II OWF N

For the plotting of altitude distribution all vertical radar signals were used, also from day and nights with less than 70 % of analysable data. Bird signals obtained from vertical radar data (up to 1,000 m altitude), showed a different vertical distribution between diurnal and nocturnal migration (Figure 5-150, Figure 5-151). During daytime, the majority of signals (34% and 39% in spring and autumn, respectively) was detected in the very first 100 metres above the water surface. Above this layer, a moderate decline of bird activity with increasing altitude occurred, reaching from 9% and 14% of signals at 100-200 m in spring and autumn, respectively to less than 8% at all higher layers in both seasons. Only in spring, a slight increase was observed again at the highest altitude layer of altitude (900-1,000 m altitude, 11%). Nocturnally detected bird signals were more evenly spread over the whole altitude range. In spring, the proportion of signals at each 100 m layer varied between 8% at the 100 – 200 m layer to 13% at the highest altitude layer (900 – 1000 m, Figure 5-150). In autumn, the first 100 m of altitude contained the highest proportions of signals (17%), with a progressive decline of the proportion of signals with increasing altitude up to about 500 – 600 m, then a slight increase in the signals was observed again up to the highest layer of altitude (900 – 1000 m, Figure 5-151).

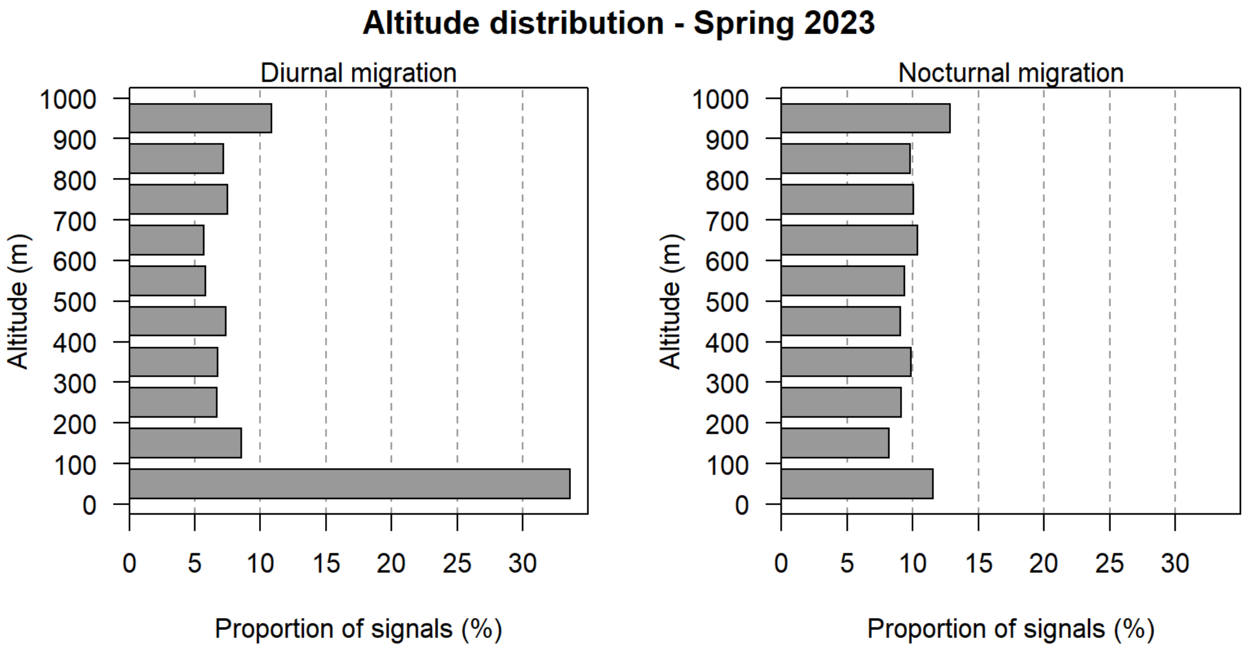


Figure 5-150 Flight altitude distribution from vertical radar data during spring at the pre-investigation area KF II OWF N. Depicted is the relative appearance of signals up to 1,000 m height in 100 m increments. The graph on the left shows the altitude distribution of birds during the daylight phase, the right graph during the night.

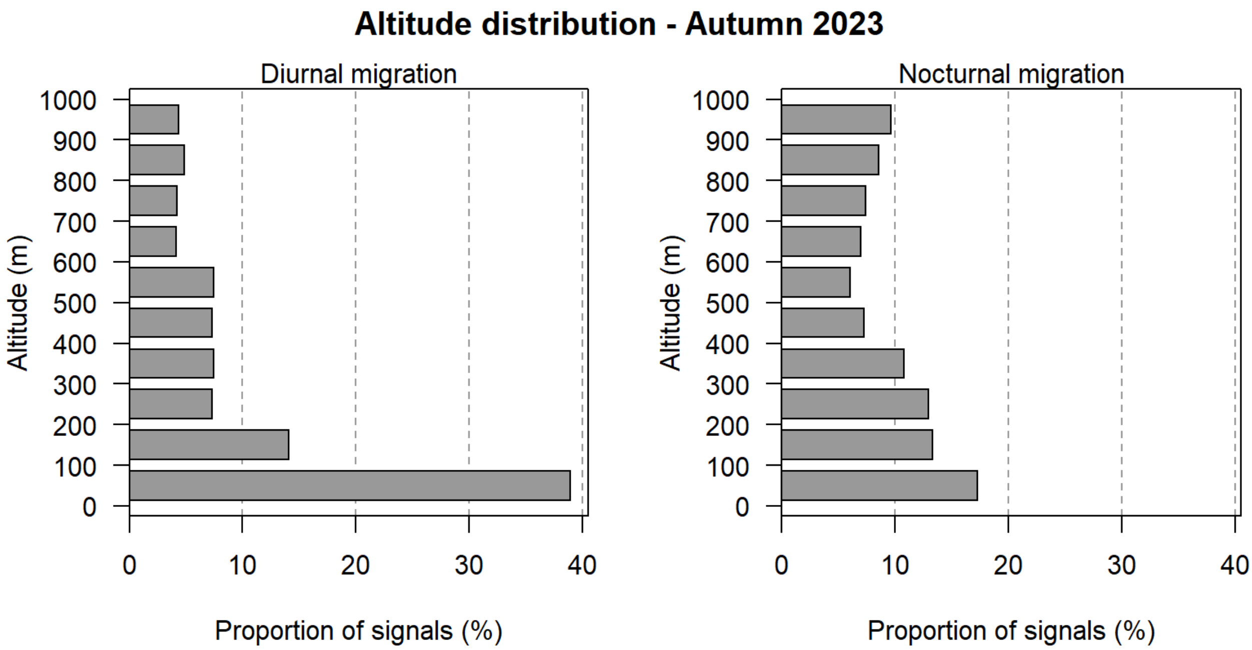


Figure 5-151 Flight altitude distribution from vertical radar data during autumn at the pre-investigation area KF II OWF N. Depicted is the relative appearance of signals up to 1,000 m height in 100 m increments. The graph on the left shows the altitude distribution of birds during the daylight phase, the right graph during the night.

KF II OWF South

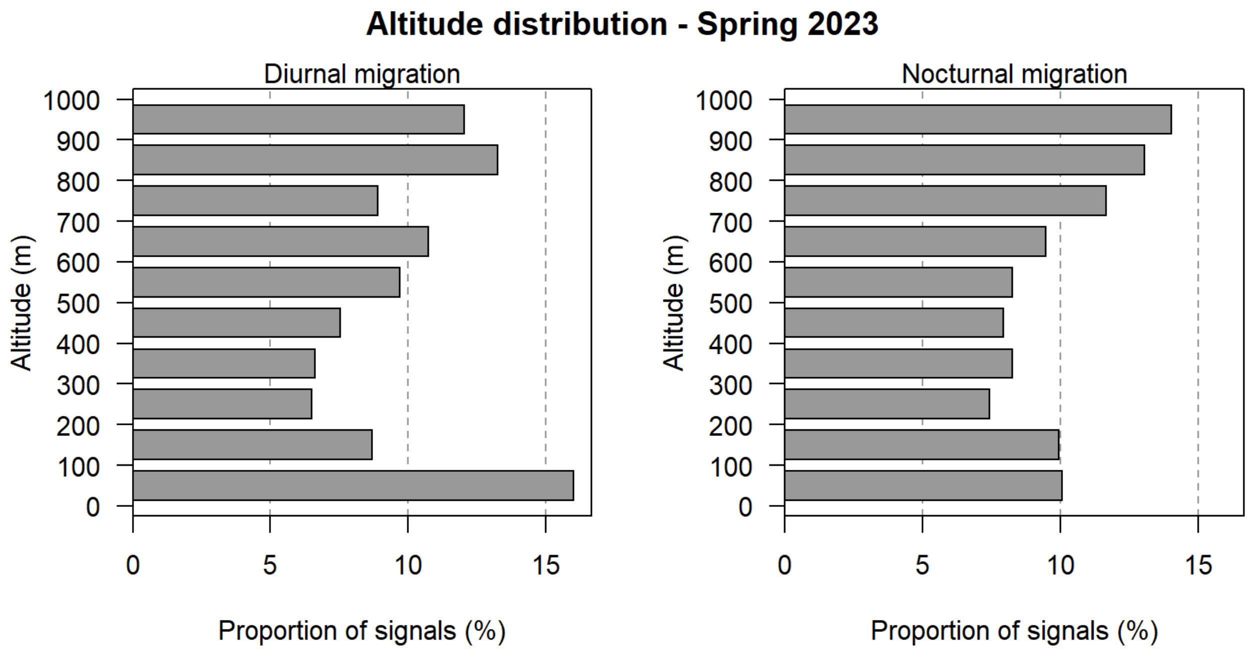


Figure 5-152 Flight altitude distribution from vertical radar data during spring at the pre-investigation area KF II OWF S. Depicted is the relative appearance of signals up to 1,000 m height in 100 m increments. The graph on the left shows the altitude distribution of birds during the daylight phase, the right graph during the night.

At the proposed KF II OWF South, vertical altitude distribution during day and night did not differ much. Whereas most of the signals were observed at the lower layer of altitude during diurnal migration in spring and autumn (> 15%, Figure 5-152 and Figure 5-153, for spring and autumn respectively), the difference between the bird signals at the lower layer and the most upper altitude layer was not striking. During nocturnal migration, a relatively similar proportion of signals were observed at all altitudes layers both in spring and autumn.

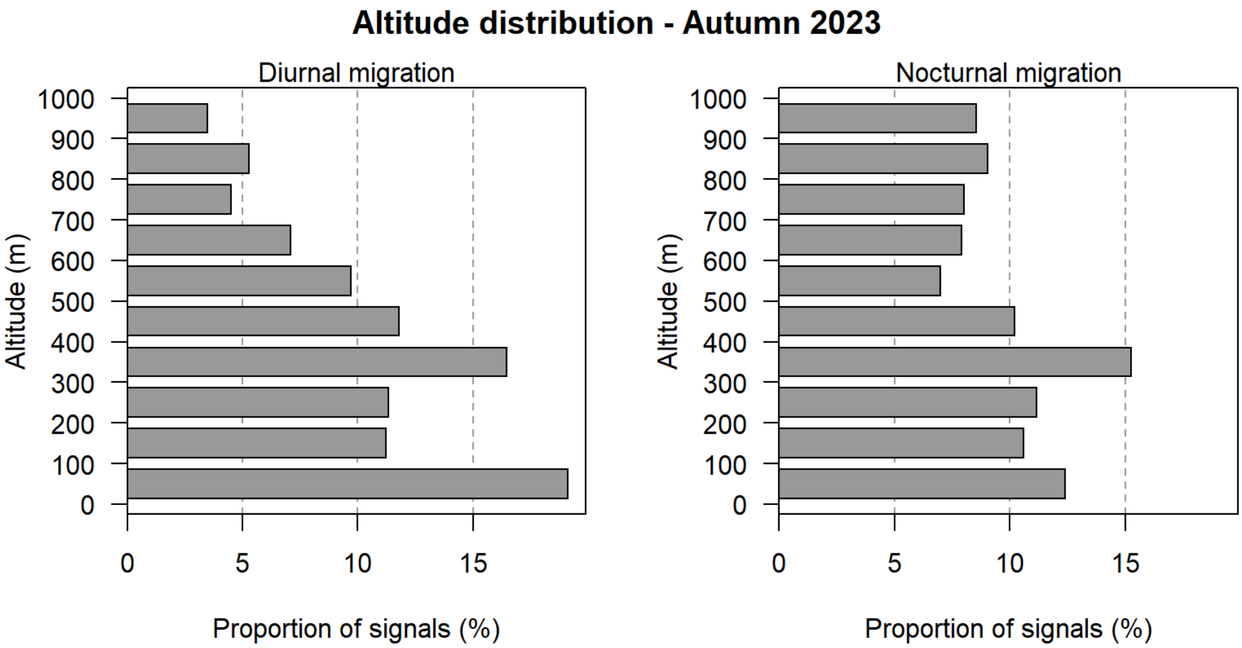


Figure 5-153 Flight altitude distribution from vertical radar data during autumn at the pre-investigation area KF II OWF S. Depicted is the relative appearance of signals up to 1,000 m height in 100 m increments. The graph on the left shows the altitude distribution of birds during the daylight phase, the right graph during the night.

TEMPORAL PATTERNS

The migration intensity considered in a course of 24 hours was very uniform in both areas and therefore the pattern is described together. Both in spring (Figure 5-154 and Figure 5-156, for the northern and southern pre-investigation areas, respectively) and autumn (Figure 5-155, Figure 5-157) a significantly higher level of migration activity was observed during the night than during the daylight phase. In the first one to five hours after sunrise, the highest migration rates were generally observed during the daylight phase, which then decreased during the course of the day and the last daylight hour was the hour with the lowest migration intensity across both seasons and areas. At night the intensity of migration was always lowest in the first hour after sunset but on average always higher in the first part of the night until midnight compared to the second part from midnight onwards when migration intensity was gradually decreasing until sunrise.

KF II OWF N

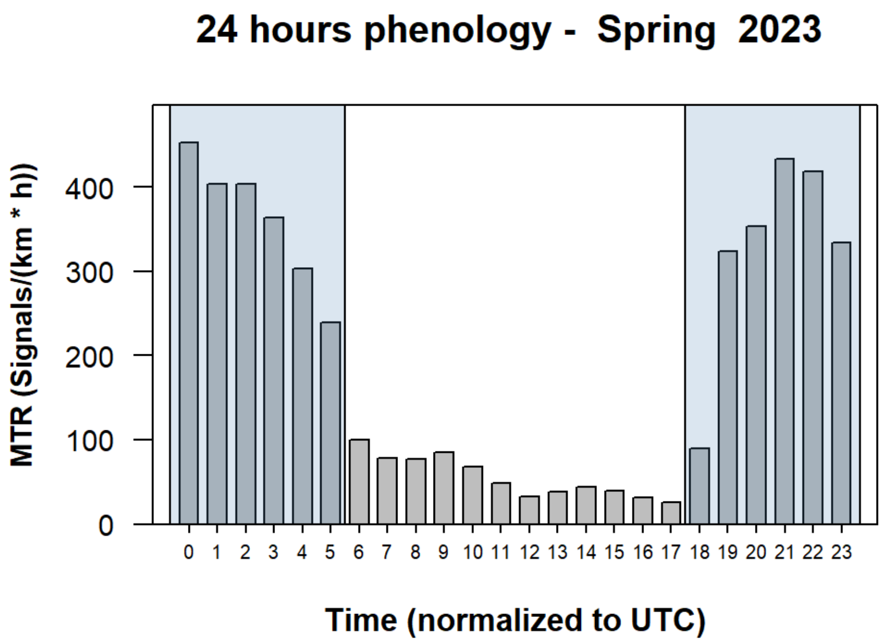


Figure 5-154 24 h migration intensity from vertical radar data in spring at the pre-investigation area KF II OWF N. As daylength varies over the year, nocturnal (blue shaded) and diurnal observations of the single survey dates are depicted stretched/compressed to a "normalised" length of 12 hours each. Time data in UTC (minus one hour compared to MET/ two hours to MEST).

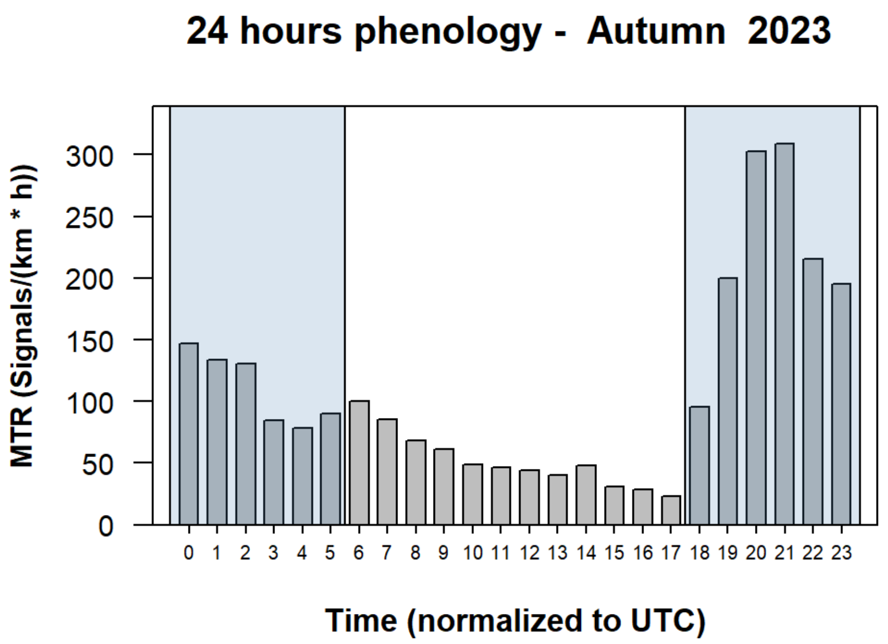


Figure 5-155 24 h migration intensity from vertical radar data in autumn at the pre-investigation area KF II OWF N See Figure 5-154 for details.

KF II OWF S

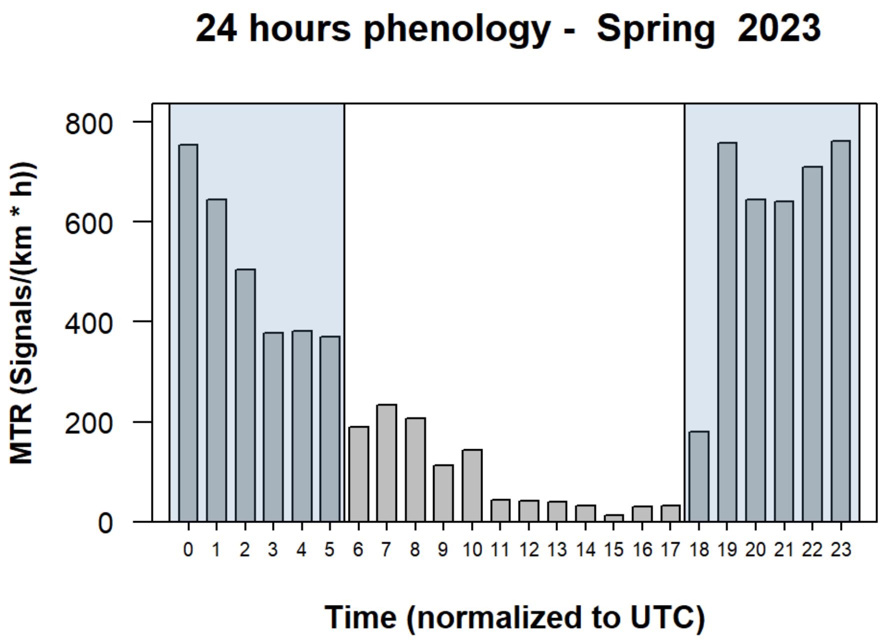


Figure 5-156 24 h migration intensity from vertical radar data in spring at the pre-investigation area KF II OWF S. See Figure 5-154 for details.

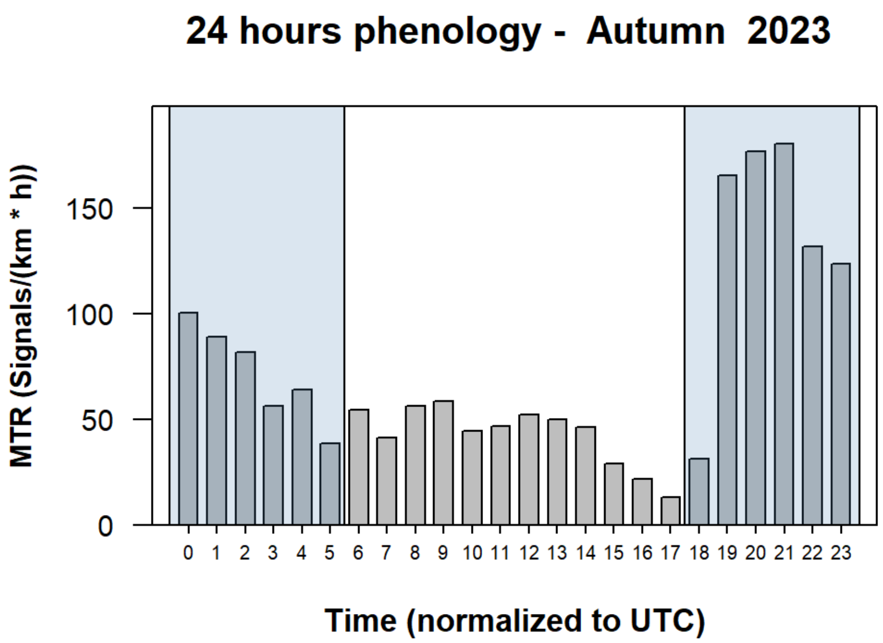


Figure 5-157 24 h migration intensity from vertical radar data in autumn at the pre-investigation area KF II OWF S See Figure 5-154 for details.

FLIGHT DIRECTIONS

Fight directions of bird signals obtained from horizontal radar indicate similar mean directions of flight for diurnal and nocturnal migration at each season and area. For instance, during spring, the mean direction of flight was 55.6° and 55.3° in the northern area (diurnal and nocturnal migration, respectively, Figure 5-158) and a bit more towards the East in the southern area (78.5° and 69.8°, diurnal and nocturnal migration, Figure 5-160). In autumn, the flying direction was almost identical in both areas for day and night: 258.7° and 258.2° in the northern area (more towards the W, Figure 5-159) and 247.5° and 250.4° for diurnal and nocturnal migration in the southern area, respectively (SWW (Figure 5-161).

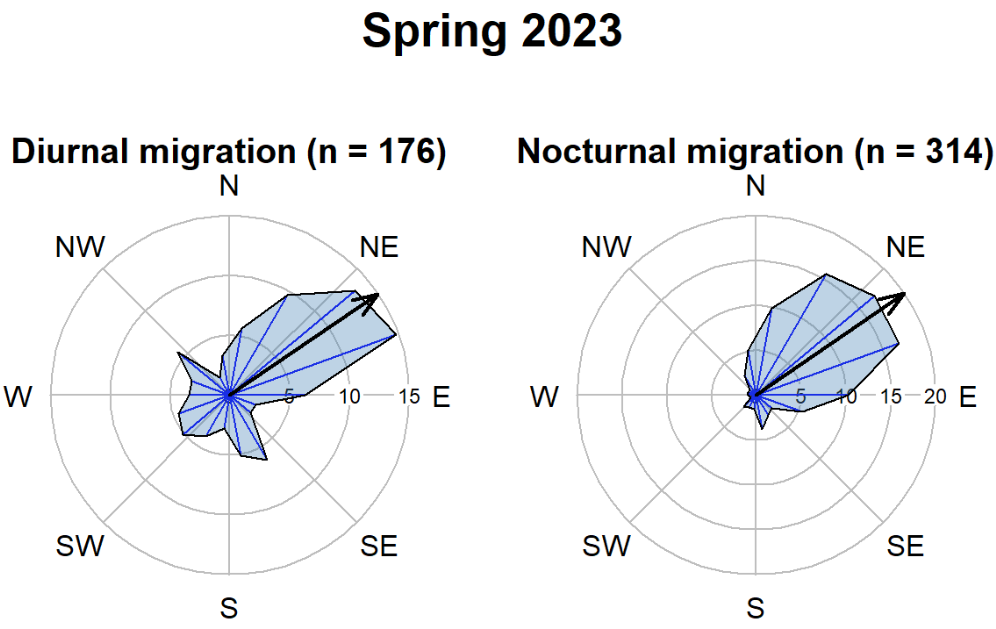


Figure 5-158 Flight direction of bird signals according to the horizontal radar shown in percentage (%) during diurnal and nocturnal migration in spring 2023 at the KF II OWF N pre-investigation area. For plotting purposes, flight directions were grouped into groups of 20° increments. Each blue line represents the middle point of the respective grouping. Black arrows indicate a statistically significant mean flight direction of all signals together.

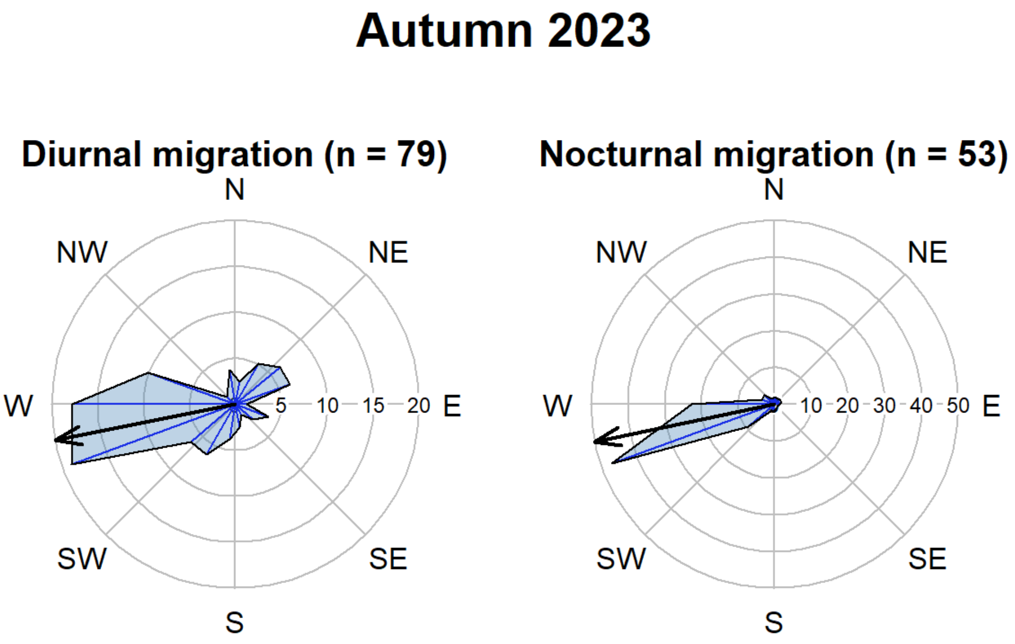


Figure 5-159 Flight direction of bird signals according to the horizontal radar shown in percentage (%) during diurnal and nocturnal migration in autumn 2023 at the KF II OWF N pre-investigation area. See Figure 5-158 for details.

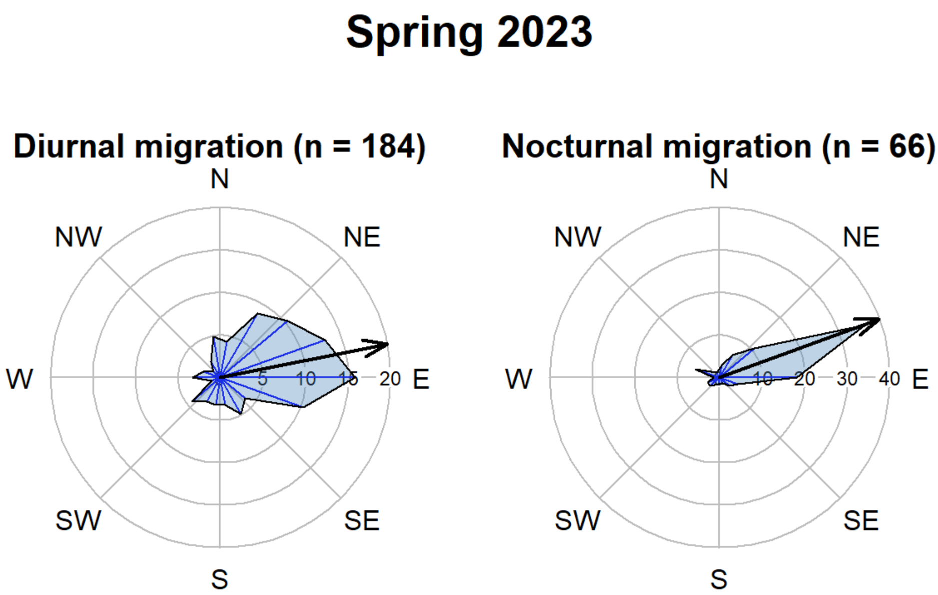


Figure 5-160 Flight direction of bird signals according to the horizontal radar shown in percentage (%) during diurnal and nocturnal migration in autumn 2023 at the KF II OWF S pre-investigation area. See Figure 5-158 for details.

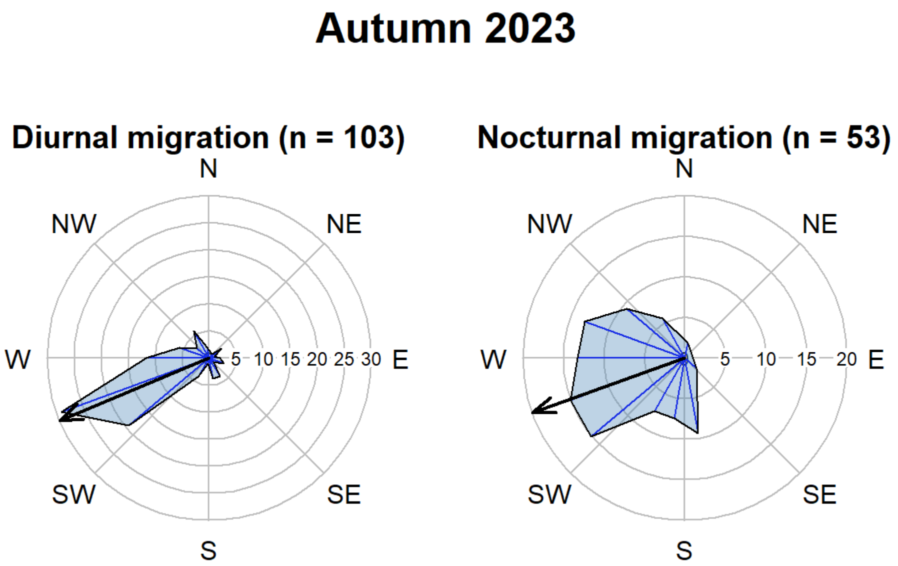


Figure 5-161 Flight direction of bird signals according to the horizontal radar shown in percentage (%) during diurnal and nocturnal migration in autumn 2023 at the KF II OWF S pre-investigation area. See Figure 5-158 for details.

6 STATUS

6.1 RESTING BIRDS

6.1.1 AERIAL SURVEYS

During the digital aerial surveys, a total of 25,621 individuals (resting birds) was counted. Among these, common eiders (7,933 individuals) and common scoters (7,777 individuals) were the most common species. Overall, sea ducks were by far the most common species group, which is not surprising as the coastal areas west of Sjælland, as well as along the coastal waters of Falster are known to support large numbers of wintering sea ducks (Durinck et al. 1994; Petersen & Nielsen 2011; Skov et al. 2011). As expected, highest densities of all sea duck species were mainly found during winter and spring in shallower areas up to 15 m water depths. They arrive in the Baltic Sea starting in late summer/early autumn to moult and numbers increase during the winter until peaking in late winter or early spring, before they leave to migrate to their breeding grounds. Since the common eider is also a breeding bird in Denmark, their numbers are still higher during summer compared to the other three sea duck species. As described by several authors, sea ducks generally prefer shallower areas for foraging (e.g. Madsen 1954; Zydelis 2000; Nehls 2001; Fox 2003). Since they obtain their prey by diving, individuals have to balance the energy gained by prey with energy spent to forage, which is generally more favourable in shallower waters. These observations were generally confirmed by the analyses of the distribution patterns of the sea ducks present in the pre-investigation area, as they mostly were located in the coastal waters. Noteworthy however is the distribution of common eiders during spring, as numerous individuals were observed in and around the operating OWF Kriegers Flak. While it is assumed that common eiders generally avoid flying between wind turbines, a few studies at operating Danish and Swedish wind farms have shown that several individuals were observed passing between them, although the majority of individuals avoided the areas (Petersen et al. 2006; Masden et al. 2009; Green 2015). If prey conditions are favourable even in areas with operating turbines, they might therefore still utilise these at least partially.

With a total of 1,702 observed individuals, gulls were the second most common species group. Among these, herring gulls were most frequently observed, followed by common gulls, black-headed gulls and great black-backed gulls. They were present in the pre-investigation area year-round. While highest densities of both common and black-headed gulls were mainly observed in coastal areas with only a few individuals further offshore, Herring and particularly great black-backed gulls were found more widespread and more often in offshore regions. Gulls generally forage by picking up prey from the water surface (e.g (Mendel et al. 2008), but they also follow fishing vessels to forage on discard (e.g. Camphuysen 1995; Garthe et al. 2016). Thus, it is not surprising that some gull species are also located in offshore regions. Except for the black-headed gull, all other gull species were repeatedly observed with and around the operating wind farm Kriegers Flak. Dierschke et al. (2016) reported that specifically larger gull species are often attracted to offshore wind farms, as these provide roosting areas.

The number of observed auks was comparatively low with a total of 990 individuals. Common guillemots were generally as common as razorbills, yet their distribution patterns were quite different. Densities of razorbills were relatively similar during winter and spring, but during spring they were more concentrated within and around the operating Kriegers Flak OWF. Numbers of common guillemots were highest during winter and decreased during spring. Only a few individuals were counted during the summer months. Compared to razorbills, which were

mostly located in the centre of the pre-investigation area and within the already operating wind farm Kriegers Flak, common guillemots were more widespread across the investigation area. Nevertheless, a few individuals were repeatedly observed in and in close proximity to the operating Kriegers Flak. Several studies conducted in different European offshore wind farms have shown, that common guillemots are usually avoiding these areas (PETERSEN ET AL. 2006; IMARES 2013; MENDEL ET AL. 2014; VANERMEN ET AL. 2015; PESCHKO ET AL. 2020), while others could find no effect (VALLEJO ET AL. 2017). Leopold (2018) suggested that the layout of the offshore wind farms itself might have an influence on common guillemot distribution. Based on his hypothesis, this species might avoid wind farms with densely built turbines, whereas wind farms with turbines built at greater distances from each other might have reduced impacts. Wind farms with the latter setup might therefore still be occasionally frequented, especially if favourable food resources can be found.
Cormorants, the fourth most common bird species, were mainly found close to the coast near the island of Møn and the Falsterbo peninsula. However, it could also be shown that the structures of the existing OWF are used as new resting habitat by cormorants.

Observed densities of other relevant resting bird species such as terns, divers, or grebes, where relatively low in the entire area throughout the survey period. In general, the results of the present report align with description of resting bird distribution patterns of several previous studies (such as PETERSEN & NIELSEN 2011; SKOV ET AL. 2011), but give much more detail in fine scale distribution and phenology.

6.2 MIGRATING BIRDS

6.2.1 *DIURNAL MIGRATION*

Both pre-investigation areas surveyed here presented similar species during spring and autumn migration. However, abundances and thus, the proportion at which the most common species occurred differed.
At the northern pre-investigation area there were 15,841 migrating birds, and rather similar numbers in both seasons, whereas in the most southern area three times as many birds were registered in both seasons with 27,355 in spring and 18,282 in autumn. Thus, migration intensity was also much higher in the southern area, which was not expected since the northern area is closer to land and located between Falsterbo and Møn, where we expected higher migration intensity compared to the more offshore area in the south. The most common species in both areas and both seasons was the same and was the barnacle goose, and it represented varying proportions between 28 and 37% of all birds (in each season and each area, see Results). However, it must be emphasized that during spring in the southern area where geese were by far the most common species group (> 80% of all birds were geese), most geese could not be determined to species level, but probably represented barnacle geese (i.e., unidentified black goose).

The largest population of barnacle geese in Europe migrates in spring to their breeding locations in Russia while it returns to their wintering areas in the North Sea in autumn (e.g., GREEN 1998; VAN DER JEUGD ET AL. 2009). The location of the pre-investigation areas studied here lies within the main path of their migratory flyway (e.g., GREEN 1998; VAN DER JEUGD ET AL. 2009). Green (1998) has indicated that there is a gradient from south to north in terms of the routes of (spring) migration for barnacle geese with most birds crossing the sea close to the southwestern part of Sweden, and coinciding with the location of the proposed OWF areas of KF II OWF (see GREEN 1998). This might explain why so many geese occurred in both areas and especially in the most southern area. Given that the species has experienced a rapid increase in its numbers in the last decades, reaching 1,400,000 individuals according to the Waterbirds Populations Portal (estimation till 2018, http://wpe.wetlands.org, accessed on 11.04.2024), the large numbers observed of this species during spring and autumn migration are not unsurprising.

Ducks were the second most abundant group of diurnally migrating birds in both areas during both seasons. Two species were common: the common scoter and the common eider.
Common scoters breed at northern latitudes, in tundra regions of Iceland, northern Norway and Siberia, but also in Britain and Ireland (MENDEL ET AL. 2008). In the North Sea, Skagerrak and Baltic Sea they occur as resting and moulting birds all year, but at especially higher numbers in winter (MENDEL ET AL. 2008). The main wintering areas are located in the Baltic, Wadden Sea and along the Atlantic coast up to North Africa, with especially high numbers in the northern Kattegatt (SKOV ET AL. 1995). Common eiders breed in the coasts of Iceland, Britain, Fennoscandia and on the arctic coast of Russia. They also breed in Denmark and these individuals are mostly sedentary. They winter in the Baltic Sea (a large part on the east of Denmark and north-east coast of Germany), and along the west coast of Norway and the Wadden Sea (DURINCK ET AL. 1994).
While some of these ducks were migrating to and from their breeding areas in spring and autumn (especially in the middle of the season, when peak migration events occurred, sea Results), it is possible that some of these birds may have been wintering in very close areas, especially common eiders that may also winter in shallower waters to the west of the planning areas (DURINCK ET AL. 1994). During the five digital aerial surveys conducted in the area, there were also high numbers of these species observed especially in spring (in particular of common eiders). To the west of the area, there are shallow waters suitable for these ducks.
Songbirds were the third most abundant group during diurnal migration, especially in autumn in both areas where they represented about 12% of all migrating birds. Many species were registered, and none were very dominant but among passerines, Eurasian siskin, sky lark and barn swallow were common to both areas and seasons. In addition, white wagtails were common in spring in the northern area while common starlings were very common in the southern area in autumn. That there were comparatively more songbirds in autumn than in spring at both areas is known. Often there is a larger passerine migration in autumn than in spring (almost double as many birds are known to be migrating over the Baltic, cf. BELLEBAUM et al., 2010).

Altogether, these three groups represented the bulk of migrating birds (>90%) during bird migration in both seasons and both areas. Nonetheless, there were also some other groups and species that are worth mentioning because they are species whose numbers are threatened and are thus requiring conservation measurements, and because considerable numbers of them were observed flying at altitudes above 20 m and thus, at an altitude possibly coinciding with the rotor height. These were for example, divers (red-throated divers), which were more common towards the end of the autumn season, especially in the northern area, birds of prey such as red kites and Eurasian sparrowhawks (also relatively common in the northern area during autumn) and Eurasian curlews. These are all species, whose populations have been declining for different reasons in the last years and/or are considered under some type of conservation category (Birds Directive, SPEC or UICN, see Appendix)

Information from horizontal radar shows that most of the detected bird echoes during daylight headed towards NE in spring for the northern area and ENE in spring for the southern area and WSW in autumn for both areas indicating that the great majority of detected birds by horizontal radar were crossing the area on their way into breeding grounds (spring) and wintering areas (autumn). This is expected since the horizontal radar especially collects data when the sea is calm which normally coincides with suitable weather conditions for migration.
Data from the vertical radar confirm, that at all positions and all seasons, highest proportion of migrating birds during day use the lowest level <100 m altitude and that bird migration intensity at least in spring was nearly twice as high in the southern area compared to the northern area. In autumn it was the opposite but the

difference was less pronounced. Why migrating birds are more abundant in the southern more offshore area remains unclear and data from the second year will show if this pattern is consistent.

6.2.2 NOCTURNAL MIGRATION

Many species of nocturnally migrating birds produce species-specific flight calls during migration, that are thought to serve different functions among which flock maintenance, orientation and stimulation of migration activity are highlighted (FARNSWORTH 2005). Because direct observations of nocturnal migrants are difficult to obtain, the recording of flight calls is often used to study nocturnal migration and is the only method that provides taxonomic information on the migrating species (WELCKER & VILELA 2018). The analysis of flight calls conducted at both areas of KF II OWF showed that songbirds were by far the dominant group during nocturnal migration (90%), with other groups such as waders, gulls and ducks occurring less frequently.

It is well known that the bulk of migration movements occur during the nights (ALERSTAM 1990) and that it is clearly dominated by passerines. Millions of songbirds migrate twice a year between their breeding ranges in Scandinavia and northern Russia and their wintering grounds in southern Europe and Africa (BERTHOLD ET AL. 2003). The total number of nocturnal passerine migrants has been estimated at about 200-300 million in spring and about half a billion for the western Baltic Sea (BELLEBAUM ET AL. 2010a).

Results obtained from the analysis of flight calls only give us information on species composition and relative frequency of their abundances as well as the temporal activity pattern. However, it is not possible to compare calls/h with individuals/h, since flight calls are not only dependent on calling species but also may be affected by time of the day and atmospheric conditions (FARNSWORTH 2005; HÜPPOP & HILGERLOH 2012).

There were, however, substantially more nocturnal bird calls detected in autumn than in spring in both areas, which is line with expectations since the autumn migration also includes young birds on their first migration towards the wintering areas. It is known, however, that call intensity during migration is especially high during nights with poor visibility, and such weather conditions are more common in autumn. Several studies have suggested that call rates may be directly affected by cloud cover, ceiling height and humidity (GRABER & COCHRAN 1960; GRABER 1968; FARNSWORTH 2005; HÜPPOP & HILGERLOH 2012). Moreover, WELCKER & VILELA (2019) also found that call rates are typically low in spring especially with clear skies or when the sky was partly cloudy. In autumn, however, they found high call intensities also during nights when the skies were cloudless.

Thrushes were more common than other songbirds during spring and autumn migration except during the autumn migration at the southern area where they represented the minority of all songbirds. This is more caused through less effort in late autumn at the southern area since main passage of thrushes is late autumn .

The results from the horizontal radar show that most of the detected bird echoes during night headed towards NE in spring for the northern area and ENE in spring for the southern area and WSW in autumn for both areas indicating that the great majority of detected birds by horizontal radar were crossing the area on their way into breeding grounds (spring) and wintering areas (autumn). This is expected since the horizontal radar especially collects data when the sea is calm which normally coincides with suitable weather conditions for migration. The difference in flight direction between the two areas in spring may be caused by the specific location of the anchor points: birds in the northern area heading for the nearest point on the coast, which in this case is Falsterbo in the north-east and in the southern, more offshore area, the birds tend to be orientated by their internal compass towards the Scandinavian/Siberian breeding areas.

Data from the vertical radar show very high migration intensity during the night at both areas with significantly higher intensity at the southern area, where a value of >2,300 MTR for a single night occurred. The flight height distribution shows a more even distribution of birds during the night and since no decreasing gradient towards higher altitudes was observed it can be assumed that also above 1,000 m migration takes place and we only covered part of the bird migration at these locations. The phenology of bird migration shows that birds arrive appr. 1 hour after sunset at both anchor locations and most birds crossed the area during the first half of the night. This is expected when nocturnal migrants start to move with sunset and reach the area after a few hours flight. Towards the end of the night bird migration gradually decreases, which is typipically for offshore areas when birds stop moving with the coming day, especially in front of large barriers like the Baltic.

7 DATA AND KNOWLEDGE GAPS

The present study shows that quite a good existing knowledge of birds regularly occurring within the pre-investigation area of the proposed OWF area KF II OWF exists. However, the analysis of data collected in the field between February 2023 and January 2024 show, that details on fine-scale distribution patterns, seasonal occurrence and absolute density information from different times of the year are very valuable and add a lot of new and additional information to the existing knowledge.
In this study, six digital aerial surveys were conducted covering an area of 3,739 km² with 11 % of the area covered to 100 %. The advantage of digital aerial data collection is that densities of seabirds can be assessed quickly and with a uniform collection effort on a large spatial scale in contrast to ship-based surveys and observer-based aerial surveys, where corrections for missing birds in greater distances have to be applied (ŽYDELIS ET AL. 2019). Still, this method is considered a “snap-shot”-method since the distribution of seabirds is only observed during the specific time frame of a flight and not continuously. Therefore, the results only show the abundance on the specific survey date and during daylight hours, so that distribution pattern can be different comparing results from different days and a high variablity between surveys, seasons and years can be expected.

Nonetheless our results show that basically the pattern of resting birds in the Kriegers Flak area coincides with the existing knowledge but can provide more precise details on the presence of birds inside and outside the proposed KF II OWF areas. As the distribution of birds always depends on the situation on the respective survey day, surveys should therefore be performed in different months, covering different seasons and preferably two years in order to be able to draw better conclusions about seasonal and spatial distribution patterns.

Even more, the data collected on migrating birds are important to fill the gap of existing knowledge from the offshore areas, since no data are existing from the proposed OWF areas themself. Although the extensive literature review provided a solid basis to assess, which migratory bird species should be expected in the investigation area and its surroundings, the field data give precise information on migration intensity, species composition and flight height distribution.
In this study we have been surprised about the high migration intensity at the southern anchor point, where we expected to observe less intensive migration compared to the northern anchor point.
A combination of results from the baseline study in the pre-investigation area and existing results is therefore crucial. The upcoming additional study period from February 2024 to January 2025 will not only strengthen the overall data-set and the following analysis of the data. It will also make it possible to get a better understanding of the annual variability in abundances and distribution patterns, thereby strengthening the conclusions of this study by either confirming or rejecting the conclusions made based on the first-year survey results.

8 CONCLUSION

Resting birds:
The results of the resting birds survey revealed first valuable information on their presence and distribution in the pre-investigation area for the proposed OWFs KF II. Sea ducks dominated the resting bird community with common eiders and common scoters being the most frequent. According to their habitat preferences, they were mostly located in shallower waters particularly in the western parts of the pre-investigation area with highest densities in spring and winter. Common eiders however were also found in higher numbers within the proposed OWF areas of KF II N and S. Gulls and auks were the second and third most common species groups. Depending on the species, gulls were either observed closer to the coast or more widespread across the pre-investigation area. Except for the black-headed gull, all other gull species were repeatedly observed in and around the operating wind farm Kriegers Flak. Razorbill densities were relatively similar during winter and spring. Common guillemot densities were highest during winter. Compared to razorbills, which were mostly located in the centre of the pre-investigation area and within the already operating wind farm Kriegers Flak, common guillemots occurred more widespread. However, a few individuals were repeatedly observed in and in close proximity to the operating OWF Kriegers Flak. Cormorants have been observed in high concentrations close to the coast and very locally within the existing OWF at Kriegers Flak using the transformer platform for resting.

While the observed distribution patterns and densities generally confirmed knowledge from existing data, the present data give more precise insight into the fine scale distribution and presence of birds in the pre-investigation area and observations from the upcoming second survey year will provide relevant information whether the observed seasonal and spatial patterns of the studied resting bird species will be consistent over time.

Migrating birds:
Results from visual observations and flight calls indicate that the pre-investigation area is crossed by migrating birds in quite high numbers compared to areas in the North Sea and other areas in the western Baltic Sea (e.g., the Pomeranian Bay). A much larger migration intensity, both diurnal and nocturnal was registered at the southern anchor position than at the northern one, contrary to expectations. Both areas (northern and southern areas) are part of the coastal diurnal migration with geese (barnacle goose) and ducks (common scoter and common eider) as the most dominant species occurring in high to very high numbers on certain days with good migration conditions. Flying altitudes of ducks were mostly below 20 m whereas geese were frequently observed at altitudes above 50 m, as expected. Songbirds were mostly representative in autumn during diurnal migration when they crossed the area regularly. During nocturnal migration, they were the most relevant species group.

Birds of prey were frequently observed as expected but compared to the most abundant species like geese and ducks in much smaller numbers (6-105 individuals each season), thus their relative abundances in relation to the total number of migrating birds registered in any of the areas were negligible. Other groups such as cranes occurred also regularly in spring (47 – 64 individuals) but compared to the extreme high numbers of geese and ducks, in much lower numbers. Nonetheless, both, birds of prey and cranes, are large birds which need to be mentioned, due to their large sizes, their known vulnerability to collisions with wind turbines, and in many cases their already endangered populations.

Results from both, the vertical radar and the bird calls suggest that the pre-investigation area is part of the broadband nocturnal migration route for passerines. Flight height distribution between 0 and 1,000 m shows that during day the lower level below 100 m is the level with highest bird migration intensity. At night birds were more evenly distributed and highest intensity occurred between 900-1000 m (KF II N) and between 300-400 m (KF II S), which suggests that at least part of the bird migration took place above 1,000 metres and thus outside our survey range. The temporal distribution of birds during a 24h day show, that the nocturnal migrants arrived at the positions inside the proposed OWF areas one hour after sunset and highest Migration Traffic Rates (MTR) occurred in the first half of the night before the migration intensity gradually decreased until sunrise. During the day light phase, migration was significantly reduced compared with nights and highest MTR was measured in the first hours after sunrise. The hour with lowest migration was always the hour before sunset. This pattern reflects the typical migration pattern from offshore areas with a high flux of nocturnal migrants. A second year will certainly provide more information about whether the current results reflect a common pattern or that 2023 was a rather especially high-migration year.

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10 APPENDIX

Table A-1: Species list of all birds detected during the six digital aerial surveys between February 2023 and January 2024 at the pre-investigation area KF II OWF (N and S). Species names are provided in English, Danish and in latin names as well as their inclusion in various relevant categories of conservation at European level. Number of individuals and whether the bird is considered a resting or only a migratory bird (and thus not considered in the analysis of resting birds) is also indicated.

Species groups	Common names in		Scientific names	Resting / Migratory	Number of ind.	Conservation/Protection categories			
	English	Danish				Birds Dir	UICN	EU Cat 28	AEWA
Divers	Red-throated diver	Rødstrubet Lom	*Gavia stellata*	R/M	163	I	LC	LC	B 2e
Divers	Black-throated diver	Sortstrubet Lom	*Gavia arctica*	R/M	88	I	LC	LC	B 2c
Divers	unidentified diver		*Gavia sp.*	R/M	70				
Grebes	Great crested grebe	Toppet Lappedykker	*Podiceps cristatus*	R/M	48		LC	LC	C 1
Grebes	Red-necked grebe	Gråstrubet Lappedykker	*Podiceps grisegena*	R/M	18		VU	VU	A 3c
Grebes	Slavonian grebe	Nordisk Lappedykker	*Podiceps auritus*	R/M	63	I	NT	VU	A 1b 1c
Grebes	Red-necked/great crested grebe		*Podiceps grisegena/Podiceps cristatus*	R/M	51				

Grebes	Slavonian/Black-necked Grebe		*Podiceps auritus/Podiceps cristatus*	R/M	4				
Grebes	unidentified grebe		*Podicipedidae sp.*	R/M	109				
Gannets	Northern gannet	Sule	*Morus bassanus*	R/M	8		LC	LC	C 1
Cormorans	Great cormorant	Skarv	*Phalacrocorax carbo*	R/M	729		LC	LC	C 1
Herons	Great egret	Sølvhejre	*Ardea alba*	M	1	I	LC	LC	C 1
Herons	Grey heron	Fiskehejre	*Ardea cinerea*	M	3		LC	LC	C 1
Swans	Mute swan	Knopsvane	*Cygnus olor*	M	220		LC	LC	C 1
Swans	unidentified swan		*Cygnus sp.*	M	3				
Geese	unidentified goose		*Anser/Branta sp.*	M	1				
Geese	Greater white-fronted goose	Blisgås	*Anser albifrons*	M	33	I * (albifrons)	LC	LC	C 1
Geese	Greylag goose	Grågås	*Anser anser*	M	95		LC	LC	C 1 / B 1
Geese	unidentified grey goose		*Anser sp.*	M	5				
Geese	Barnacle goose	Bramgås	*Branta leucopsis*	M	318	I	LC	LC	C 1

Geese	Brent goose	Knortegås	*Branta bernicla*	M	24		LC	LC	
Geese	Common shelduck	Gravand	*Tadorna tadorna*	M	54		LC	LC	B 2a
Ducks	Eurasian wigeon	Pibeand	*Mareca penelope*	M	198		LC	VU	B 2c
Ducks	Eurasian teal	Krikand/Amerikansk Krikand	*Anas crecca*	M	34		LC	LC	C 1
Ducks	Mallard	Gråand	*Anas platyrhynchos*	M	239		LC	LC	C 1
Ducks	Northern pintail	Spidsand	*Anas acuta*	M	6		VU	EN	B 1
Ducks	Northern shoveler	Skeand	*Spatula clypeata*	M	10		LC	NT	B 1
Ducks	unidentified swimming duck		*Anas sp.*	M	13				
Ducks	Common pochard	Taffeland	*Aythya ferina*	M	16		VU	VU	A 1b
Ducks	Tufted duck	Troldand	*Aythya fuligula*	M	7		NT	VU	B (2c)
Ducks	Common eider	Ederfugl	*Somateria mollissima*	R/M	7,933		EN	VU	A 4
Ducks	Long-tailed duck	Havlit	*Clangula hyemalis*	R/M	1,570		LC	LC	A 1b
Ducks	Common scoter	Sortand	*Melanitta nigra*	R/M	7,777		LC	N/A	B 2a
Ducks	Common/velvet scoter		*Melanitta sp.*	R/M	333				

Ducks	Velvet scoter	Fløjlsand	*Melanitta fusca*	R/M	631		VU	VU	A 1b
Ducks	Common goldeneye	Hvinand	*Bucephala clangula*	M	73		LC	LC	B 2c
Ducks	Red-breasted merganser	Toppet Skallesluger	*Mergus serrator*	M	550		NT	NT	B 2c
Ducks	unidentified merganser/goosander		*Mergus sp.*	M	6				
Ducks	unidentified duck		*Anatinae sp.*	M	240				
Birds of prey	European honey-buzzard	Hvepsevåge	*Pernis apivorus*	M	4	I	LC	LC	
Birds of prey	Red kite	Rød Glente	*Milvus milvus*	M	2	I	LC	LC	
Birds of prey	Eurasian sparrowhawk	Spurvehøg	*Accipiter nisus*	M	18	I * (granti)	LC	LC	
Birds of prey	Common buzzard	Musvåge	*Buteo buteo*	M	2		LC	LC	
Birds of prey	unidentified bird of prey		*Falconiformes/Accipitriformes*	M	2				
Birds of prey	Common kestrel	Tårnfalk	*Falco tinnunculus*	M	1		LC	LC	
Waders	Common coot	Blishøne	*Fulica atra*	M	13		NT	LC	B 2c

Waders	Eurasian oystercatcher	Strandskade	*Haematopus ostralegus*	M	15		VU	VU	A 4
Waders	European golden plover	Hjejle	*Pluvialis apricaria*	M	6	I	LC	LC	C 1
Waders	Northern lapwing	Vibe	*Vanellus vanellus*	M	5		VU	VU	A 4
Waders	Eurasian curlew	Storspove	*Numenius arquata*	M	21		NT	NT	A 4
Waders	Common redshank	Rødben	*Tringa totanus*	M	13		VU	VU	B 2c / C 1
Waders	unidentified wader		*Limicolae*	M	40				
Gulls	Little gull	Dværgmåge	*Hydrocoloeus minutus*	R/M	44	I	LC	LC	A (3c 3e)
Gulls	Black-headed gull	Hættemåge	*Chroicocephalus ridibundus*	R/M	217		LC	VU	B 2c
Gulls	Common gull	Stormmåge	*Larus canus*	R/M	456		LC	LC	B 2c
Gulls	unidentified small gull		*Larus small sp.*	R/M	39				
Gulls	Lesser black-backed gull	Sildemåge	*Larus fuscus*	R/M	19		LC	LC	A 3c / B 2e / C1
Gulls	Herring gull	Sølvmåge	*Larus argentatus*	R/M	652		LC	VU	B 2c 2e /C1
Gulls	Common/Herring gull		*Larus canus / Larus argentatus*	R/M	61				
Gulls	Great black-backed gull	Svartbag	*Larus marinus*	R/M	136		LC	NT	B 2c

Gulls	unidentified large gull		*Larus (magnus) sp.*	R/M	52				
Gulls	Great / lesser black-backed gull		*Larus fuscus/Larus marinus*	R/M	5				
Gulls	fulmar/gull		*Fulmarus/Larus*	R/M	1				
Gulls	unidentified gull		*Laridae sp.*	R/M	20				
Terns	Sandwich tern	Splitterne	*Thalasseus sandvicensis*	R/M	43	I	LC	LC	C 1
Terns	Common/Arctic tern		*Sterna hirundo/Sterna paradisaea*	R/M	67	I			C 1
Terns	Little tern	Dværgterne	*Sternula albifrons*	R/M	5	I	LC	LC	A 2
Terns	tern/small gull		*Sterna spp / Larus spp.*	R/M	8				
Terns	unidentified tern		*Sternidae sp.*	R/M	5				
Auks	Common guillemot	Lomvie	*Uria aalge*	R/M	362	I * (iberica)	LC	LC	C 1 / B 1
Auks	Common guillemot/razorbill		*Uria aalge / Alca torda*	R/M	224				
Auks	Razorbill	Alk	*Alca torda*	R/M	362		LC	LC	C 1
Auks	Black guillemot	Tejst	*Cepphus grylle*	R/M	30		LC	LC	B 1

Auks	unidentified auk		*Alcidae sp.*	R/M	12				
Pigeons	Feral pigeon		*Columba livia domestica*	M	13				
Pigeons	Stock pigeon	Huldue	*Columba oenas*	M	20		LC	LC	
Pigeons	Common wood pigeon	Ringdue	*Columba palumbus*	M	1	I * (azorica)	LC	LC	
Pigeons	unidentified dove/pigeon		*Columbidae sp.*	M	4				
Swifts	Common swift	Mursejler	*Apus apus*	M	6		NT	NT	
Songbirds	Sky lark	Sanglærke	*Alauda arvensis*	M	1		LC	LC	
Songbirds	Hooded crow	Gråkrage	*Corvus cornix*	M	3				
Songbirds	unidentified *Fringilla* finch		Fringilla sp.	M	4				
Songbirds	unidentified songbird		Passerine sp	M	270				
Bird	unidentified bird		Aves sp	M	593				
					25,621				

Table A-2: Species list of all migrating birds observed (diurnal migration, visual observations) and heard (nocturnal migration, flight calls) during the surveys in autumn 2023 at the pre-investigation area KF II OWF N. Species names are provided in English, Danish and in latin names as well as their inclusion in various relevant categories of conservation at European level. The number of individual birds seen or calls heard is given for each season. If there is an asterisk at the Bird Directive Category, it means that the protection category applies only to the subspecies in parentheses.

Species groups	Common names in		Scientific names	Conservation/Protection categories				Visual observations		Flight calls	
	English	Danish		Birds Dir	UICN	EU Cat 28	AEWA	Spring	Autumn	Spring	Autumn
Divers	Red-throated diver	Rødstrubet Lom	*Gavia stellata*	I	LC	LC	B 2e	10	134		
Divers	Black-throated diver	Sortstrubet Lom	*Gavia arctica*	I	LC	LC	B 2c	4	7		
Divers	unidentified diver		*Gavia sp.*					14	14		
Grebes	Great crested grebe	Toppet Lappedykker	*Podiceps cristatus*		LC	LC	C 1	2	0		
Grebes	Red-necked grebe	Gråstrubet Lappedykker	*Podiceps grisegena*		VU	VU	A 3c	7	0		
Gannets	Northern gannet	Sule	*Morus bassanus*		LC	LC	C 1	1	5		
Cormorants	Great cormorant	Skarv	*Phalacrocorax carbo*		LC	LC	C 1	403	422		
Herons	Great egret	Sølvhejre	*Ardea alba*	I	LC	LC	C 1	0	4		
Herons	Grey heron	Fiskehejre	*Ardea cinerea*		LC	LC	C 1	0	2	0	2
Swans	Mute swan	Knopsvane	*Cygnus olor*		LC	LC	C 1	6	16		

Swans	Bewickâ€™s swan		*Cygnus columbianus bewickii*				A 2	4	0		
Swans	Whooper swan	Sangsvane	*Cygnus cygnus*	I	LC	LC	C 1	4	69		
Swans	unidentified swan		*Cygnus sp.*					14	8		
Geese	unidentified goose		*Anser/Branta sp.*					190	174		
Geese	Bean goose	Tajgasædgås	*Anser fabalis*		LC	VU	A 3c*	0	78		
Geese	Greater white-fronted goose	Blisgås	*Anser albifrons*	I * (flavirostris)	LC	LC	C 1	519	5		
Geese	Greylag goose	Grågås	*Anser anser*		LC	LC	C 1 / B 1	316	66		
Geese	Canada goose	Canadagås	*Branta canadensis*		LC	N/A		0	2		
Geese	Barnacle goose	Bramgås	*Branta leucopsis*	I	LC	LC	C 1	2899	2304	0	6
Geese	Brent goose	Knortegås	*Branta bernicla*		LC	LC		51	11		
Geese	unidentified black goose		*Branta sp.*					0	306		
Geese	Common shelduck	Gravand	*Tadorna tadorna*		LC	LC	B 2a	2	2		
Ducks	Eurasian wigeon	Pibeand	*Mareca penelope*		LC	VU	B 2c	14	208		
Ducks	Eurasian teal	Krikand/Amerikansk Krikand	*Anas crecca*		LC	LC	C 1	0	32		

Ducks	Mallard	Gråand	*Anas platyrhynchos*		LC	LC	C 1	0	3		
Ducks	Northern pintail	Spidsand	*Anas acuta*		VU	EN	B 1	0	6		
Ducks	Northern shoveler	Skeand	*Spatula clypeata*		LC	NT	B 1	0	10		
Ducks	unidentified swimming duck		*Anas sp.*					0	75		
Ducks	Common pochard	Taffeland	*Aythya ferina*		VU	VU	A 1b	0	1		
Ducks	Tufted duck	Troldand	*Aythya fuligula*		NT	VU	B (2c)	4	4		
Ducks	Greater scaup	Bjergand	*Aythya marila*		LC	EN	C 1	0	28		
Ducks	Common eider	Ederfugl	*Somateria mollissima*		EN	VU	A 4	1064	413		
Ducks	Long-tailed duck	Havlit	*Clangula hyemalis*		LC	LC	A 1b	82	18		
Ducks	Common scoter	Sortand	*Melanitta nigra*		LC	N/A	B 2a	906	908	3	0
Ducks	Common scoter / velvet scoter		*Melanitta sp.*					25	0		
Ducks	Velvet scoter	Fløjlsand	*Melanitta fusca*		VU	VU	A 1b	49	99		
Ducks	Common goldeneye	Hvinand	*Bucephala clangula*		LC	LC	B 2c	0	4		
Ducks	Red-breasted merganser	Toppet Skallesluger	*Mergus serrator*		NT	NT	B 2c	105	45		

Ducks	Goosander	Stor Skallesluger	*Mergus merganser*		LC	LC	C 1	15	37			
Ducks	unidentified merganser / goosander		*Mergus sp.*					9	26			
Ducks	unidentified duck		*Anatinae sp.*					74	513			
Birds of prey	European honey-buzzard	Hvepsevåge	*Pernis apivorus*	I	LC	LC		0	2			
Birds of prey	Red kite	Rød Glente	*Milvus milvus*	I	LC	LC		0	36			
Birds of prey	White-tailed eagle	Havørn	*Haliaeetus albicilla*	I	LC	LC		1	0			
Birds of prey	Eurasian marsh harrier	Rørhøg	*Circus aeruginosus*	I	LC	LC		0	11			
Birds of prey	Hen harrier	Blå Kærhøg	*Circus cyaneus*	I	LC	VU		1	1			
Birds of prey	unidentified harrier		*Circus sp.*					0	1			
Birds of prey	Eurasian sparrowhawk	Spurvehøg	*Accipiter nisus*	I * (granti)	LC	LC		3	33			
Birds of prey	Osprey	Fiskeørn	*Pandion haliaetus*	I	LC	LC		1	3			

Birds of prey	Common kestrel	Tårnfalk	*Falco tinnunculus*		LC	LC		0	1		
Birds of prey	Merlin	Dværgfalk	*Falco columbarius*	I	VU	VU		0	1		
Cranes	Common crane	Trane	*Grus grus*	I	LC	LC	C 1	47	0		
Waders	Eurasian oystercatcher	Strandskade	*Haematopus ostralegus*		VU	VU	A 4	0	35		
Waders	Avocet	Klyde	*Recurvirostra avosetta*	I	LC	LC	B 1			0	2
Waders	Little plover	Lille Præstekrave	*Charadrius dubius*		LC	LC	C 1	1	0	0	2
Waders	Ringed plover	Stor Præstekrave	*Charadrius hiaticula*		LC	LC	B 1	1	20	0	15
Waders	European golden plover	Hjejle	*Pluvialis apricaria*	I	LC	LC	C 1	2	13	4	0
Waders	Grey plover	Strandhjejle	*Pluvialis squatarola*		LC	LC	B 2e	0	9		
Waders	Dunlin	Almindelig Ryle	*Calidris alpina*	I * (schinzii)	LC	LC	C1	0	135	0	231
Waders	Ruff	Brushane	*Calidris pugnax*	I	NT	NT	B 2c	0	1		
Waders	Jack snipe	Enkeltbekkasin	*Lymnocryptes minimus*		LC	LC	C 1			0	8
Waders	Snipe	Dobbeltbekkasin	*Gallinago gallinago*		VU	LC	B 2c	0	4	11	23

Waders	Black-tailed godwit	Stor Kobbersneppe	*Limosa limosa*		NT	EN	A 3c 3e	0	4		
Waders	Bar-tailed godwit	Lille Kobbersneppe	*Limosa lapponica*	I	LC	LC	A 4	0	13	2	0
Waders	Whimbrel	Småspove	*Numenius phaeopus*		LC	LC	C 1	0	6	0	2
Waders	Eurasian curlew	Storspove	*Numenius arquata*		NT	NT	A 4	121	8		
Waders	Spotted redshank	Sortklire	*Tringa erythropus*		LC	NT	A 3c 3e			0	2
Waders	Common redshank	Rødben	*Tringa totanus*		VU	VU	B 2c / C 1	0	3		
Waders	Wood sandpiper	Tinksmed	*Tringa glareola*	I	LC	LC	C 1			5	0
Waders	Common sandpiper	Mudderklire	*Actitis hypoleucos*		LC	LC	B 2c			0	17
Waders	unidentified wader		*Limicolae*					24	18		
Skuas	Arctic skua	Almindelig Kjove	*Stercorarius parasiticus*		EN	EN		0	4		
Skuas	unidentified skua		*Stercorarius sp.*					0	12		
Gulls	Little gull	Dværgmåge	*Hydrocoloeus minutus*	I	LC	LC	A (3c 3e)	27	80		
Gulls	Black-headed gull	Hættemåge	*Chroicocephalus ridibundus*		LC	VU	B 2c	34	11		
Gulls	Common gull	Stormmåge	*Larus canus*		LC	LC	B 2c	208	50	87	0
Gulls	Lesser black-backed gull	Sildemåge	*Larus fuscus*		LC	LC	A 3c / B 2e / C1	26	5		

Gulls	Herring gull	Sølvmåge	*Larus argentatus*		LC	VU	B 2c 2e /C1	77	43	5	0
Gulls	Caspian gull	Kaspisk Måge	*Larus cachinnans*		LC	LC	C 1	0	6		
Gulls	Great black-backed gull	Svartbag	*Larus marinus*		LC	NT	B 2c	4	18		
Gulls	unidentified large gull		*Larus (magnus) sp.*					18	14		
Gulls	Great black-backed gull / lesser black-backed gull		*Larus fuscus/Larus marinus*					0	2		
Gulls	Black-legged kittiwake	Ride	*Rissa tridactyla*		VU	EN	A 1b	2	3		
Terns	Sandwich tern	Splitterne	*Thalasseus sandvicensis*	I	LC	LC	C 1	33	3		
Terns	Common tern	Fjordterne	*Sterna hirundo*	I	LC	LC	C 1	0	168		
Terns	Arctic tern	Havterne	*Sterna paradisaea*	I	LC	LC	C 1	0	1		
Terns	Common tern / Arctic tern		*Sterna hirundo/Sterna paradisaea*	I			C 1	0	49		
Terns	unidentified tern		*Sternidae sp.*					22	30		
Auks	Common guillemot	Lomvie	*Uria aalge*	I * (ibericus)	LC	LC	C 1 / B 1	40	14		

Auks	Common guillemot / razorbill		*Uria aalge / Alca torda*					49	31		
Auks	Razorbill	Alk	*Alca torda*		LC	LC	C 1	34	25		
Auks	Black guillemot	Tejst	*Cepphus grylle*		LC	LC	B 1	21	4		
Auks	unidentified auk		*Alcidae sp.*					0	1		
Pigeons	Common wood pigeon	Ringdue	*Columba palumbus*	I * (azorica)	LC	LC		1	0		
Owls	Long-eared owl	Skovhornugle	*Asio otus*		LC	LC		0	1		
Owls	Long-eared / short-eared owl		*Asio otus / Asio flammeus*					0	1		
Owls	Short-eared owl	Mosehornugle	*Asio flammeus*	I	LC	LC		0	1		
Swifts	Common swift	Mursejler	*Apus apus*		NT	NT		0	1		
Songbirds	Wood lark	Hedelærke	*Lullula arborea*	I	LC	LC		0	8		
Songbirds	Sky lark	Sanglærke	*Alauda arvensis*		LC	LC		18	293	0	14
Songbirds	Sand martin	Digesvale	*Riparia riparia*		LC	LC		1	0		
Songbirds	Barn swallow	Landsvale	*Hirundo rustica*		LC	LC		18	110		
Songbirds	unidentified swallow / martin		*Hirundinidae sp.*					4	0		

Songbirds	Tree pipit	Skovpiber	*Anthus trivialis*		LC	LC		0	6	0	67
Songbirds	Meadow pipit	Engpiber	*Anthus pratensis*		LC	LC		3	45	0	6
Songbirds	Rock pipit (eastern)		*Anthus spinoletta litoralis*					0	3		
Songbirds	unidentified pipit		*Anthus sp.*					25	28		
Songbirds	Yellow wagtail	Gul Vipstjert	*Motacilla flava*		LC	LC		0	17		
Songbirds	White wagtail / Pied wagtail	Hvid Vipstjert	*Motacilla alba*		LC	LC		27	1		
Songbirds	Winter wren	Gærdesmutte	*Troglodytes troglodytes*	I * (fridariensis)	LC	LC		1	4	0	3
Songbirds	Hedge accentor	Jernspurv	*Prunella modularis*		LC	LC		1	0	0	10
Songbirds	European robin	Rødhals	*Erithacus rubecula*		LC	LC				62	421
Songbirds	Common redstart	Rødstjert	*Phoenicurus phoenicurus*		LC	LC				0	1
Songbirds	Northern wheatear	Stenpikker	*Oenanthe oenanthe*		LC	NT		0	1		
Songbirds	Common blackbird	Solsort	*Turdus merula*		LC	LC		1	1	56	1007
Songbirds	Fieldfare	Sjagger	*Turdus pilaris*		LC	LC				2	57
Songbirds	Song thrush	Sangdrossel	*Turdus philomelos*		LC	LC		0	1	25	291
Songbirds	Redwing	Vindrossel	*Turdus iliacus*		LC	LC				98	1602

Songbirds	Mistle thrush	Misteldrossel	*Turdus viscivorus*		LC	LC				0	3
Songbirds	unidentified thrush		*Turdus sp.*					0	1		
Songbirds	Goldcrest	Fuglekonge	*Regulus regulus*		LC	LC		1	2	0	14
Songbirds	Spotted flycatcher	Grå Fluesnapper/Tyrrhensk Fluesnapper	*Muscicapa striata*		LC	LC		0	1	0	5
Songbirds	Blue tit	Blåmejse	*Cyanistes caeruleus*		LC	N/A		0	1		
Songbirds	Great tit	Musvit	*Parus major*		LC	LC		1	3	0	6
Songbirds	Rook	Råge	*Corvus frugilegus*		VU	LC		4	0		
Songbirds	Carrion crow		*Corvus corone corone*					3	0		
Songbirds	Common starling	Stær	*Sturnus vulgaris*		LC	LC		10	6	0	3
Songbirds	Chaffinch	Bogfinke	*Fringilla coelebs*	I * (ombriosa)	LC	LC		1	19	0	2
Songbirds	Brambling	Kvækerfinke	*Fringilla montifringilla*		LC	LC		16	0	0	6
Songbirds	unidentified *Fringilla* finch		*Fringilla sp.*					5	0		
Songbirds	European greenfinch	Grønirisk	*Chloris chloris*		LC	LC		8	6		

Songbirds	European goldfinch	Stillits	*Carduelis carduelis*		LC	LC		5	0		
Songbirds	Eurasian siskin	Grønsisken	*Spinus spinus*		LC	LC		19	106		
Songbirds	Common linnet	Tornirisk	*Linaria cannabina*		LC	LC		2	2		
Songbirds	Twite	Bjergirisk	*Linaria flavirostris*		LC	VU		0	41		
Songbirds	Lesser redpoll	Stor Gråsisken	*Acanthis flammea*		LC	LC		0	15		
Songbirds	unidentified *Carduelis* finch		*Carduelis sp.*					4	160		
Songbirds	Snow bunting	Snespurv	*Plectrophenax nivalis*		LC	LC		0	1		
Songbirds	Reed bunting	Rørspurv	*Emberiza schoeniclus*		LC	LC		0	4	0	32
Songbirds	unidentified songbird		*Passerine sp*					78	106	0	79
Birds	unidentified bird		*Aves sp*					7	0		
Total	**120 spp**							**7854**	**7987**	**360**	**3939**

Table A-3: Species list of all migrating birds observed (diurnal migration, visual observations) and heard (nocturnal migration, flight calls) during the surveys in autumn 2023 at the pre-investigation area KF II OWF S. Species names are provided in English, Danish and in latin names as well as their inclusion in various relevant categories of conservation at European level. The number of individual birds seen or calls heard is given for each season. If there is an asterisk at the Bird Directive Category, it means that the protection category applies only to the subspecies in parentheses.

Species groups	Common names in		Scientific names	Conservation/Protection categories				Visual observations		Flight calls	
	English	Danish		Birds Dir	UICN	EU Cat 28	AEWA	Spring	Autumn	Spring	Autumn
Divers	Red-throated Diver	Rødstrubet Lom	*Gavia stellata*	I	LC	LC	B 2e	19	8		
Divers	Black-throated Diver	Sortstrubet Lom	*Gavia arctica*	I	LC	LC	B 2c	6	2		
Divers	Great Northern Diver	Islom	*Gavia immer*	I	LC	LC	A 1c	1	0		
Divers	unidentified diver		*Gavia sp.*					23	6		
Grebes	Red-necked Grebe	Gråstrubet Lappedykker	*Podiceps grisegena*		VU	VU	A 3c	6	0		
Gannets	Northern Gannet	Sule	*Morus bassanus*		LC	LC	C 1	0	2		
Cormorants	Great Cormorant	Skarv	*Phalacrocorax carbo*		LC	LC	C 1	262	174		
Herons	Grey Heron	Fiskehejre	*Ardea cinerea*		LC	LC	C 1	2	3		
Swans	Mute Swan	Knopsvane	*Cygnus olor*		LC	LC	C 1	1	2		

Swans	unidentified swan		*Cygnus sp.*					20	0		
Geese	unidentified goose		*Anser/Branta sp.*					56	3513		
Geese	Bean Goose	Tajgasædgås	*Anser fabalis*		LC	VU	A 3c*	0	1		
Geese	Greater White-fronted Goose	Blisgås	*Anser albifrons*	I * (albifrons)	LC	LC	C 1	350	548		
Geese	Greylag Goose	Grågås	*Anser anser*		LC	LC	C 1 / B 1	214	38		
Geese	Barnacle Goose	Bramgås	*Branta leucopsis*	I	LC	LC	C 1	7792	6378		
Geese	Brent Goose	Knortegås	*Branta bernicla*		LC	LC		28	262	5	0
Geese	unidentified black goose		*Branta sp.*					14203	59		
Ducks	Eurasian Wigeon	Pibeand	*Mareca penelope*		LC	VU	B 2c	4	378		
Ducks	Gadwall	Knarand	*Mareca strepera*		LC	LC	C 1	0	2		
Ducks	Eurasian Teal	Krikand/Amerikansk Krikand	*Anas crecca*		LC	LC	C 1	12	70	3	0
Ducks	Mallard	Gråand	*Anas platyrhynchos*		LC	LC	C 1	4	5		
Ducks	Northern Pintail	Spidsand	*Anas acuta*		VU	EN	B 1	0	20		

Ducks	Northern Shoveler	Skeand	*Spatula clypeata*		LC	NT	B 1	8	4		
Ducks	unidentified swimming duck		*Anas sp.*					8	49		
Ducks	Tufted Duck	Troldand	*Aythya fuligula*		NT	VU	B (2c)	0	43		
Ducks	Common Eider	Ederfugl	*Somateria mollissima*		EN	VU	A 4	1247	3308		
Ducks	Long-tailed Duck	Havlit	*Clangula hyemalis*		LC	LC	A 1b	23	2		
Ducks	Common Scoter	Sortand	*Melanitta nigra*		LC	N/A	B 2a	2007	318	17	0
Ducks	Common Scoter / Velvet Scoter		*Melanitta sp.*					0	13		
Ducks	Velvet Scoter	Fløjlsand	*Melanitta fusca*		VU	VU	A 1b	62	36		
Ducks	Red-breasted Merganser	Toppet Skallesluger	*Mergus serrator*		NT	NT	B 2c	76	37		
Ducks	Goosander	Stor Skallesluger	*Mergus merganser*		LC	LC	C 1	5	103		
Ducks	unidentified merganser / goosander		*Mergus sp.*					0	1		
Ducks	unidentified duck		*Anatinae sp.*					39	202		

Birds of prey	European Honey-Buzzard	Hvepsevåge	*Pernis apivorus*	I	LC	LC		1	6		
Birds of prey	Red Kite	Rød Glente	*Milvus milvus*	I	LC	LC		0	4		
Birds of prey	Hen Harrier	Blå Kærhøg	*Circus cyaneus*	I	LC	VU		0	8		
Birds of prey	unidentified harrier		*Circus sp.*					2	0		
Birds of prey	Northern Goshawk	Duehøg	*Accipiter gentilis*	I * (arrigoni)	LC	LC		0	2		
Birds of prey	Eurasian Sparrowhawk	Spurvehøg	*Accipiter nisus*	I * (granti)	LC	LC		8	70		
Birds of prey	Common Buzzard	Musvåge	*Buteo buteo*		LC	LC		0	2		
Birds of prey	unidentified bird of prey		*Falconiformes/Accipitriformes*					3	2		
Birds of prey	Osprey	Fiskeørn	*Pandion haliaetus*	I	LC	LC		0	2		
Birds of prey	Common Kestrel	Tårnfalk	*Falco tinnunculus*		LC	LC		0	7		

Birds of prey	Merlin	Dværgfalk	*Falco columbarius*	I	VU	VU		0	2		
Cranes	Common Crane	Trane	*Grus grus*	I	LC	LC	C 1	64	0		
Waders	Eurasian Oystercatcher	Strandskade	*Haematopus ostralegus*		VU	VU	A 4			1	0
Waders	European Golden Plover	Hjejle	*Pluvialis apricaria*	I	LC	LC	C 1	1	0	0	7
Waders	Sanderling	Sandløber	*Calidris alba*		LC	LC	C 1	0	2		
Waders	Dunlin	Almindelig Ryle	*Calidris alpina*	I * (schinzii)	LC	LC	C1	0	7	0	24
Waders	Whimbrel	Småspove	*Numenius phaeopus*		LC	LC	C 1			0	3
Waders	Eurasian Curlew	Storspove	*Numenius arquata*		NT	NT	A 4	89	3		
Waders	Common Sandpiper	Mudderklire	*Actitis hypoleucos*		LC	LC	B 2c			0	110
Waders	unidentified wader		*Limicolae*					0	21		
Skuas	Arctic Skua	Almindelig Kjove	*Stercorarius parasiticus*		EN	EN		1	0		
Gulls	Little Gull	Dværgmåge	*Hydrocoloeus minutus*	I	LC	LC	A (3c 3e)	8	36		

Gulls	Black-headed Gull	Hættemåge	*Chroicocephalus ridibundus*		LC	VU	B 2c	9	17	10	0
Gulls	Common Gull	Stormmåge	*Larus canus*		LC	LC	B 2c	63	54	4	0
Gulls	Lesser Black-backed Gull	Sildemåge	*Larus fuscus*		LC	LC	A 3c / B 2e / C1	20	6		
Gulls	Herring Gull	Sølvmåge	*Larus argentatus*		LC	VU	B 2c 2e /C1	76	40		
Gulls	Caspian Gull	Kaspisk Måge	*Larus cachinnans*		LC	LC	C 1	6	11		
Gulls	Great Black-backed Gull	Svartbag	*Larus marinus*		LC	NT	B 2c	4	35		
Gulls	unidentified large gull		*Larus (magnus) sp.*					12	36		
Gulls	unidentified gull		*Laridae sp.*					3	1		
Terns	Sandwich Tern	Splitterne	*Thalasseus sandvicensis*	I	LC	LC	C 1	5	0		
Auks	Common Guillemot	Lomvie	*Uria aalge*	I * (ibericus)	LC	LC	C 1 / B 1	13	17		
Auks	Common Guillemot / Razorbill		*Uria aalge / Alca torda*					34	21		

Auks	Razorbill	Alk	*Alca torda*		LC	LC	C 1	24	11		
Auks	unidentified auk		*Alcidae sp.*					1	0		
Pigeons	Stock Pigeon	Huldue	*Columba oenas*		LC	LC		1	3	0	1
Pigeons	Common Wood Pigeon	Ringdue	*Columba palumbus*	I * (azorica)	LC	LC		3	0		
Owls	Long-eared owl	Skovhornugle	*Asio otus*		LC	LC				1	0
Owls	Short-eared owl	Mosehornugle	*Asio flammeus*	I	LC	LC		0	1		
Swifts	Common swift	Mursejler	*Apus apus*		NT	NT		1	0		
Songbirds	Sky lark	Sanglærke	*Alauda arvensis*		LC	LC		26	309	31	162
Songbirds	Sand martin	Digesvale	*Riparia riparia*		LC	LC		1	1		
Songbirds	Barn swallow	Landsvale	*Hirundo rustica*		LC	LC		46	122		
Songbirds	House martin	Bysvale	*Delichon urbicum*		LC	LC		1	0		
Songbirds	unidentified swallow / martin		*Hirundinidae sp.*					3	0		
Songbirds	Tree pipit	Skovpiber	*Anthus trivialis*		LC	LC		0	2	0	43
Songbirds	Meadow pipit	Engpiber	*Anthus pratensis*		LC	LC		40	80		

Songbirds	Rock pipit (eastern)		*Anthus spinoletta litoralis*					0	2		
Songbirds	unidentified pipit		*Anthus sp.*					72	70	0	1
Songbirds	Yellow wagtail	Gul Vipstjert	*Motacilla flava*		LC	LC		0	1		
Songbirds	Grey wagtail	Bjergvipstjert	*Motacilla cinerea*		LC	LC		0	1		
Songbirds	White wagtail / pied wagtail	Hvid Vipstjert	*Motacilla alba*		LC	LC		9	14	0	3
Songbirds	Winter wren	Gærdesmutte	*Troglodytes troglodytes*	I * (fridariensis)	LC	LC		8	1		
Songbirds	Hedge accentor	Jernspurv	*Prunella modularis*		LC	LC		2	0		
Songbirds	European robin	Rødhals	*Erithacus rubecula*		LC	LC		6	3	132	3304
Songbirds	Common redstart	Rødstjert	*Phoenicurus phoenicurus*		LC	LC				0	9
Songbirds	Redstart		*Phoenicurus sp.*					1	0		
Songbirds	Northern wheatear	Stenpikker	*Oenanthe oenanthe*		LC	NT		0	1		
Songbirds	Common blackbird	Solsort	*Turdus merula*		LC	LC		5	0	176	126
Songbirds	Fieldfare	Sjagger	*Turdus pilaris*		LC	LC				5	1

Songbirds	Song thrush	Sangdrossel	*Turdus philomelos*		LC	LC				224	201
Songbirds	Redwing	Vindrossel	*Turdus iliacus*		LC	LC		8	5	124	453
Songbirds	unidentified thrush		*Turdus sp.*					3	2		
Songbirds	Lesser whitethroat	Gærdesanger	*Curruca curruca*		LC	N/A				0	1
Songbirds	Common chiffchaff	Gransanger	*Phylloscopus collybita*		LC	N/A		2	0		
Songbirds	Willow warbler	Løvsanger	*Phylloscopus trochilus*		LC	LC		0	1		
Songbirds	unidentified leaf warbler		*Phylloscopus sp.*					0	2	0	24
Songbirds	Goldcrest	Fuglekonge	*Regulus regulus*		LC	LC		2	2	0	15
Songbirds	Common firecrest	Rødtoppet Fuglekonge	*Regulus ignicapilla*		LC	LC		10	0		
Songbirds	Spotted flycatcher	Grå Fluesnapper/Tyrrhensk Fluesnapper	*Muscicapa striata*		LC	LC				0	4
Songbirds	Blue tit	Blåmejse	*Cyanistes caeruleus*		LC	N/A		2	2		
Songbirds	Great tit	Musvit	*Parus major*		LC	LC		4	0		
Songbirds	Crow	Sortkrage	*Corvus corone*		LC	LC		7	0		

Songbirds	Carrion crow		*Corvus corone corone*					0	9		
Songbirds	Hooded crow	Gråkrage	*Corvus cornix*					9	0		
Songbirds	unidentified crow		*Corvus sp.*					3	0		
Songbirds	Common starling	Stær	*Sturnus vulgaris*		LC	LC		6	568		
Songbirds	Chaffinch	Bogfinke	*Fringilla coelebs*	I * (ombriosa)	LC	LC		13	61		
Songbirds	Brambling	Kvækerfinke	*Fringilla montifringilla*		LC	LC		10	10	2	3
Songbirds	European greenfinch	Grønirisk	*Chloris chloris*		LC	LC		3	0		
Songbirds	European goldfinch	Stillits	*Carduelis carduelis*		LC	LC		18	37		
Songbirds	Eurasian siskin	Grønsisken	*Spinus spinus*		LC	LC		16	450		
Songbirds	Common linnet	Tornirisk	*Linaria cannabina*		LC	LC		3	16		
Songbirds	Twite	Bjergirisk	*Linaria flavirostris*		LC	VU		0	6		
Songbirds	Lesser redpoll	Stor Gråsisken	*Acanthis flammea*		LC	LC		0	9		
Songbirds	unidentified *Carduelis* finch		*Carduelis sp.*					6	78		

Songbirds	Reed bunting	Rørspurv	*Emberiza schoeniclus*		LC	LC		0	3	0	42
Songbirds	unidentified songbird		*Passerine sp*					71	400		
Birds	unidentified bird		*Aves sp*					9	0	1	288
Total	**100 spp**							**27,355**	**18,282**	**736**	**4,825**