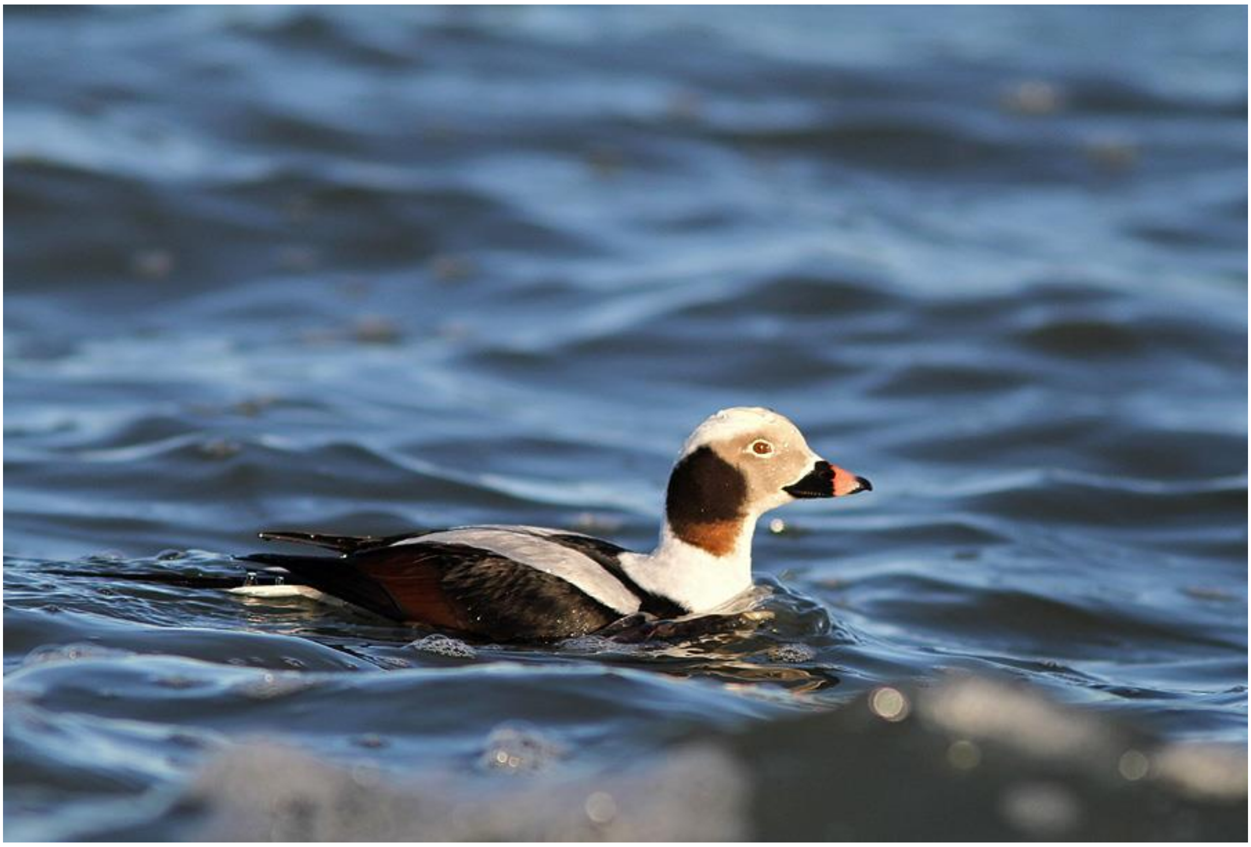
The pre-investment monitoring of birds flying over the area of the offshore wind farm Bałtyk Środkowy III

Final report with the research results



Bałtyk Środkowy III Sp. z o.o.

Final report

November 2014

The expert in **WATER ENVIRONMENTS**

The pre-investment monitoring of birds flying over the area of the offshore wind farm Bałtyk Środkowy III

Final report with the research results

Prepared for Bałtyk Środkowy III Sp. z o.o.

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Glossary

Seaducks – ducks of tribe *Mergini*

Dabbling ducks – ducks of genus *Anas*

Diving ducks – ducks of genus *Aythya*

Abbreviations

BŚ III – Bałtyk Środkowy III

EIA – Environmental Impact Assessment

OWF – offshore wind farm

EDR – effective distance radius

IUCN – International Union for Conservation of Nature

SPEC – Species of European Conservation Concern (categories)

1 Non-technical summary

The subject of the report

The report contains the results of the monitoring of birds flying over the area of the planned offshore wind farm Bałtyk Środkowy III („OWF BŚ III").

The location of the project

OWF BŚ III is planned to be constructed in the Polish exclusive economic zone, about 23 km from the shore, to the north of the city of Ustka. The location of the investment is presented in Figure 1.1.

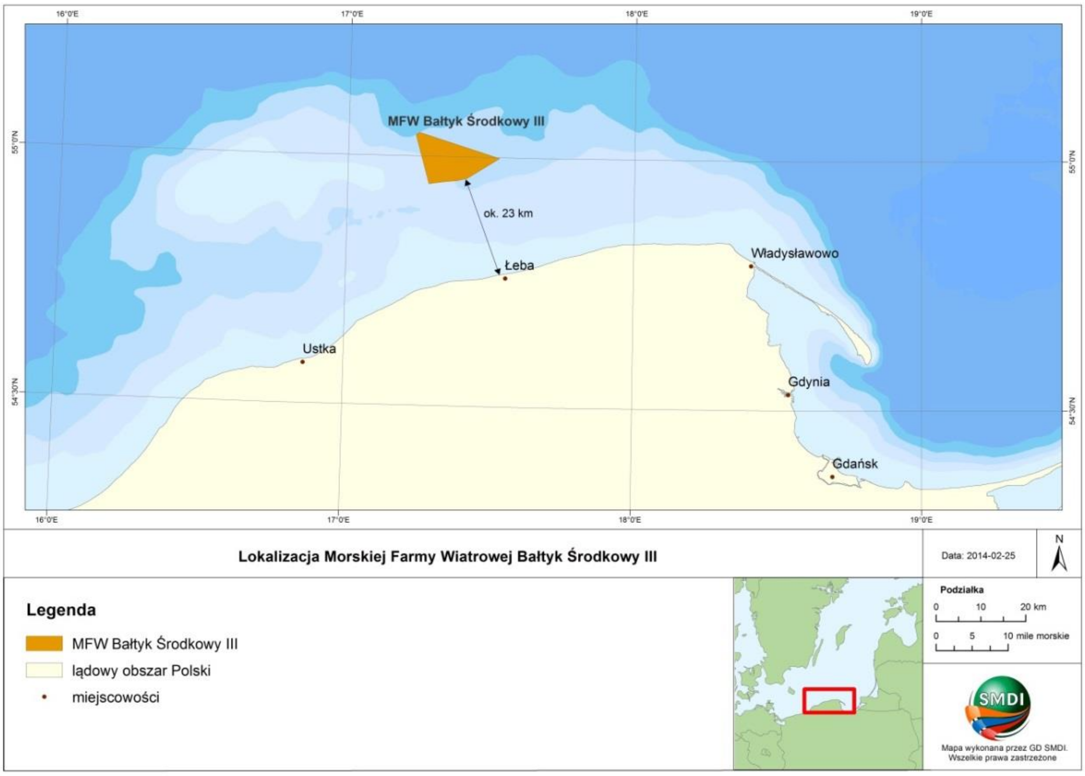


Figure 1.1 Location of OWF BŚ III. Source: own materials

The overall area of the project together with the buffer zones (which have to be excluded from the construction) is about 117 km^2. The area which can be developed with wind turbines is about 89 km^2.

The aim and scope of the monitoring

The aim of the monitoring was to collect the data needed to assess the quantity of birds flying over the area of the planned offshore wind farm and afterwards to carry out the valuation of the planned wind farm construction on avifauna.

We observed birds migrating over the area of the project as well as sea birds which permanently or temporary use this area. We collected the data on:

- the species composition,
- relative migration intensities,
- migration timing,
- flight directions,
- flying altitude of migrating birds.

We also propose to add the information about:

Research methodology

Research on migrating birds was undertaken during spring and autumn bird migration periods from March to May 2013 and from the second half of July to the end of November 2013.

Surveys of migrating birds were conducted from the survey vessel anchored at the predetermined location in the centre of the survey area. The area was marked with 8 buoys (A-H; Figure 4.3), which helped the observers to annotate positions of observed birds with certainty. The schematic illustration of buoy setting around the observation ship is presented in the figure below (Figure 1.2).

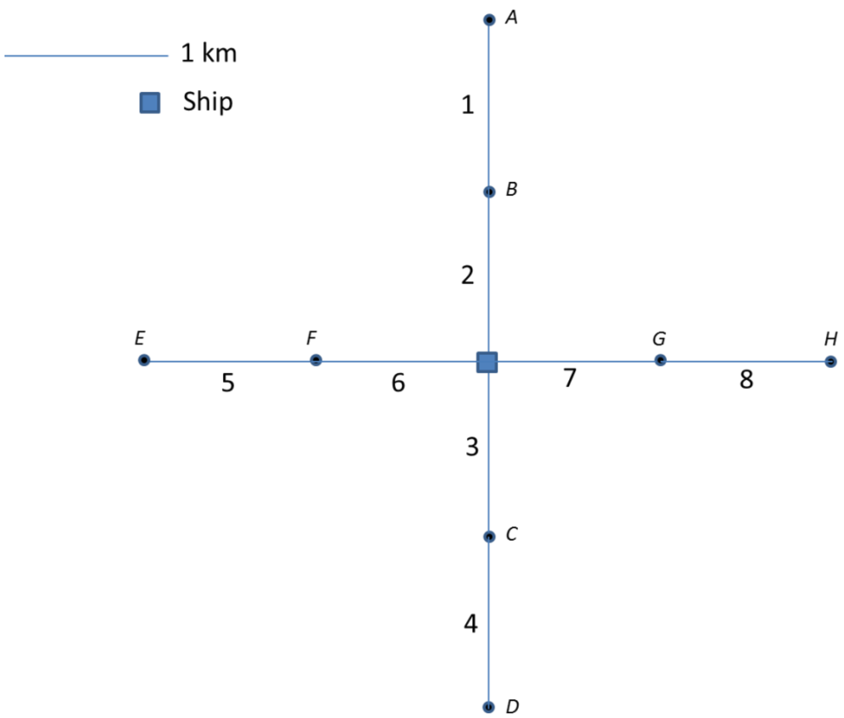


Figure 1.2 A schematic illustration of buoy setting around the observation ship, where observation transect segments are indicated by numbers and buoys indicated by dot symbols with letters.

The research programme included four types of investigations aimed to cover different aspects of bird migration and supplement each other:

- visual bird observations during daylight hours,
- tracking of migrating birds with the horizontal radar during daylight hours,
- recording altitude of migrating birds with the vertical radar at night,
- acoustic observations of migrating birds at night.

Visual observations were conducted through the day starting 30 minutes before sunrise to 30 minutes after sunset. Observers monitored the area around the ship and recorded all birds crossing the observation transect delimited by the buoys. Observers recorded bird species, number of observed birds, their flight altitude, direction, behaviour, time of observation and location in the transect.

Tracking of migrating birds during daylight hours was carried out using the horizontal radar with the range of 6 km, which was installed on the survey ship. The radar registered individual birds or flocks of birds and provided accurate data on flight direction. Horizontal tracking of birds was conducted simultaneously with visual observations, in order to identify the species tracked by the radar. Tracking was only possible in good weather conditions.

The flight altitude of birds at night was registered by the vertical radar with the range of 1500 m. The radar registered the flight altitude but it did not allow identification of the species. The altitude measurements were carried out during three fixed one hour recording periods (the first hour after dusk, midnight and the last hour before dawn), and bird echoes detected by the radar were documented recording their altitude.

Acoustic recordings during the night enabled the identification of dominating nocturnal migrating species which call when flying. Acoustic observations of migrating birds at night were conducted at the same hours as vertical radar observations. Acoustic observations provide a qualitative assessment of the species composition of nocturnal migration, albeit the method is biased towards the most audible species. These observations are only possible in good weather conditions.

The effective observation time for each research methodology, divided into spring and summer/autumn period, is presented in Table 1.1.

Table 1.1 The effective hours of observations of bird migration for each research methodology conducted at BŚ III in spring and summer-autumn 2013.

Research methodology	Spring 2013 [hours]	Summer-autumn 2013 [hours]
Visual observations during daylight hours	217.5	242
Tracking of migrating birds with the horizontal radar during daylight hours	178.3	236.3
Recording altitude of migrating birds with the vertical radar at night	45	61
Acoustic observations of migrating birds at night.	45	57

The collected data were processed in order to achieve the form enabling the analyses carried out to assess the environmental impacts.

Results

Investigations of migratory bird monitoring at BŚ III area in spring and summer-autumn 2013 allowed to characterise seasonal migrations of birds over the study area.

High diversity of migrating birds was registered and included 97 identified species (32 waterbirds and 65 landbirds) during spring (Table 1.2) and 56 identified species (25 waterbirds and 31 landbirds) during autumn migration (Table 1.3). Of the registered birds, 39 species in spring and 25 in autumn are considered being of conservation concern according to at least one of the four national and international criteria used to assess conservation status.

Visual daytime surveys, which were the main source of species identification and quantification, yielded 7,136 birds registered during the spring period (Table 1.2) and 17,569 during the autumn migration (Table 1.3).

In spring 60% of all registered daytime migrants were waterbirds and the remaining 40% landbirds. Among waterbirds, duck species were dominant, the most numerous being Long-tailed Ducks and Common Scoters. Landbirds included at least 60 species, mostly small passerines, the most abundant being Common Chaffinch and Common Starling. Large landbirds, which usually receive particular attention in wind farm studies due to high collision risk, were not numerous in spring: 8 raptors of different species were recorded and 3 small flocks of cranes consisting of 31 individuals in total (Table 1.2).

In autumn the majority of registered daytime migrants were waterbirds making up 90% of all counted birds (Table 1.3). Among waterbirds, the most numerous were geese (over 12,000 birds), of which mass migration was recorded mostly during a single survey cruise in late September-early October. Cranes dominated the composition of landbirds and were migrating in high numbers (nearly 1,500 cranes in total) during the same period as the migrating geese. The autumn of 2013 was generally very windy and days suitable for observations of migrating birds were few. Late September-early October represented a small 'window' of calm weather when mass migration of many bird species took place.

Table 1.2 Numbers of recorded birds of different species by survey method at BŚ III in spring 2013.

English name	Scientific name	Visual surveys, number	Horizontal radar tracks, number	Vertical radar records, number	Night time acoustic records, number
Waterbirds / marine birds					
Unidentified ducks	*Anatinae*	1,363	78		
Common Scoter	*Melanitta nigra*	970	52		41
Long-tailed Duck	*Clangula hyemalis*	489	20		12
Velvet Scoter	*Melanitta fusca*	323	19		
Black/Velvet Scoter	*Melanitta sp.*	293	16		
Great Cormorant	*Phalacrocorax carbo*	123	6		
Razorbill	*Alca torda*	96	5		
Northern Pintail	*Anas acuta*	92			
Unidentified geese	*Anserini*	75	9		
Mallard	*Anas platyrhynchos*	74			2
Eurasian Wigeon	*Anas penelope*	70	4		
Whooper Swan	*Cygnus cygnus*	52	2		
Unidentified divers	*Gavia sp.*	47	14		
Little Gull	*Larus minutus*	47	6		
Black-Headed Gull	*Larus ridibundus*	34			1
Black-throated Diver	*Gavia arctica*	21	2		
Common/Arctic Tern	*Sterna hirundo /*	19			

English name	Scientific name	Visual surveys, number	Horizontal radar tracks, number	Vertical radar records, number	Night time acoustic records, number
	paradisea				
Unidentified swans	*Cygnidae*	13	2		
Greater White-fronted Goose	*Anser albifrons*	12			
Mute Swan	*Cygnus olor*	11	1		
Common Tern	*Sterna hirundo*	11			
Goosander	*Mergus merganser*	10	1		
Arctic Skua	*Stercorarius parasiticus*	10			
Northern Shoveler	*Anas clypeata*	9			
Red-throated Loon	*Gavia stellata*	9	2		
Eurasian Teal	*Anas crecca*	8			24
Red-breasted Merganser	*Mergus serrator*	8	1		
Common Guillemot	*Uria aalge*	7			
Greylag Goose	*Anser anser*	5			
Black Guillemot	*Cepphus grylle*	5			
Common Eider	*Somateria mollissima*	4	1		
Unidentified tern	*Sterninae*	4			
Common Gull	*Larus canus*	3	1		
Common Goldeneye	*Bucephala clangula*	2			
Unidentified auk	*Alcidae*	2			
Whiskered Tern	*Chlidonias hybrida*	1			
Tundra Swan	*Cygnus columbianus*	1			
Great Crested Grebe	*Podiceps cristatus*	1			
Parasitic/Pomarine Skua	*Stercorarius parasiticus / pomarinus*	1			
Unidentified gull	*Laridae*		6		
Eurasian Coot	*Fulica atra*				11
Total waterbirds		***4,325***	***248***		***91***
Landbirds					

English name	Scientific name	Visual surveys, number	Horizontal radar tracks, number	Vertical radar records, number	Night time acoustic records, number
Common Chaffinch	*Fringilla coelebs*	500	1		
Common Starling	*Sturnus vulgaris*	429			10
Common Wood Pigeon	*Columba palumbus*	390	7		
European Golden Plover	*Pluvialis apricaria*	325	2		
Great Tit	*Parus major*	295			
White Wagtail	*Motacilla alba*	175			1
Unidentified passerines	*Passeriformes*	115			
Eurasian Skylark	*Alauda arvensis*	101			1,291
Meadow Pipit	*Anthus pratensis*	69			
Barn Swallow	*Hirundo rustica*	59			
Common Blackbird	*Turdus merula*	54			3,344
Eurasian Siskin	*Carduelis spinus*	51			
Common Crane	*Grus grus*	31	2		
Song Thrush	*Turdus philomelos*	18			333
European Greenfinch	*Carduelis chloris*	15			
Brambling	*Fringilla montifringilla*	13			
Unidentified thrushes	*Turdidae*	13			
European Robin	*Erithacus rubecula*	12			646
Rook	*Corvus frugilegus*	10			
Common Swift	*Apus apus*	9	1		
Dunnock	*Prunella modularis*	9			
Redwing	*Turdus iliacus*	9			589
Common Reed Bunting	*Emberiza schoeniclus*	7			
Wood Lark	*Lullula arborea*	7			
Northern Lapwing	*Vanellus vanellus*	7			
Long-tailed Bushtit	*Aegithalos caudatus*	4			
Tree Pipit	*Anthus trivialis*	4			

English name	Scientific name	Visual surveys, number	Horizontal radar tracks, number	Vertical radar records, number	Night time acoustic records, number
Red Knot	*Calidris canutus*	4			
Common Linnet	*Carduelis cannabina*	4			
Twite	*Carduelis flavirostris*	4			
Common Pigeon	*Columba livia*	4			
Red-breasted Flycatcher	*Ficedula parva*	4			
Chaffinch/Brambling	*Fringilla sp.*	4	1		
Eurasian Wren	*Troglodytes troglodytes*	4			
Fieldfare	*Turdus pilaris*	4			105
Grey Heron	*Ardea cinerea*	3	1		
Common House Martin	*Delichon urbica*	3			
Eurasian Sparrowhawk	*Accipiter nisus*	2			
Long-eared Owl	*Asio otus*	2			
Lapland Bunting	*Calcarius lapponicus*	2			
Eurasian Hobby	*Falco subbuteo*	2			
Yellow Wagtail	*Motacilla flava*	2			
Whimbrel	*Numenius phaeopus*	2			
Blue Tit	*Parus caeruleus*	2			
Black Redstart	*Phoenicurus ochruros*	2			
Common Chiffchaff	*Phylloscopus collybita*	2			
Wood Warbler	*Phylloscopus sibilatrix*	2			
Eurasian Woodcock	*Scolopax rusticola*	2			
Eurasian Blackcap	*Sylvia atricapilla*	2			
Unidentified *Acrocephalus* warbler	*Acrocephalus sp.*	1			
Common Buzzard	*Buteo buteo*	1			
European Goldfinch	*Carduelis carduelis*	1			
Western Marsh Harrier	*Circus aeruginosus*	1			
Stock Dove	*Columba oenas*	1			

English name	Scientific name	Visual surveys, number	Horizontal radar tracks, number	Vertical radar records, number	Night time acoustic records, number
Unidentified pigeon	*Columba sp.*	1	1		
Carrion Crow	*Corvus corone*	1			
Yellowhammer	*Emberiza citrinella*	1			
Common Kestrel	*Falco tinnunculus*	1			
Eurasian Pied Flycatcher	*Ficedula hypoleuca*	1			
Common Snipe	*Gallinago gallinago*	1			
Common Grasshopper Warbler	*Locustella naevia*	1			
Unidentified Pipit	*Motacillidae.*	1			
Osprey	*Pandion haliaetus*	1			
Eurasian Tree Sparrow	*Passer montanus*	1			1
Goldcrest	*Regulus regulus*	1			
Sand Martin	*Riparia riparia*	1			
Common Redshank	*Tringa totanus*	1			
Little Ringed Plover	*Charadrius dubius*				7
Eurasian Oystercatcher	*Haematopus ostralegus*				4
Spotted Redshank	*Tringa erythropus*				1
Total landbirds		***2,811***	***16***		***6,332***
Unidentified bird	*Aves*			1,102	
GRAND TOTAL		**7,136**	**264**	**1,102**	**6,423**

Table 1.3 Numbers of recorded birds of different species by survey method at BŚ III in summer-autumn 2013.

English name	Scientific name	Visual surveys, number	Horizontal radar tracks, number	Vertical radar records, number	Night time acoustic records, number
Waterbirds / marine birds					
Unidentified Geese	*Anserini*	11,969	185		

English name	Scientific name	Visual surveys, number	Horizontal radar tracks, number	Vertical radar records, number	Night time acoustic records, number
Unidentified Ducks	*Anatinae*	2,108	51		
Eurasian Wigeon	*Anas penelope*	324	9		
Unidentified swan	*Cygnus sp.*	179	11		
Common Scoter	*Melanitta nigra*	173	9		
Common/Velvet Scoter	*Melanitta sp.*	139	9		
Velvet Scoter	*Melanitta fusca*	134	2		
Long-tailed Duck	*Clangula hyemalis*	124	1		
Great Cormorant	*Phalacrocorax carbo*	71	8		
Greater White-fronted Goose	*Anser albifrons*	53	1		
Little Gull	*Larus minutus*	43			
Bean Goose	*Anser fabalis*	35			
Whooper Swan	*Cygnus cygnus*	32	3		
Eurasian Teal	*Anas crecca*	31	1		
Razorbill	*Alca torda*	24			
Black-headed Gull	*Larus ridibundus*	16			
Unidentified Tern	*Sterninae*	15			
Common Shelduck	*Tadorna tadorna*	15	1		
Unidentified Gull	*Larus sp.*	15	7		6
Common Guillemot	*Uria aalge*	13			
Red-throated Diver	*Gavia stellata*	11			
Gadwall	*Anas strepera*	8			
Common Eider	*Somateria mollissima*	4			
Black-throated Diver	*Gavia arctica*	3			
Common Gull	*Larus canus*	3			
Unidentified Merganser	*Mergus sp.*	3			
Common/Arctic Tern	*Sterna hirundo / paradisaea*	2			

English name	Scientific name	Visual surveys, number	Horizontal radar tracks, number	Vertical radar records, number	Night time acoustic records, number
Mute Swan	*Cygnus olor*	2			
Razorbill/Guillemot	*Alca torda / Uria aalge*	2			
Unidentified auk	*Alcidae*	1			
Common Tern	*Sterna hirundo*	3			
Mallard	*Anas platyrhynchos*	1			
Unidentified Diver	*Gavia sp.*	1			
Black Tern	*Chlidonias niger*	1			
Lesser Black-backed Gull	*Larus fuscus*	1			
Herring Gull	*Larus argentatus*		12		
Total waterbirds		***15,559***	***310***		***6***
Landbirds					
Common Crane	*Grus grus*	1,483	25		
Unidentified passerine	*Passeriformes*	69	9		1
Unidentified Wader	*Limicolae*	43	2		
White Wagtail	*Motacilla alba*	41			
European Robin	*Erithacus rubecula*	18			6
Eurasian Curlew	*Numenius arquata*	18			
Meadow Pipit	*Anthus pratensis*	11			
Common Starling	*Sturnus vulgaris*	11			
Goldcrest	*Regulus regulus*	10			
Eurasian Skylark	*Alauda arvensis*	10			
Common Chaffinch	*Fringilla coelebs*	8			
Whimbrel	*Numenius phaeopus*	8	1		
Common Swift	*Apus apus*	6			
Barn Swallow	*Hirundo rustica*	6			
Unidentified Thrush	*Turdidae*	4			
Yellow Wagtail	*Motacilla flava*	3			

English name	Scientific name	Visual surveys, number	Horizontal radar tracks, number	Vertical radar records, number	Night time acoustic records, number
Common Redstart	*Phoenicurus phoenicurus*	3			
Short-eared Owl	*Asio flammeus*	3			
Song Thrush	*Turdus philomelos*	2			
Sand Martin	*Riparia riparia*	2			
Yellowhammer	*Emberiza citrinella*	2			
Eurasian Pied Flycatcher	*Ficedula hypoleuca*	2			
Lesser Whitethroat	*Sylvia curruca*	1			
Fieldfare	*Turdus pilaris*	1			
Firecrest	*Regulus ignicapilla*	1			
Ruff	*Philomachus pugnax*	1			
Long-/Short-eared Owl	*Asio otus*	1			
Eurasian Siskin	*Carduelis spinus*	1			
Northern Wheatear	*Oenanthe oenanthe*	1			
Common Wood Pigeon	*Columba palumbus*	1			
Unidentified Falcon	*Falco sp.*	1			
Common Sandpiper	*Actitis hypoleucos*	1			1
Grey Heron	*Ardea cinerea*	1			
Common Blackbird	*Turdus merula*				10
Redwing	*Turdus iliacus*				4
Golden Plover	*Pluvialis apricaria*				1
Total landbirds		***1,774***	***37***		***23***
Unidentified bird	*Aves*	236		600	
GRAND TOTAL		**17,569**	**347**	**600**	**29**

Radar observations indicated consistent night time migration was during both spring and autumn, and rates of migrating birds often exceeded migration intensity observed during the day (Table 1.2, Table 1.3). Acoustic registration of bird calls suggested that nocturnal migrants consisted of mostly thrushes and other songbirds, with occasional calls of waders and ducks (Table 1.2, Table 1.3).

Out of at least 109 bird species registered during the migratory bird monitoring, 49 species are listed in at least one of the following lists indicating unfavourable species conservation status: IUCN Red List, Annex I of EU Bird Directive, SPEC category of Species of European Conservation Concern, and Annex I of the Regulation of the Minister of the Environment of Poland (Rozporządzenie Ministra Środowiska z dnia 12 października 2011 roku w sprawie ochrony gatunkowej zwierząt (Dz.U. 2011 nr 237 poz. 1419)). It should be noted that both with respect to the landbird and waterbird migration the species composition at BŚ III should be expected to be comparable to all other sites located in the same coastal zone along the Baltic mainland coast.

Recorded flying directions clearly revealed that the majority of observed birds were seasonal migrants, which maintained steady NE-E flying direction in spring and SW direction in autumn. Some species, however, did not show prevailing direction indicating that these were most likely birds that were resident in the area, namely auks, cormorants, and some of the Long-tailed Ducks.

Flight altitudes are important for evaluating potential risks of a wind farm to flying birds. Only species that fly at the altitude of the rotor swept area by the wind turbines are potentially vulnerable to collision risk. Further, collision risk is higher for species migrating at rotor altitude at night. This study, measuring the flight patterns of migrating birds, revealed that migration altitude differed substantially during the day and night time. Daytime migration was dominated by waterbirds, majority of them flying low, below 20 m representing lower range of typical offshore wind turbine. During the night time, the migration was dominated by passerines flying mostly at high altitudes of 400-600 meters, above wind turbine rotor height. An exception to this general pattern was daytime migration of geese and cranes, which flew in high numbers at altitudes higher than most other waterbirds, mostly at the potential rotor height of offshore wind turbines (60-200 m).

Conclusions

In terms of frequency and estimated abundance, seaducks dominate diurnally migrating bird composition at BŚ III, especially Long-tailed Duck, Common Scoter and Velvet Scoter. These species are numerous on wintering sites located further south and west from the BŚ III and therefore they pass the BŚ III area on their seasonal migrations. Considering flyway populations, the highest percentage was estimated at 3.7% for the Golden Plover and 3.4% for the Common Scoter passing the BŚ III area during the daylight hours. The total percentage of Common Scoters is likely higher, possibly up to 10% as this species also migrates at night. Migrating seaducks are not funnelled over the BŚ III but migrate in a broad front over the sea. Geese species were the most abundant migrants in autumn, with the total estimated exceeding 100,000 birds crossing the BŚ III area. This constitutes about 4% of geese populations considered together. The majority of geese breed in northern Siberia and migrate primarily to Western Europe for wintering, and some of these migrants pass the BŚ III area.

Other duck species, dabbling ducks and diving ducks, were not numerous and only occasional small flocks were recorded during spring and autumn migrations at BŚ III. For many of these ducks marine waters do not represent their prime habitat and therefore it could be expected that major part of their populations follow the coastline while migrating, a phenomenon frequently observed from the coast.

Two diver species, Red-throated Diver and Black-throated Diver were registered in rather low numbers and estimates suggest that up to several hundred birds pass the area per migration season, which constitute only a small percentage of the flyway population. Divers migrate both along the coasts and over open sea areas, in this way dispersing broadly

All three auk species that live in the Baltic Sea (Razorbill, Black Guillemot and Common Guillemot) were recorded and Razorbill was the most abundant of them during the migration monitoring. Estimates based on the observation data indicated that over 6,000 Razorbills could be passing the BŚ III area, but this figure almost certainly overrepresented migrating birds and is influenced by the local movements of resident birds, which is supported by the recorded flight directions.

Gulls were not very numerous during the migration periods at BŚ III. However Little Gull, which due to unfavourable conservation status in Europe is listed in the Annex I of EU Birds Directive and other conservation status defining documents, was consistently observed during both spring and autumn migrations and estimates suggest that up to 1,500 birds of this species, or 2% of the flyway population) could be passing the BŚ III area during migrations. Little gulls breed mostly to the east and north from the Baltic Sea and migrate for wintering to coastal waters in Western Europe (BirdLife International 2004). Substantial proportion of the breeding population migrates over the Baltic Sea, possibly widely dispersed from coastal to offshore areas and some bird inevitable pass the BŚ III area.

Great Cormorants were regularly observed at BŚ III although not in high numbers. Estimates suggest that up to 1,000 birds could be passing the area per migration season. While some of the observed individuals could have been migrants, many of observed cormorants did not show clear movement patterns, which suggest that they were resident birds which ventured far out to the open sea.

The investigations revealed rather intensive passage of Common Cranes in autumn. It is likely that this species was crossing the southern Baltic potentially leaving the land somewhere between Latvia and Poland and heading towards Rügen Island in Germany, a well-known staging area supporting many thousands of cranes in spring and autumn. It is not known what proportion of migrating birds could be crossing southern Baltic Sea on their seasonal migrations.

Waders, except for the Golden Plover, were not abundant at BŚ III area during migration periods. But several large flocks of Golden Plovers were recorded in spring 2013. It seems that only waders migrating in broad front over the sea cross BŚ III area and high numbers of these migrants are unlikely as they fly dispersed over a much larger region.

Only few raptors were recorded at BŚ III: 8 birds of different species in spring and 1 unidentified falcon in autumn. Being soaring birds which use raising thermal air currents for flight, raptors are unlikely to choose to cross large expanses of the open sea which lacks sufficient thermal currents. In addition, raptors are less capable to compensate for wind drift when flying over open sea. Therefore, only occasional individuals are expected to cross the BŚ III area and regular migration is not anticipated.

Although a lot of diurnally migrating passerines avoid flying over the open sea, some species were observed in relatively high numbers, though tiny proportions considering their very large populations. The most common species were: Common Chaffinch, Common Starling, Eurasian Skylark, White Wagtail, and Great Tit. The majority of passerines migrate at night and fly in a broad front at high altitudes, and thus often cross the open sea.

In conclusion, the BŚ III area does not lie on the major migratory route through which birds are funnelling during seasonal migrations. The area, however, is crossed by birds of different species which migrate in a broad front over the sea.

Considering registered species abundance, conservation status and sensitivity to offshore wind farms, several migrating bird species have been assessed as most relevant for consideration in the environmental impact assessment of the BŚ III wind farm, namely: Long-tailed Duck, Velvet Scoter, Common Scoter, geese species, swan species, Common Crane, Little Gull, Golden Plover and Razorbill.

Difficulties

Monitoring bird migration in the marine offshore environment from an unstable platform such as anchored ship has challenges and the survey methods, despite being state-of-the-art have their own limitations.

First of all, monitoring of migrating birds is affected by weather conditions, primarily wind, precipitation and clearness. Unstable observation base such as a ship cannot be used in strong winds and high waves in offshore environment. Survey instruments are also limited by weather conditions and have technical limitation in what they record. Visual observations are only efficient during daytime and even then can be affected by poor visibility, such as fog, and small passerines birds can only be noticed within a few hundred meters.

Horizontal radar tracking cannot be used at sea states above 3 bf and during precipitation; it does not measure flight altitudes; tracked targets need to be identified visually; and single individuals of small birds cannot be detected. Vertical radar measuring flying altitude of nocturnal migrants underrepresent objects in the lower 40 meters due to sea clutter and radar characteristics; species identification is not possible and number of observed individuals is unknown as radar target may represent a single bird or a flock.

Therefore, several survey methods are typically used for characterising bird migration in an offshore environment.

2 Introduction

Bałtyk Środkowy III sp. z o.o. plans to build the offshore wind farm "Bałtyk Środkowy III" in the Polish Exclusive Economic Zone of the Baltic Sea. DHI was involved as a consulting company during EIA process and assigned to conduct environmental research on marine mammals, background noise and migrating birds, as well as revise and consult research of other components and include results in the dedicated model.

This report is a summary of the results of monitoring of migrating birds in the area of OWF Bałtyk Środkowy III conducted in March – May and July – November 2013.Monitoring of migrating birds was part of a complex program of pre-investment studies of the marine environment, which was carried out for the procedure of environmental impact assessment. Results of the monitoring and analysis, which is the subject of this report will be used to assess the potential impacts of the project on the environment and included in the EIA report.

3 Project area

The project “Bałtyk Środkowy III” is situated outside the borders of Polish territorial waters, approximately 23 km from the shore (Figure 3.1).

The total area of the farm is approximately 117 km^2. This area is reduced by the 500 m buffer 1 from the inner boundary of the project area, as defined in PSZW, and buffer 2 determined by the size of the rotor. Therefore maritime area available for implementation of the project reaches 89 km^2.

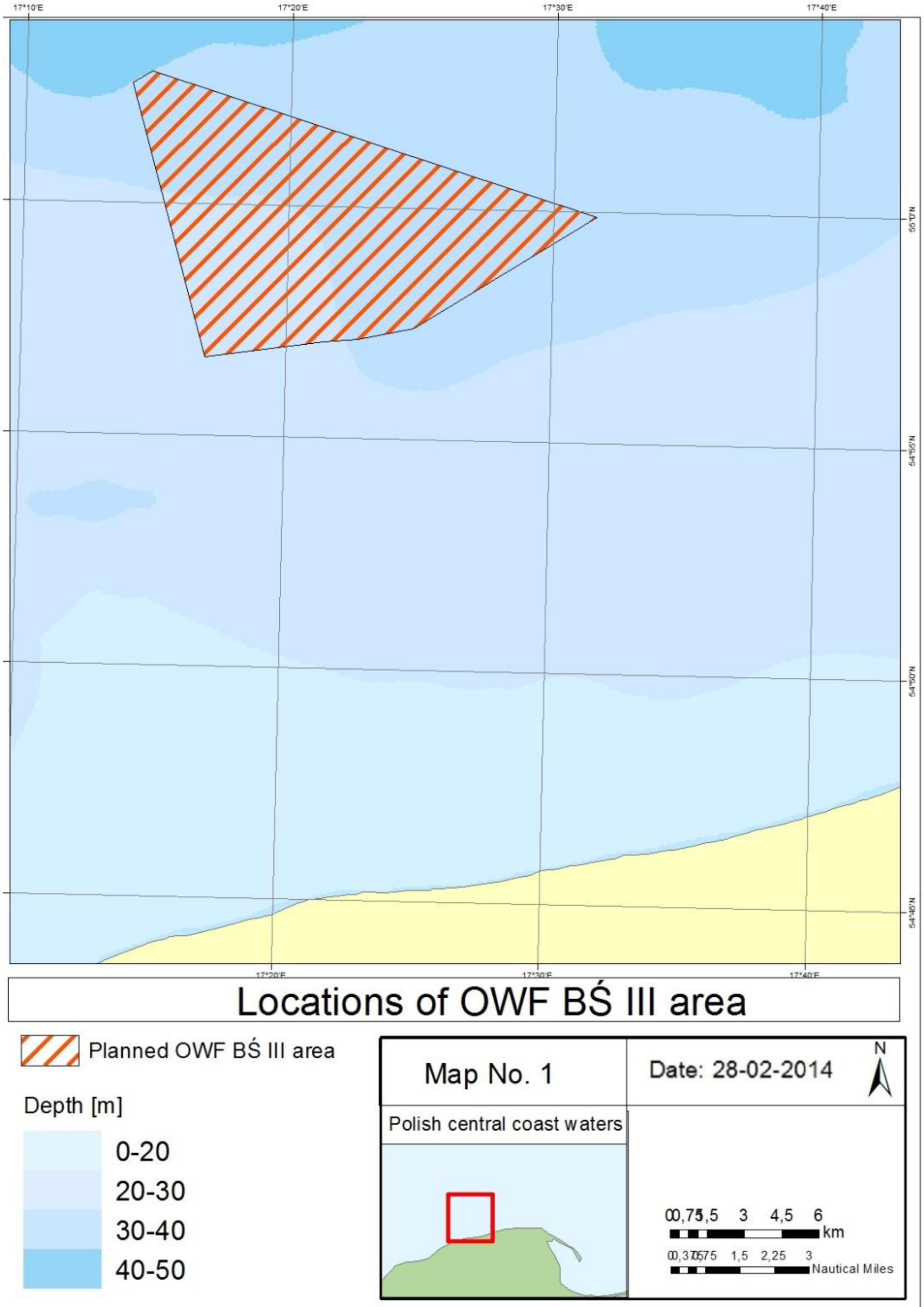


Figure 3.1 Location of the planned OWF “Bałtyk Środkowy III” area.

4 Methodology

No firmly established standards or accepted methodologies for the assessing potential impacts of offshore wind farms on birds exist in Poland, as BŚ III is the first project of this kind in the country. There are only generic guidelines for the environmental impact forecasting procedures for offshore wind farms (Stryjecki et al. 2011) but well established recommendations for land-based wind farms (Chylarecki et al. 2011, Buse 2013). Thus to assess the possible impacts of BŚ III project on birds, we used methodologies proven in the West European countries, where offshore wind energy sector is more developed, at the same time adhering to Polish national procedures of wind farm EIAs.

The purpose of monitoring migrating birds at the OWF area BŚ III was identification of species composition of migrating birds, relative migration intensities, migration phenology (timing), flight directions and measuring flying altitude of migrating birds. Collecting such information is essential for the environmental impact assessment of wind farms on migrating birds..

Existing guidelines for preconstruction monitoring of migrating birds at offshore wind farms recommend using several research methods for collecting the data, including visual observations and migration characterisation using radars and recording calls of nocturnal migrants acoustically (BSH 2007, Orth et al. 2011, Stryjecki et al. 2011, Krijsgsveld et al. 2011, Vanermen et al. 2013). With some variation in scope of investigations, the same general approach for baseline monitoring and subsequent EIAs has been used for offshore wind farm assessments in Denmark (Skov et al. 2012, 2012b), Sweden (IfAÖ 2004), Netherlands (Krijsgsveld et al. 2011), Belgium (Vanermen et al. 2013) and UK (SmartWind 2013).

Considering the methodological recommendations and prevailing practices for monitoring migrating birds offshore in the West European countries, it was decided that bird migration at BŚ III area should be monitored for at least 40 days during spring and autumn migration periods (March – May and July – November). Four methods of investigations were used aiming to answer different questions about bird migration:

- <u>Visual observations</u>: species identification and quantification of bird passage rates during daylight hours, additionally recording information on bird flight altitudes and migration direction.
- <u>Horizontal radar during daylight hours</u>: characterising species-specific flight trajectories of migrating birds (flying direction).
- <u>Vertical radar</u> at night: characterising flight altitude of nocturnal migrants.
- Acoustic observations at night: recording relative migration intensity of nocturnally migrating and vocal bird species.

Technical description of these methods follows further in this chapter and method limitations are additionally described in chapter 0.

Detailed knowledge about bird migration in offshore Baltic is rather scarce and limited to the recent baseline investigations and EIA studies of offshore wind farms. No investigations of bird migration were conducted in the Polish offshore sector of the Baltic Sea earlier. Therefore this study represents new information for the area. However some information about bird migration is available from coastal monitoring in Poland and results of these studies are referenced in the report.

When interpreting the results of migrating bird observations at BŚ III, references are made in this report to other relevant studies conducted in offshore areas of the Baltic Sea and the North Sea (Figure 4.1). This report also refers to a few review studies, which summarise information about birds at offshore wind farms and include data from studies conducted in the UK and the USA (e.g., Cook et al. 2012, Furness et al. 2013, Johnson et al. 2014).

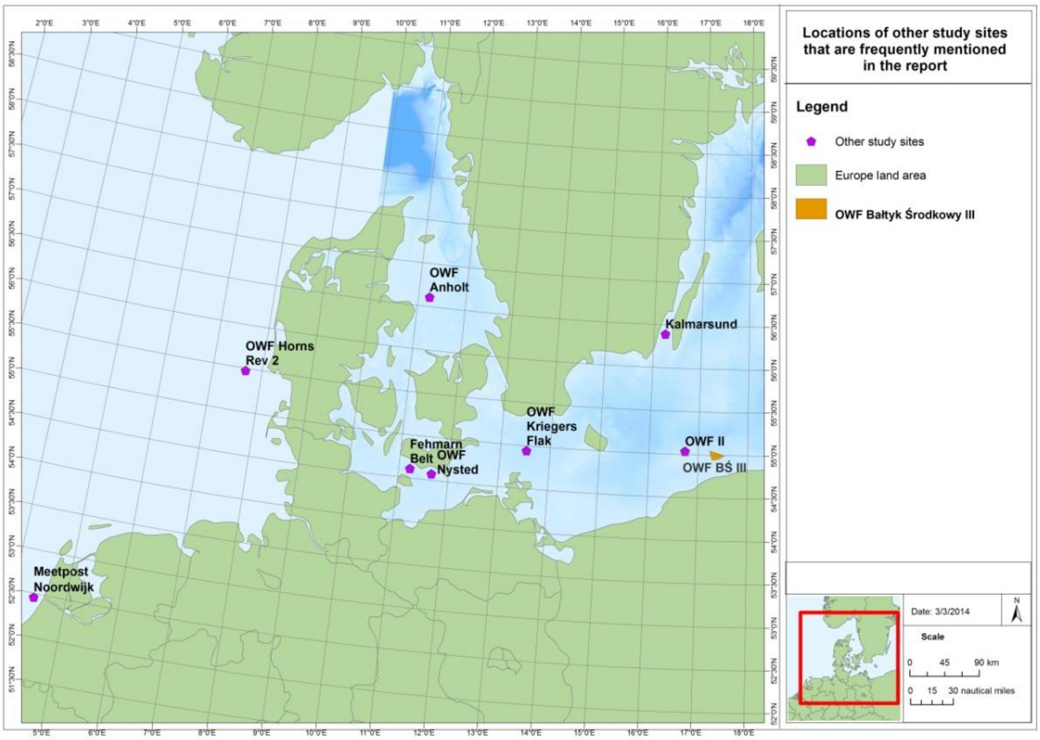


Figure 4.1 Regional map presenting locations of other relevant studies referred to in the report.

4.1 Methodology of research campaign

Research on migrating birds was undertaken during the periods from March to May and from the second half of July to the end of November 2013. Different bird species have different migration schedules, therefore investigations were planned in a way so they cover broad periods of seasonal migrations in spring and autumn. It was aimed to conduct migrating bird observations for at least 40 calendar days spread out during both spring and autumn. This period is considered sufficient for characterising migrating birds offshore and, for example, falls between the German requirements of monitoring for 52 days (BSH 2007) and Danish practice of 30 days (Piper et al. 2008).

Conducting monitoring from a stable platform is recommended, but in the absence of stable construction offshore migrating birds could be investigated from ships (BSH 2007). Because there are no stable platforms installed in the BŚ III area from which bird observations could be conducted, the preconstruction monitoring of migrating birds has been carried out from a ship anchored on the project site and included four types of investigations aimed to cover different aspects of bird migration and supplement each other. These activities consisted of visual, acoustic and radar-based observations, which are described in detail below. If a stable platform had been available as a basis for observations, the investigation methods could have been supplemented by laser rangefinders capable of making accurate measurements of flight altitudes of migrating birds (Skov et al. 2012b).

Surveys of migrating birds were conducted from the survey vessels Dr. Lubecki and Safira anchored at the predetermined location in the survey area (UTM33N: 6097281 N, 649246 E; Figure 4.2). The anchoring location was chosen in approximately the middle of the project area, and it was assumed that bird migration recorded there would characterise migration patterns in the entire BŚ III zone. As the entire BŚ III area is located relatively far offshore and there are no any landscape elements or man-made structures around, it is not expected that passage of migrating birds would differ across the project area. Also, with operational radius of horizontal radar of 6 km, the anchoring location ensured that most of the wind farm area is covered. Before anchoring a ship, the area around the position was marked by setting 8 buoys in a cross pattern Figure 4.3), which helped the observers to annotate positions of observed birds with certainty.

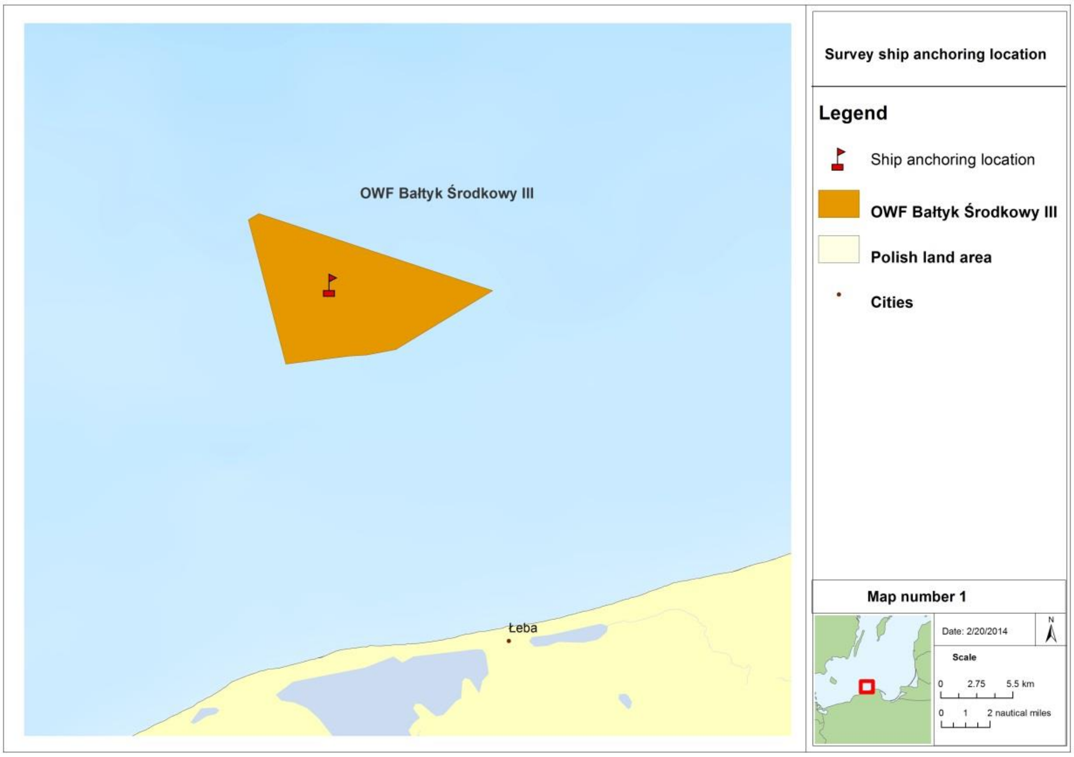


Figure 4.2 Ship anchoring location for observations of bird migration on BŚ III project area.

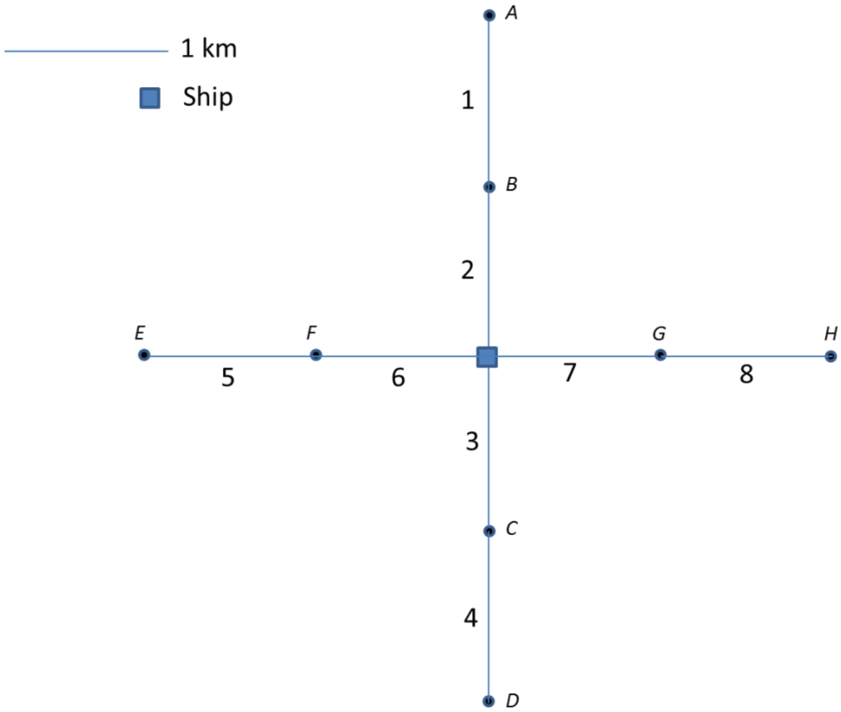


Figure 4.3 A schematic illustration of buoy setting around the observation ship, where observation transect segments are indicated by numbers and buoys indicated by dot symbols with letters.

Observations and tracking were made from the top deck behind the bridge (approximately 3.5 m above sea level) on research vessels Dr. Lubecki and Safira (Figure 4.4). Radar and radar computers were located on the bridge. The radar screen can be transferred to observer's laptop by a local network connection and a framegrabber. Observer laptops with 30 m power and Ethernet cables, local network connections and tracking software were available on both ships.

Migrating bird monitoring team consisted of 3-4 persons during a cruise, and observers alternated among different monitoring tools that were used to ensure the planned survey coverage and rest schedule of the team.

Figure 4.4 Images of the research vessel Dr. Lubecki.

4.1.1 Visual observations during daylight hours

Visual observations provide species identification and passage rates of most frequent migrants during daylight hours. Observations were conducted through the day starting 30 minutes before sunrise to 30 minutes after sunset and were possible in most weather conditions. Observers had four 30 minute breaks during the day: breakfast (usually 07:00-07:30), lunch (13:00-13:30), afternoon break (15:00-15:30) and dinner (18:00-18:30). Observers using the aid of binoculars monitored the area around the ship and recorded all birds crossing the observation transect delimited by the buoys. Observers recorded bird species, number of observed birds, their flight altitude, direction, behaviour, time of observation and location in the transect. Flying bird altitude was visually assessed in approximate altitude bands (1-2-3-4-5-6-7-8-9-10-15-20-25-30-40-50-60-70-80-90-100-150-200-250-300-400-500 meters and above). Three times during the day observers have 30 minute break, which do not count into the observation time.

The distances covered by visual observations depend on the bird species, flock size and environmental conditions determining visibility. Typically, large birds (waterbirds, raptors) can be reliably covered visually up to distances of 3-5 km during good visibility conditions, while small passerines and waders can only be seen within a radius of a few hundred meters. Likewise, bird flight altitude can also be reliably covered only up to 100-200 meters, again depending on weather conditions, species and flock size. Biased detectability means that bird migration is only characterised in relative terms, but not in absolute numbers.

Birds seen which are not crossing the transect are ignored. Sitting birds or birds associated with the survey boat or other boats are also ignored. Observations are made by one observer at a time. A close collaboration with the radar operator should always take place to ensure birds a picked up at some distance before using binoculars to search and identify the species.

Data are recorded into data sheets and should include transect segment, species, number, age, plumage, behaviour, distance, flight direction and height (Figure 4.5).

visual observations / daytime							**study area:**				
date:					**vessel:**						**sheet-no.:**
observer:							**counting side:** portside / starboard				
position: berth spring / berth autumn / berth movable spring / autumn											
age [1]: juv = juvenil; ad = adult; imm = immatur; 2 = 2nd year of life; 3 = 3d year of life; 4 = 4th year of life; no value = empty											
plumage [2]: W = winter plumage; B = breeding plumage; T = transient; M = male, F = female; gannet = plumage code 1- 5;											
distance [4]: exact meters; **flight-height** [5]: exact meters											
interval (UTC)	**species**	**Transect segment**	***Radar Target* (from BirdTracker)**	**number**	**age**[1]	**plu-mage**[2]	**beha-viour**[3]	**dis-tance**[4]	**height**[5]	**direction foll. ESAS**	**comments**
: -											
: -											
: -											
: -											

Figure 4.5 Data sheet for entering visual observations while in the field.

Following each day or during periods of few birds the visual observation data are entered into a database. Results entered into the databases should be double-checked for plausibility and errors by the cruise leader.

- Migration. Continuous observations of transect are made every hour and entered into a worksheet.
- Eight transect buoys marking each 1 km segment need to be launched and retrieved before/after each cruise.

Equipment:

- Binoculars (personal for each observer)

4.1.2 Tracking of migrating birds with the horizontal radar during daylight hours

Tracks of migrating birds were recorded using the horizontal radar with the specialized software program "BirdTracker" which makes it possible to log tracks of individual birds or flocks from the horizontal surveillance radar (Figure 4.6). A radar range of 6 km was used. During tracking the PC screen is divided into two parts, the radar video and the window to record data, including number of birds, flock altitude, flock size (dimension), behaviour, status when start tracking, status when end tracking and comments per track or per session. Start and end time, number of nodes and coordinates per node are added automatically. Several tracks plus data can be recorded in parallel (at the same time) on the screen, one of them active (Figure 4.5). Each track has several nodes, representing the different locations of the track. In addition to the start and the end-point, directions are calculated automatically for all tracks. The radars installed on survey ships used Furuno 25 kW X-band technology and had GPS-stabilization to ensure correct geo-referencing of recordings. Horizontal radar tracking provides accurate data on migration direction. Tracking is only possible in good weather conditions (sea state less than 3, no precipitation), therefore this methods was not 100% effective during the days with high waves and/or precipitation. When such conditions were temporary, radar was running and observers were on duty and such periods were included into effective observation time, as bird tracks were often recorded also during marginal conditions. Horizontal radar tracking provides qualitative rather than quantitative data (recorded track characteristics are the main focus, but not number of tracks per time unit). Two observers are involved in the real-time radar-tracking. The observer operating the radar computer with "BirdTracker" software coordinated closely with the observer carrying out visual observation on the deck (described in chapter 4.1.1 above) and records species identification to each logged bird track. As a back-up and a resource for potential further investigation of bird migration, images of the radar screen were saved automatically every 2 minutes during the cruises.

The purpose of the tracking session is to track and identify as many birds/flocks as possible. It is important to stress that the bird tracks identified may well constitute only a proportion of the total number of birds or bird flocks moving through the area investigated. This is a result of the sampling frequency combined with the number of bird tracks that is possible to identify by observers on the radar screen, which is an underestimation of the actual tracks. However, no selective tracking should be used in order to make the recordings representative.

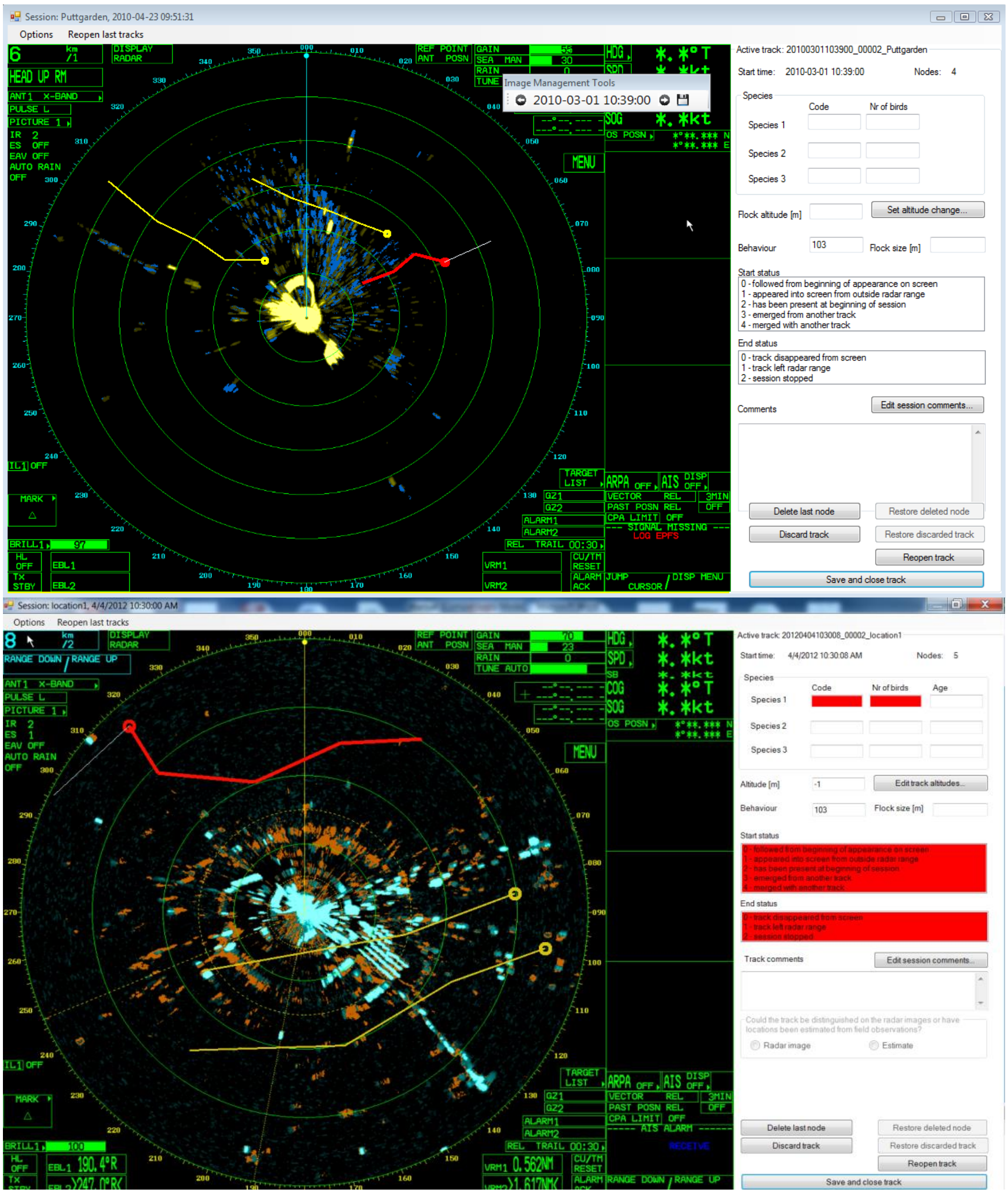


Figure 4.6 Examples of "BirdTracker" views with radar screen as background image on the left and editing sheet on the right. One active (red) and two inactive tracks (yellow) are shown from the same session.

Equipment for horizontal radar tracking:

- HD screen laptop
- Mouse
- Laptop hood for outdoor work
- Instructions in case of power cut off (PCs need to be running at all times)
- Tracking software: BirdTrack2

Settings not to be changed:

- Range: 6 km
- Trail: 1 minute

Settings which are allowed to be changed:

- Gain (50-60 normally should work)
- Sea (20-50)
- Rain (20 as a standard setting)
- EBL (guide lines)

Description of the radar system

The radar system consists of a 25 kW X-band radar, with separate processor and keyboard.

Two identical computers are connected to the radar. The first computer is the primary computer and should be used for all work. The second computer is a backup computer. It has the same functionality and connections as the first computer, and this computer should be used in case of a failure in the first computer.

The radar is connected to a satellite compass which enables the system to produce a north up picture and also the ability to plot true trails after objects. The satellite compass also provides ship course, speed, and position.

A laptop computer is available for outside observations. This laptop needs to be connected to the white Ethernet router with an Ethernet cable. From this laptop it is possible to make a remote desktop connection to one of the two stationary computers, which enables observers to make observations from the outside observation deck.

The laptop case contains a 500 GB external hard drive for transporting data from the boat after each cruise.

The entire system is supplied via a UPS. The UPS can power the complete system for approx. 10 min in case of a power failure on the boat.

When the system is not used or between surveys, the two stationary computers and the laptop should be left powered and connected to white router. The framegrabber software should be left running. The radar processor should be turned off using the radar keyboard.

Radar characteristics

Conventional ship radars were used (see Table 4.1). The horizontally mounted radar was at a 6 km range and once tilted vertically the range was changed to 1.5 km.

Table 4.1 Specification of surveillance radar.

Feature	Characteristic
Brand	Furuno
Type	FAR2127
Power output [kW]	25 kW
Frequency	9,410 ± 30 MHz (X-band)
Horizontal aperture angle of radar	1 degree
Vertical aperture angle of radar	10 degree
Rotational speed [min-1]	24
Antenna length [mm]	2,400

The number of echoes and tracks as recorded by the radar is biased both by the detection rate of the radar and noise sources. The detection rate can be approximated by comparing the number of tracks recorded by the horizontal surveillance radars at the land stations with the number of tracks recorded at the offshore station, as it was done during the study of bird migration in the Fehmarn Belt (Figure 4.7, FEBI 2013). It was found that while the density of tracks recorded at the coast will to some degree depend on the location of flight paths parallel to the coastline and thus the distance to the radar (waterbirds), the distribution of migrating birds offshore is assumed to be equally dispersed and the detection of bird echoes offshore should be uniform. This, however, was not the case and as shown in Figure 4.7 detections increase to a distance of 2 km and decrease after a distance of 3 km. The empirical curve of the offshore station thus describes the distance-dependent detection of the radar (Figure 4.7).

The left side of the detection curve offshore displayed in Figure 4.7 reflects the elimination of clutter close to the radar by the STC filter (set to 1800 m) and the small volume covered, while the right side of the curve reflects a combination of the distance-related decrease in sensitivity and the increasing volume covered by the radar beam (Figure 4.8).

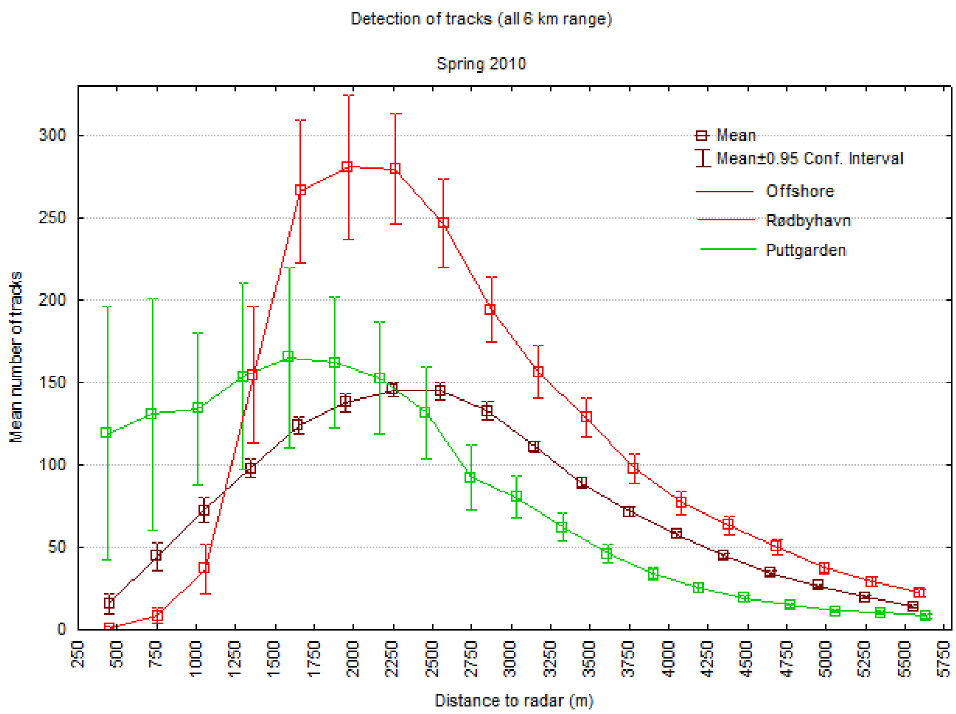


Figure 4.7 Example illustrating surveillance radar sensitivity to distance to an object: all birds tracks with a range of 6 km in Puttgarden and in Rødbyhavn spring 2010 compared to the track detection offshore (entire 2010) in Fehmarn Belt. The plot shows mean (± 95% confidence intervals) number of tracks per distance category from radar (figure adapted from FEBI 2013).

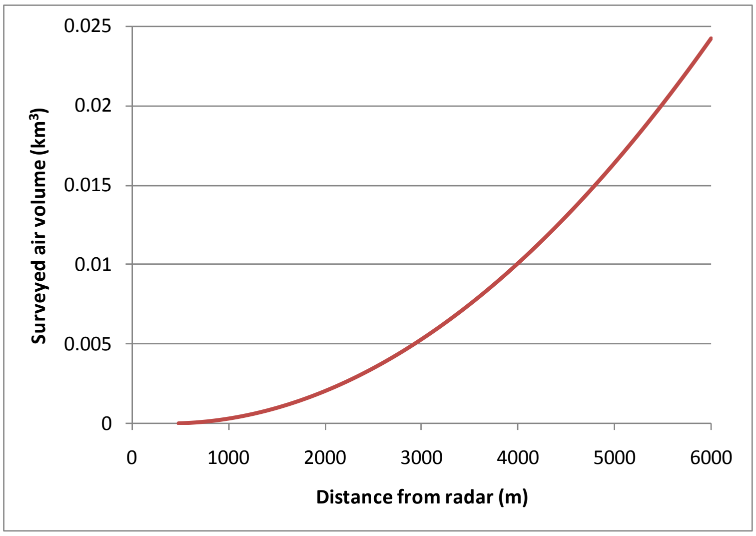


Figure 4.8 Estimated surveyed air volume by the horizontal surveillance radar depending on distance to the radar applying an opening angle of 10°. The estimate assumes equal species-specific radar cross sections (figure adapted from FEBI 2013).

4.1.3 Recording altitude of migrating birds with the vertical radar at night

Vertical radar recordings provide flight altitudes and relative passage rates for nocturnal migrants. No species discrimination is possible. The horizontal radar (described above) was installed with a switch which allows changing the mode of the radar antenna to vertical in order to record altitude measurements of migrating birds during the night (Figure 4.9). Once in vertical mode, radar range was changed to 1500 meters. Recordings using vertical radar are possible during most weather conditions, except for really heavy swell and rain. The altitude measurements were carried out during three fixed one hour recording periods (the first hour after dusk, midnight and the last hour before dawn), and bird echoes were documented recording their altitude. The altitude range below 40 m is only insufficiently captured (due to small dihedral angle and sea clutter) and therefore should be viewed as suggestive but not certain measurements.

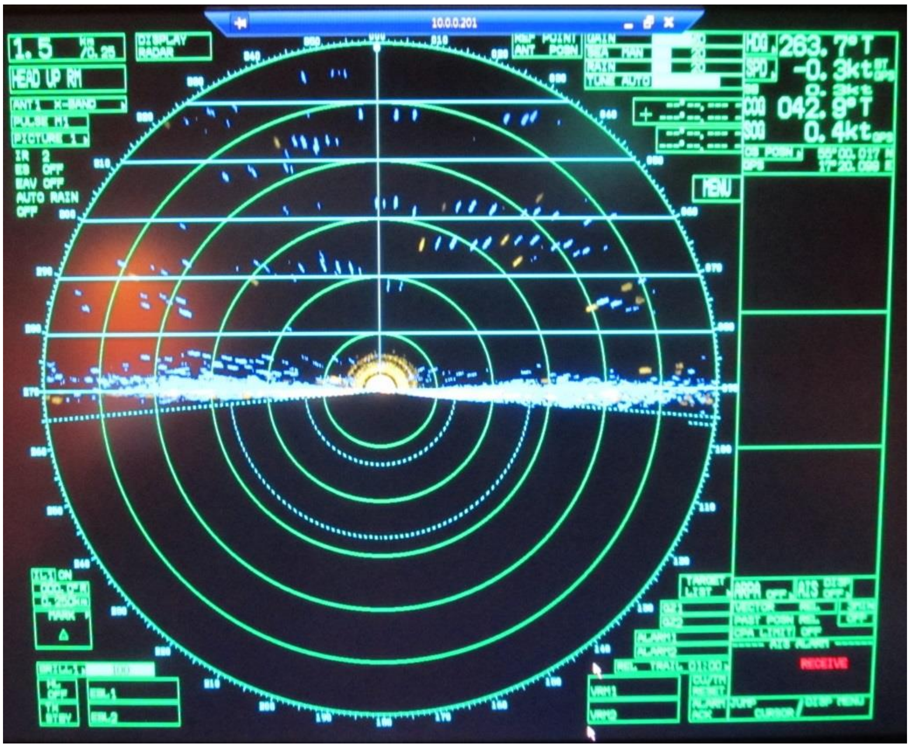


Figure 4.9 Computer screen shot showing vertical radar in operation.

Equipment for vertical radar tracking:

- HD screen laptop
- Mouse
- Laptop hood for outdoor work
- Instructions in case of power cut off (PCs need to be running at all times)

Settings not to be changed:

- Range: 1.5 km
- Trail: 1 minute

Settings which are allowed to be changed:

- Gain (50-60 normally should work)
- Sea (20-50)
- Rain (20 as a standard setting)
- EBL (guide lines)

4.1.4 Acoustic observations of migrating birds at night

Acoustic recordings during the night enable the identification of dominating nocturnal migrating species which call when flying. Acoustic observations of migrating birds at night were conducted during the three fixed one hour recording periods: the first hour after dusk, midnight and the last hour before dawn. Acoustic observations provide a qualitative assessment of the species composition of nocturnal migration, albeit the method is biased towards the most audible species. The number of flying individuals as well as any other parameters like distance to the station, flight direction or altitude cannot be covered by this method (Figure 4.10). These observations are only possible in calm weather conditions and no precipitation. Observers listened to the calls of migrating birds while standing on the deck, identified the species, counted separate calls and summed them for one-hour period. As a backup, bird calls were recorded automatically using specialized recorder SM2BAT (Wildlife Acoustics) fitted with Telinga Mono microphone for bird calls.

bird calls			study area:				
date:		vessel:					sheet-no.:
observer:			counting side:	portside + starboard (all around)			
position: berth spring / berth autumn / berth movable spring / autumn							
age [1]: juv = juvenil; ad = adult; imm = immatur; 2 = 2nd year of life; 3 = 3d year of life; 4 = 4th year of life; no value = empty							
interval (UTC)	species	number calls	beha- viour[3]	dis- tance[4]	height[5]	direction foll. ESAS	comments
: -							
: -							
: -							
: -							
: -							
: -							

Figure 4.10 Data sheet for entering nocturnal acoustic observations while in the field.

Equipment used:

- Microphone and recording box
- Recorder
- Recording sheets

4.1.5 Technical limitations of survey methods

Monitoring bird migration in the marine offshore environment from an unstable platform such as anchored ship has challenges, and despite representing the state-of-the-art the survey methods that are used have some limitations, which are not encountered during wildlife studies on land. This is primarily related to the unstable observation base and strong influence of weather conditions. Therefore, several survey methods are typically used for characterising bird migration in an offshore environment. The results allow characterising bird migration in qualitative and relative quantitative terms. However, we have to acknowledge that our understanding about bird migration is incomplete considering technological deficiencies of study methods, gaps in basic biological knowledge, high diversity of migrating bird species, variability of environmental conditions and usually limited duration of investigations. Pros and cons of the used survey methods are summarised in Table 4.2.

Table 4.2 Comparison of four survey methods that were used for monitoring migrating birds at BŚ III by showing their advantages and limitations.

Migrating bird survey method	Advantages	Limitations
Visual daytime surveys	• Can be conducted in most wind conditions • Bird species are identified and number counted • Approximate assessment of flight altitude and direction	• Limited and visibility-dependent detection distance • Small passerines are detected only within few hundred meters

Migrating bird survey method	Advantages	Limitations
Horizontal radar tracking during daylight hours	• Logging precise trajectories of flying birds over relatively long distances	• Does not work at sea states higher than 3 bf • Does not work during precipitation • No altitude measurements • Tracked targets have to be identified visually • Single individuals of small bodied birds cannot be tracked
Acoustic night time surveys	• Identification of nocturnal migrants that cannot be seen	• Depends on weather conditions – sounds are difficult to hear with increasing wind or during rain • Limited detection distance • Silent species are undetected • Unknown true number of passing migrants
Vertical radar recording during night time	• Can be used in most wind conditions • Records vertical distribution of nocturnal migrants up to 1500m	• Lower 40 meters are poorly presented due to sea clutter and radar characteristics • No species identification • Unknown number of individuals: radar target may represent a single bird and a flock

4.1.6 Realized survey effort

Field observations were conducted over 20 calendar days in spring and 26 calendar days during the autumn migration period by spreading sampling effort in order to cover migration of different species and varying environmental conditions (Table 4.3, Table 4.4). As intended, the surveys were conducted during ship cruises in March – May and July – November 2013, exact survey dates being determined by adjusting the initial survey plan to weather conditions. There were a lot of days with rough weather in September – November, when frequent strong winds and high waves affected the survey schedule. Successful survey cruise requires at least 4 days with suitable weather for sailing to/from the survey site, setting and retrieving the marking buoys and conducting at least 2 days of observations.

During most of the time all planned observation types followed their respective schedules but during some conditions the horizontal radar was not fully effective due to high waves and sea clutter, although it was still run and birds were tracked whenever possible. Horizontal radar was not used at all during the cruises in March and July, and not during two days in late April and one day during the November cruise due to unsuitable sea conditions.

Due to the nature of bird observations at sea it is generally expected that all methods will not be equally efficient at all times, and this is one of the reasons why several methods are simultaneously used when monitoring migrating birds at sea. None of the survey methods is absolute in terms of providing complete quantitative account of bird migration and full qualitative characteristics of bird passage events. It should be acknowledged that these methods provide relative samples of bird migration by supplementing each other, and the data requires qualified interpretation by experts and comparison with the findings of other studies, which used similar methodologies. Imperfect as they are although qualitative, the applied survey methods represent the current state of the art of investigations of bird migration at sea. Bird tracking by horizontal radar is the most sensitive method to survey conditions, however impact due to lost observation opportunities is not major as the method is primarily qualitative, characterizing trajectories of migrating birds.

Despite some of the observation time lost due to unfavourable weather and sea conditions, the overall effective survey effort was high considering the monitoring plan and theoretically available time when the observers were out at sea. During spring season the effective survey effort was 100% for visual observations, vertical radar use at night and night time acoustic recordings, and 76% for horizontal radar tracking during daylight hours (Table 4.3). In late summer - autumn the effective survey effort was 98% for visual observations, 79% for horizontal radar tracking, 100% for vertical radar use at night, and 93% for night time acoustic recordings (Table 4.4).

We therefore conclude that the conducted field investigation campaign was successful and collected data meets the requirements of pre-construction monitoring of offshore wind farms and allows characterising bird migration quantitatively and qualitatively in the BŚ III project area. Subsequently the collected data are sufficient to carry out the reliable analyses for the purpose of the EIA.

Table 4.3 List of cruises for observations of migrating birds at BŚ III area in spring 2013. Sailing times to/from the area and preparation on site are not included. Time indicated as UTC.

Cruise	Start date/time of observations	End date/time of observations	Survey type*	Planned observation hours	Effective observation hours	Conditions
1	2013-03-27 09:30	2013-03-29 09:00	Vd HR VR An	27.8 27.8 6.0 6.0	27.8 0.0 6.0 6.0	Rather strong wind and waves did not allow using horizontal radar during this survey.
2	2013-04-11 03:30	2013-04-14 03:30	Vd HR VR An	39.8 44.3 9.0 9.0	39.8 44.3 9.0 9.0	Generally good conditions, but periods with fog obstructed periods of observations on some days.
3	2013-04-23 08:15	2013-04-26 08:15	Vd HR VR An	43.5 47.55 9.0 9.0	43.5 21.3 9.0 9.0	Sea clutter obstructed horizontal radar use on April 23-24, otherwise good conditions.
4	2013-05-07 08:00	2013-05-11 08:00	Vd HR VR An	60.8 66.8 12.0 12.0	60.8 66.8 12.0 12.0	Favourable wind and wave conditions, but foggy on May 9-10 with poor visibility.
5	2013-05-21 05:30	2013-05-24 05:30	Vd HR VR An	45.8 49.75 9.0 9.0	45.8 46.0 9.0 9.0	Generally favourable survey conditions with only brief periods of rain and fog.
Total sum of effective observations in spring 2013			Vd HR VR An	217.5 236.2 45.0 45.0	217.5 (100%) 178.3 (76%) 45.0 (100%) 45.0 (100%)	

* Vd – visual daytime observations, HR – horizontal radar tracking, VR – vertical radar recordings, An – acoustic night time observations.

Table 4.4 List of cruises for observations of migrating birds at BŚ III area in summer-autumn 2013. Sailing times to/from the area and preparation on site are not included. Time indicated as

Cruise	Start date/time of observations	End date/time of observations	Survey type*	Planned observation hours	Effective observation hours	Conditions
6	2013-07-18 07:00	2013-07-19 08:00	Vd HR VR An	17.5 19.0 3.0 3.0	17.5 0.0 3.0 3.0	Rather strong wind and high waves did not allow using horizontal radar.
7	2013-08-06 04:00	2013-08-09 04:00	Vd HR VR An	45.0 49.5 9.0 9.0	45.0 33.0 9.0 9.0	Favourable conditions except high wind and waves on 9-Aug.
8	2013-08-22 11:00	2013-08-25 11:00	Vd HR VR An	40.3 45.3 9.0 9.0	40.3 45.3 9.0 9.0	Generally good conditions, with some periods of waves interfering with horizontal radar tracking.
9	2013-09-05 04:15	2013-09-09 04:15	Vd HR VR An	52.0 57.8 12.0 11.0	52.0 57.8 12.0 11.0	Good conditions; only in the evening of 6-Sept and 8-Sept radar tracking was affected due to high wind and waves.
10	2013-09-29 03:30	2013-10-03 03:30	Vd HR VR An	44.0 50.0 13.0 12.0	44.0 50.0 13.0 12.0	Although a little windy and seastate 3-5 bf, survey conditions were favourable.
11	2013-11-14 11:00	2013-11-19 13:00	Vd HR VR An	49.3 54.05 15.0 15.0	43.3 30.3 15.0 13.0	Rather windy with seastate up to 5bf, which affects tracking with horizontal radar.
Total sum of effective observations in summer-autumn 2013			Vd HR VR An	248.0 275.65 61.0 61.0	242.0 (98%) 216.4 (79%) 61.0 (100%) 57.0 (93%)	

* Vd – visual daytime observations, HR – horizontal radar tracking, VR – vertical radar recordings, An – acoustic night time observations.

4.2 Data analysis methodology

4.2.1 Analysis of visual observation data

Visual observation data provide the major bulk of information on bird migration. Initially, the data are summarised so that number of observed species per migration period, spring and autumn separately, is presented. Each species is associated with a number of observation events and total number of individuals counted. Observation event is understood as a separated encounter of the species, be it single individual or a flock.

Further, observed migration of birds is standardised and summarised temporally. Standardisation is done by calculating the number of birds per observation hour, which is expressed as both average bird passage rate per day and bird passage rate per month (in both cases the unit is number of birds per hour). Such calculations are done for the most numerous species only, and less numerous species are grouped into lower taxonomic units.

Flight direction of observed birds was noted by observers in most of the cases and such information was summarised and plotted as circular diagrams for all observations together and separately for the most abundant species. Such diagrams overlaid onto geographic maps allow clear visualisation of flight directions of recorded birds, which allow determining whether observed species were residents or migrants and what is their likely flight trajectory.

Flying bird altitude was visually assessed in approximate altitude bands (1-2-3-4-5-6-7-8-9-10-15-20-25-30-40-50-60-70-80-90-100-150-200-250-300-400-500 meters and above). Since visual assessment of flying birds has high degree of uncertainty, the results are reported by grouping observations into a few broad bands: 0-15, 15-20, 20-60, 60-200 and >200 meters, and plotting them as horizontal bar charts. Data on flight altitude of migrating birds provide information that is important in the EIA when calculating likely collision risk with wind turbines.

Visual observation data was the main dataset used for calculating total numbers of diurnally migrating birds. This was done using several step procedure (illustrated in Figure 4.11): observed numbers of each sufficiently abundant species were processed using Distance analysis software in order to account for distance detection bias (describe below), then corrected number of observations was standardized by calculating number of bird passing per linear kilometre of the sea surface per hour of observation time. This calculation was done separately for tail wind and head wind directions, as it is well established that bird migration intensity differs in different wind conditions (Alerstam 1978; wind data described below). Extrapolation of bird numbers was done by using calculated bird passage rates per hour (bird/km/hour) to bird passage rates per month (bird/km/month) using the number of daylight hours in a particular month. Day length was downloaded from the US Naval Observatory website (http://www.usno.navy.mil/USNO/astronomical-applications/data-services) for the BŚ III location (17°20’E, 55°00’N). This extrapolation also accounted for wind directions during the daylight hours of each month (wind data described below). Finally, the total bird flux passing the BŚ III area each month was obtained by multiplying monthly bird passage rate per linear kilometre by 14 km, which is the maximum width of the BŚ III wind farm area along the NW-SE axis, which is crossed perpendicularly by seasonally migrating birds (Figure 4.12).

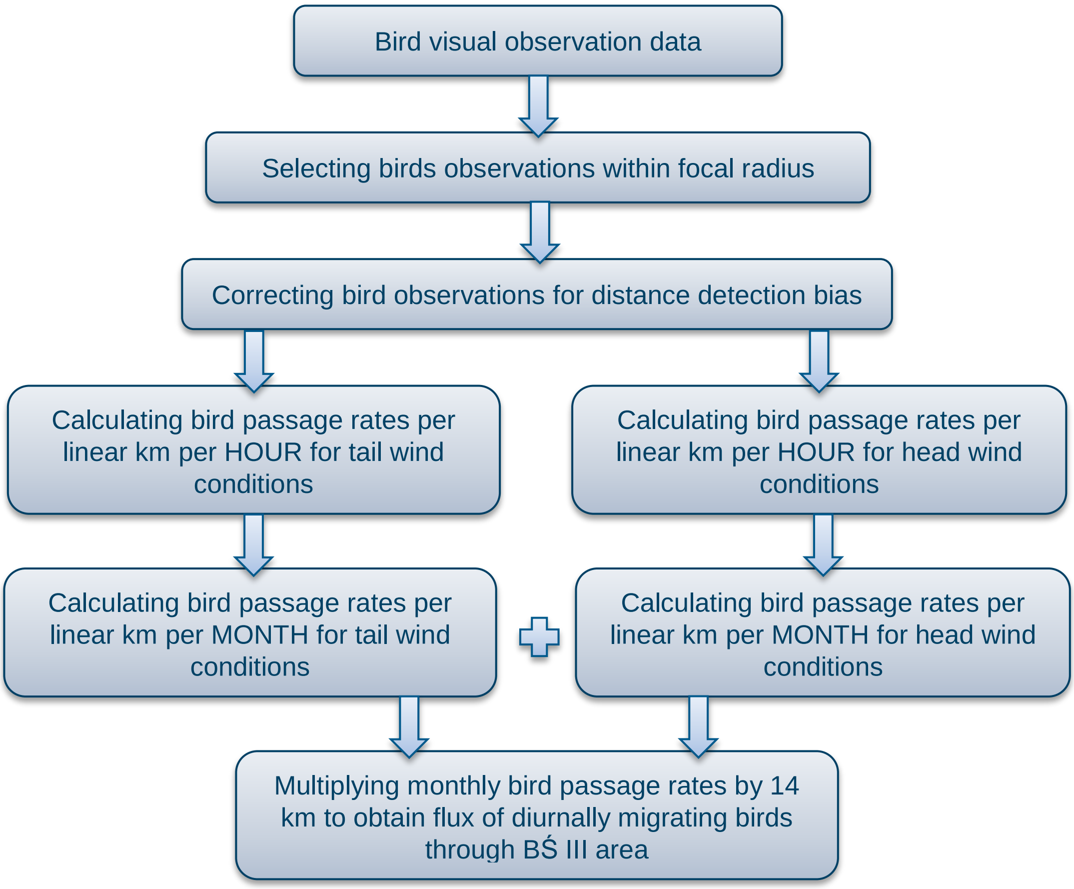


Figure 4.11. Flow chart illustrating the main steps taken when estimating the total passage of migrating birds through the BŚ III area based on visual daytime observations.

As an additional metric to bird numbers calculated using visual bird observations, we have also calculated the potential number of migrants crossing the BŚ III area based on simple proportion the BŚ III occupies along the NW-SE axis of the Baltic Sea. The approximate width of the Baltic Sea in that area is 170 km and BŚ III width is 14 km, making up 8.2% (Figure 4.12). If to assume passage of bird being evenly dispersed along the entire width of the Baltic Sea, 8.2% of the relevant regional population could be passing the BŚ III area. The assumption about even distribution of migrant across the entire width of the Baltic Sea probably holds only for some waterbird species, but does not for many others.

Similar logic is used for the assessment of passage numbers of long-distance migrants in the UK, as individual projects are unlikely to be able to study bird migration over large region. However, for the UK a regional model Migropath (developed by APEM LtD) is available for theoretical assessment of bird migration, which has been used for impact assessments of offshore wind farms (e.g., APEM 2013, Forewind 2013, Smartwind 2013). Similar model system does not exist for the Baltic Sea region; therefore a simplified form of the same idea was implemented assuming even dispersion of the broad front migrants over the Baltic Sea.

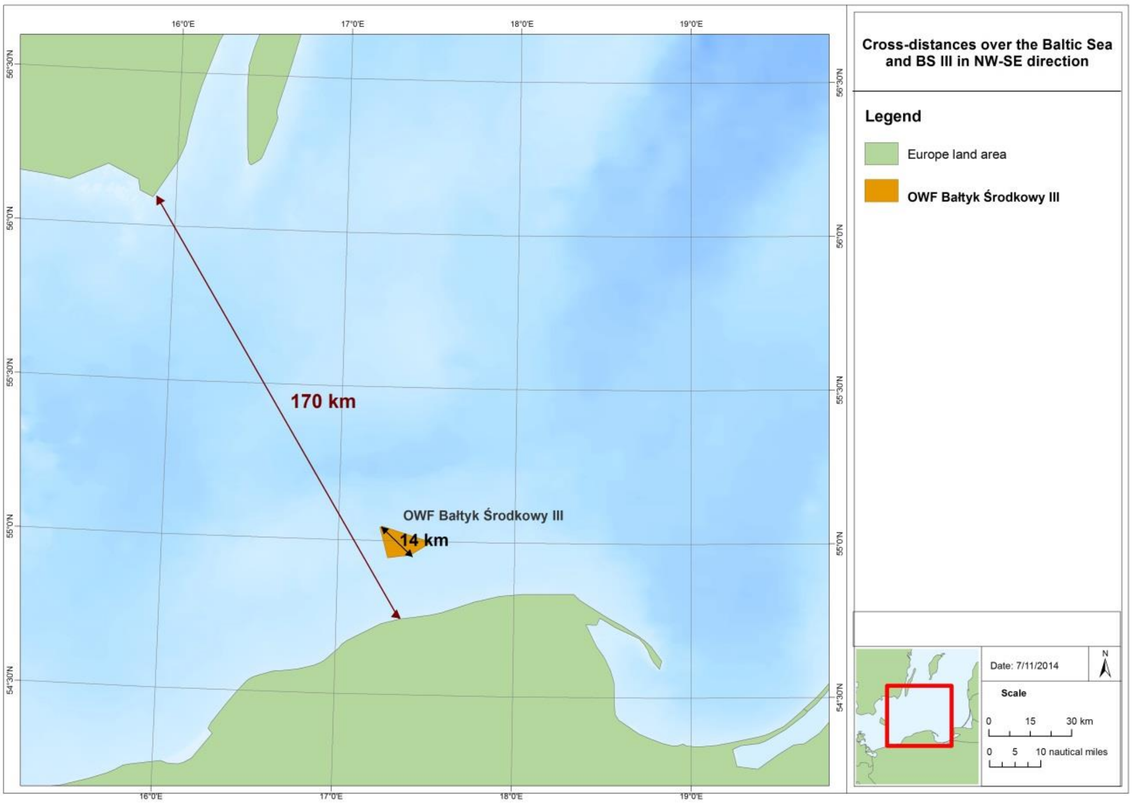


Figure 4.12. Map showing cross distances over the Baltic Sea and BŚ III wind farm in NW-SE direction.

Wind data

The modelled wind data was obtained from the regional model (WRF) by StormGeo (www.storm.no). This regional weather model is based on the global weather model run by the European Centre for Medium-Range Weather Forecasts (UK). The spatial resolution of the WRF model is 0.1 x 0.1 degree, and the temporal resolution is one hour. The model by StormGeo uses inputs from a broad network of meteorological stations and wind data has very close match with the data measured at the BŚ III site (by Marine Institute, Gdansk). StormGeo data were used because of broader regional coverage and availability in dfs2 format allowing flawless association with bird observation data using geographic coordinates and time stamps. Using the model wind direction (at 10 m) was calculated from the U and V wind components. We define head wind in spring as: <135 and >315 and tailwind in spring was thus defined as: >135 and <315. In autumn the wind directions were defined as opposite to spring. As we also calculated the proportion of head and tail wind during the whole migration period we could, based on the proportion of birds flying either in head or tail wind, extrapolate the number of birds passing during each month while accounting for wind directions. The same data was also used for defining proportion of birds flying up wind and down wind.

Distance analysis

The term 'Distance analysis' used in this report refers to analyses conducted using Distance software (Distance v.6. r2, http://www.ruwpa.st-and.ac.uk, Thomas et al. 2010). Distance analysis was conducted aiming to calculate distance detection functions for main bird species observations registered during visual observations from an anchored ship (Buckland et al. 1993, 2001).

The detection of birds declines with radial distance from the observation position. The decline is typically non-linear with a high detection close to an observer to a deflection point further out from where the detection gradually drops to low values as the distance increases (Buckland et al. 2001).

Estimation of distance detection function was achieved by integration of the sources of variance for three parameters: encounter rate, detection probability, and cluster size. Key parametric functions were evaluated with cosines and simple polynomials for adjustment terms: uniform, half-normal and hazard rate, and the best fitting function was chosen on the basis of the smallest Akaike Information Criterion (AIC) values (Burnham and Anderson 2002). The data were analysed by truncating survey radius between 1,000 m and 3,000 depending on a species detection distance and inspections of detection function curves obtained using all data. This means that after establishing the truncation distance for the species, all observation recorded farther away were not included. We also considered applying left-truncation for observations of species, which show strong avoidance reaction to the observation ship, in which case observations within defined closest distance to the ship would not be included in the analyses.

As detection probabilities for birds vary depending on bird behaviour, weather conditions, observer platform and observer skills, estimation of densities was done by stratifying data into separate surveys (Buckland et al. 1993). However, sample size limits the degree of stratification which can be applied to survey data therefore no further stratification, e.g. to account for individual observers or varying weather conditions, was applied (Buckland et al. 2001). Global detection functions were calculated for the entire dataset for each species with sufficient number of observations.

Results of Distance analysis are presented as species-specific detection curve chart, detection curve function and adjustment term, estimated effective detection radius (ERD) with standard error (SE) and percent coefficient of variance (CV).

Effective detection radius (ERD) is the key parameter that is used in correcting the observed bird numbers for distance detection bias, while others characterise the fit of the model. EDR is the distance from the sampling point at which as many birds are detected beyond EDR as remained undetected within EDR. Subsequently, ERD value was used to estimate the number of birds that were likely migrating within the observation radius. For example, if observation radius (*R)* for a given species was 2000 m, and estimated ERD was 800 m, the corrected bird number (*Ncor*) was calculated by dividing the observed number of birds (*Nobs*) by ERD and multiplying by R:

$$Ncor = \frac{Nobs}{ERD} \times R$$

4.2.2 Treatment of horizontal radar data

Bird tracking data collected by horizontal radar were initially recorded using the custom written “BirdTracker” software, which provides user interface and allows registering, characterising and storing radar targets. In the next step the collected data was processed using the custom-built software “PostProcessor”, which organises the data and associates geographic coordinates, so the resulting comma delimited files could be further imported into any database and GIS package. Imported data was first cleaned by removing single points and tracks with no associated bird ID. Finally, the flight trajectories of the most numerous and relevant species were mapped using BŚ III area boundary in the background. This provides results presenting flight trajectories and directions of observed birds, and additionally information about species responses to unnatural objects at sea (survey ship in this case).

In order to visualise spatial trends in directions of different species the track directions were averaged for each season using circular statistics. The calculation of the linear directional mean (LDM) is given as:

$$\text{LDM} = \arctan \frac{\sum_{i=1}^{n} \sin \theta_i}{\sum_{i=1}^{n} \cos \theta_i}$$

where θi are the directions of a set of tracks from a single origin. It should be noted that while many tracks have several vertices between the starting point and the ending point the average angles were calculated using only the start point and the end point of each track. The average directions were superimposed on a 1 km grid, and visualised as vectors with a raster showing the number of tracks displayed as a backdrop.

4.2.3 Treatment of vertical radar data

When the vertical radar was in operation, the program "FrameGrabber" recorded images of radar screen every minute. After completion of the fieldwork, radar images were processed in the office. The altitude measurements of bird targets were carried out for the three fixed one hour recording periods for each night of observations: the first hour after dusk, midnight and the last hour before dawn. In practical terms, analysts inspected each stored image and clicked identified bird echoes, which were automatically recorded by the specialised software using coordinates of the geo-referenced images. Species identification is impossible in the vertical radar data, thus the results present just targets of nocturnally migrating birds. The altitude range below 40 m is only insufficiently captured (due to small dihedral angle and sea clutter) and therefore should be viewed as suggestive but not certain measurements.

Finally, the collected data of bird echoes were summarised in the following vertical bins:

0 - 40 m

41 – 60 m

61 - 100 m

101 - 200 m

201 – every 100 m until 1,500 m

Summarized data were displayed as horizontal bar charts separately for each cruise. Data on flight altitude of nocturnally migrating birds provide information about possible vulnerability of nocturnally migrating birds to collisions with wind turbines.

4.2.4 Processing of acoustic data of nocturnal migrants

Acoustic observations of migrating birds collected during the three one-hour periods each survey night (the first hour after dusk, midnight and the last hour before dawn) were summarised as a number of species-specific calls per observation hour for a particular night. Such information about registered calls of nocturnal migrants provides supplementary data to night time tracking with vertical radar and diurnal observations of migrating birds.

5 Results

5.1 Introduction

The data on bird migration collected at BŚ III area will be used for the purpose of EIA of this offshore wind farm. Primary impacts potentially arising for migrating birds from an offshore wind farm are collision risk and barrier effect. The aim of conducted observations was to characterise migrating bird species composition, passage rates, phenology, flying directions and flight altitudes.

The collected information allows general characterisation of bird migration in BŚ III area and also enables using the recorded parameters in species-specific collision risk estimates. Collision risk of migrating birds will be assessed using the most recent version of the Band's collision risk model that has been developed for the assessment of bird collision risk at offshore wind farms in the UK (Band 2012).

More specifically, the conducted investigations of migrating birds have been designed to provide information for "Stage A – Flight Activity" in the collision risk model (Band 2012). The aim of this stage is to estimate the number of flights which, in the absence of birds being displaced or taking other avoiding action, or being attracted to the wind farm, would potentially be at risk from the wind farm turbines.

Flight activity of migrating birds was expressed as Mean Traffic Rate (also termed "Bird flux") measured as the number of birds flying per hour across an imaginary horizontal line of length of 1 km (birds/km/hour). Mean Traffic Rate can be recalculated to different other metrics when/if needed, such as bird flux in birds/sec per metre of baseline, and divided further by the height to get the bird flux in birds/ sec /m^2. Visual daytime observations were the primary method for recording the Mean Traffic Rate for different species.

Birds flying at risk altitude were assessed as the proportion of birds flying between the lowest and highest points of the rotors. Visual daytime observations were the primary method for this information, but for species where sample size was insufficient, literature information was used. Where sample size was sufficient, flight altitude was also assessed separately for spring and autumn migration seasons and different wind conditions.

Night time activity of migrating birds and associated collision risk was assessed basing on expert judgement of likely level of nocturnal activity of migrants, as the methods used in this study do not allow quantification of nocturnal migration flux. Expert opinion about nocturnal activity of marine bird species provided by Garthe and Hüppop (2004) was used in most cases, unless more recent and scientific evidence-based information was available.

5.2 Characteristics of relevant species identified within the project area

Key basic information of the registered migrating bird species, which could be important in the environmental impact assessment, is provided below. Species, which were only rarely recorded in the monitored area "Bałtyk Środkowy III", i.e. total registrations not exceeding 10 during one season, were excluded assuming that their observations were only exceptional and do not represent regular migration that could be affected by the wind farm (unless there was additional knowledge suggesting that this was not the case).

Red-throated Diver and Black-throated Diver (*Gavia stellata, Gavia arctica*)

General elements
Red-throated Diver and Black-throated Diver are often considered together when studying seabirds at sea due to difficulties to identify these birds to species level when they are in winter plumage in marine environment.

Both diver species are listed in Annex I of the EU Birds directive, they are also SPEC3 category species (species not concentrated in Europe, but with unfavourable conservation status in Europe) considering status of EU Conservation Concern (BirdLife International 2004), and listed in Annex 1 of the list of strictly protected species in Poland (Journal of Laws 2011, No. 237, item. 1419).

Sizes of the flyway populations of these two diver species are highly uncertain: it is thought that there are between 150,000 – 450,000 Red-throated Divers and 250,000-500,000 Black-throated Divers (Wetlands International 2014), of which only about 8,600 spend winter in the Baltic Sea (Skov et al. 2011). The Baltic Sea population estimated in 2007-2009, represents a remarkable decline from about 56,500 birds estimated in 1992-1993 (Durinck et al. 1994, Skov et al. 2011).

Red-throated Diver is widely distributed, circumpolar and highly migratory species breeding from boreal forests to Arctic tundra and migrating to temperate climate zone for the wintering period. The Western Palearctic population breeds in northern Europe and western Siberia, the River Yenisey possibly being its eastern boundary. Birds nesting in Iceland and possibly in Greenland likely overwinter at European coasts as well. Red-throated Divers winter in coastal waters and shallow offshore banks of the Baltic Sea, North Sea and northeast Atlantic (BirdLife International 2014). Majority of divers are found at depths below 30 meters in the Baltic Sea (Durinck et al. 1994).

Similarly, Black-throated Diver is widely distributed, circumpolar and highly migratory species. Its breeding range has more southerly limit compared to Red-throated Diver, but still it's breeding range could be defined the same: from boreal forests to Arctic tundra. During the wintering period Black-throated Divers also have more southerly distribution than Red-throated divers and occurs not only in the Baltic, north Sea and northeast Atlantic, but also in the Mediterranean Sea, Black Sea and Caspian Sea (BirdLife International 2014). The Western Palearctic population breeds in northern Europe and western Siberia. Black-throated Divers winter in coastal waters and shallow offshore habitats, the majority being found at depths below 30 meters in the Baltic Sea (Durinck et al. 1994).

The main spring migration route from the Baltic Sea goes through the Gulf of Finland towards the White Sea in the north and eastwards. Autumn migration is reverse. Migrating routes in the Baltic Sea are not well known, some birds are seen flying within visible distances from coastlines but there are likely birds migrating offshore and overland as well.

Both divers species are opportunistic piscivores, foraging on fish of suitable size that are locally most abundant, which in the Baltic Sea often include Baltic herring (*Clupea harengus*), sprat (*Sprattus sprattus*) and smelt (*Osmerus eperlanus*) (Žydelis 2002, Guse et al. 2009). Knowledge about bird mobility during the wintering season and their winter home ranges is very scarce, but recent results of satellite telemetry suggest high mobility of wintering Red-throated Divers (see study "Seabird telemetry in Lithuania" posted on www.movebenk.org).

Baltic waters of Poland are in the central part of the Baltic distribution range of wintering divers. Important wintering areas are located in the Gulf of Riga, Lithuanian coastal waters, Gulf of Gdansk, Pomeranian Bay, Kattegat, NW coast of Skåne, Darss, Mecklenburg Bay. Both diver species also winter in the North Sea. It is likely that divers recorded during seasonal migrations at BŚ III overwinter in areas further south and west, where several Natura 2000 sites have been designated for protection of these species.

Sensitivity of the species to collisions with wind farms was assessed as medium by Chylarecki et al. (2011; category 2 in Table 3.1 in Chylarecki et al. 2011), and similarly medium to high by Furness et al. (2013; score 213 for Red-throated Diver and 240 for Black-throated Diver in Table 2 in Furness et al. 2013). EU guidance document on wind energy development (European Union 2011) lists that there is evidence on substantial risk of impact on wintering Red-throated Divers due to habitat displacement and potential risks of collision (Table 5.1). For Black-throated Diver this assessment suggest that there is potential risk due to habitat displacement and collision (Table 5.1)

Table 5.1 Sensitivity of diver species to wind farms: XXX = Evidence on substantial risk of impact, XX = Evidence or indications of risk or impact, X = Potential risk or impact, x = small or non-significant risk or impact. (adapted from European Union 2011)

Species	Habitat displacement	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Red-throated Diver *Gavia stellata*	XXX	X			
Black-throated Diver *Gavia arctica*	X	X			

Elements basing on the results of the monitoring for BŚ III

In total 77 divers have been recorded during spring daytime visual observations and 15 in autumn at BŚ III (Appendix A). The species was observed migrating in April and May in spring and September-November in autumn (Figure 5.1).

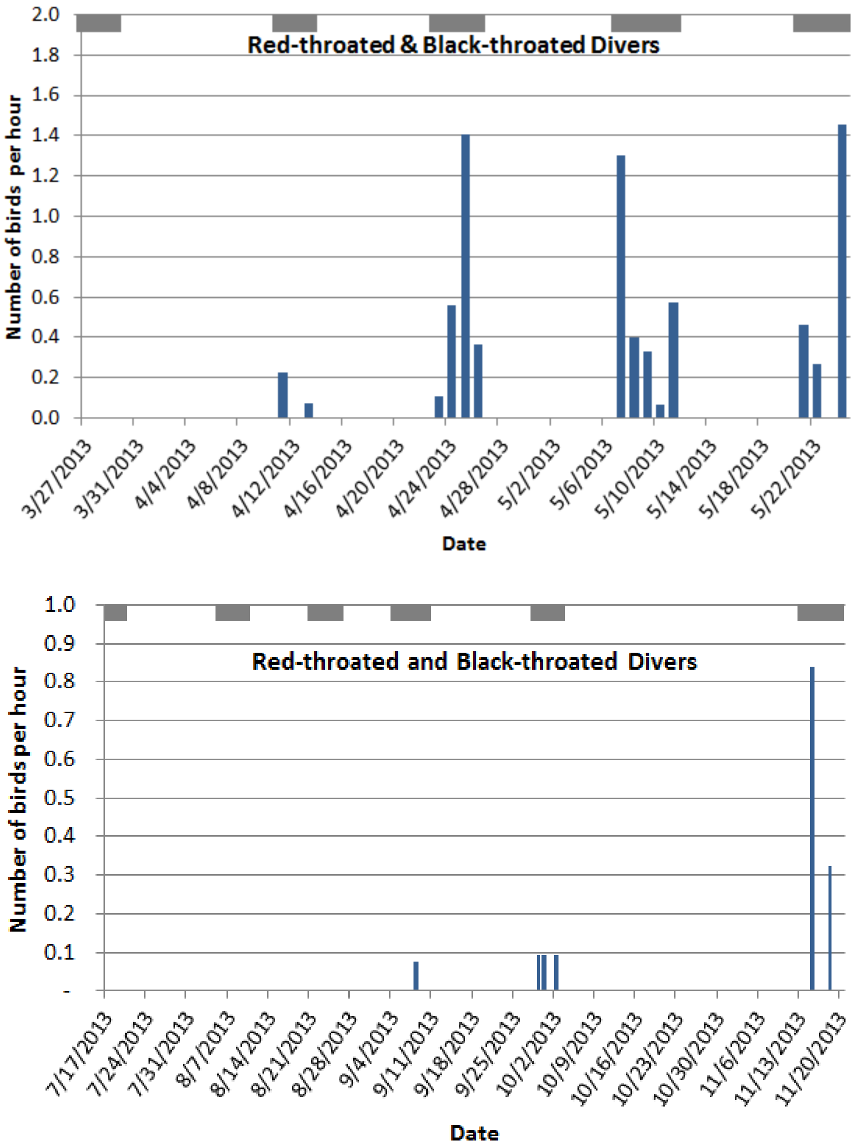


Figure 5.1 Migration periods and passage rates (birds/hour) of divers recorded at BŚ III area during daylight hours in March – May and July-November 2013. Grey areas on top of the charts indicate periods when observations were conducted.

Using horizontal radar for bird tracking 18 diver tracks were recorded in spring but no tracks in autumn (Figure 5.2, Appendix B). The majority of the recorded diver tracks were directed NE in spring indicating migratory movements of the species (Figure 5.3). Similarly, flight direction recording during daytime visual observations show that divers maintained NE-E direction in spring, but in autumn recorded flight directions were more variable with dominating southerly destination autumn (Figure 5.4). The birds were most likely flying from wintering sites located to the south and west from BŚ III area.

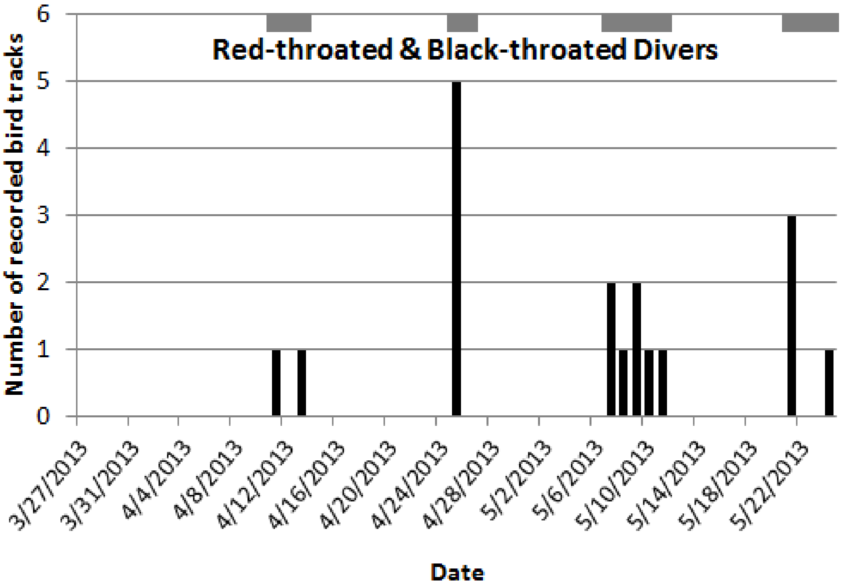


Figure 5.2 Temporal distribution of recorded diver tracks using horizontal surveillance at BŚ III in spring 2013.

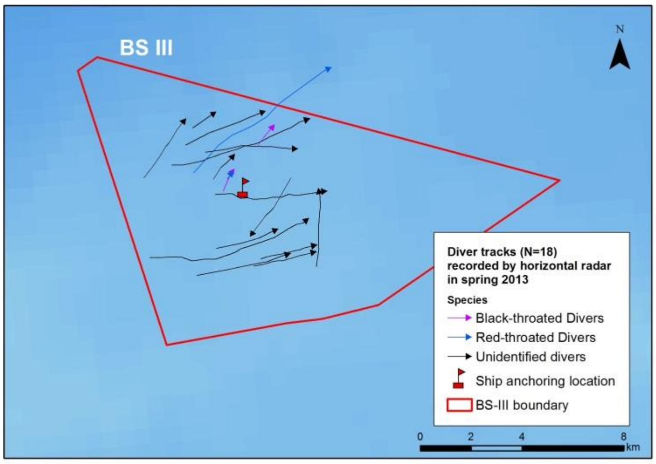


Figure 5.3 Flight trajectories of divers recorded using horizontal surveillance radar at BŚ III in spring 2013.

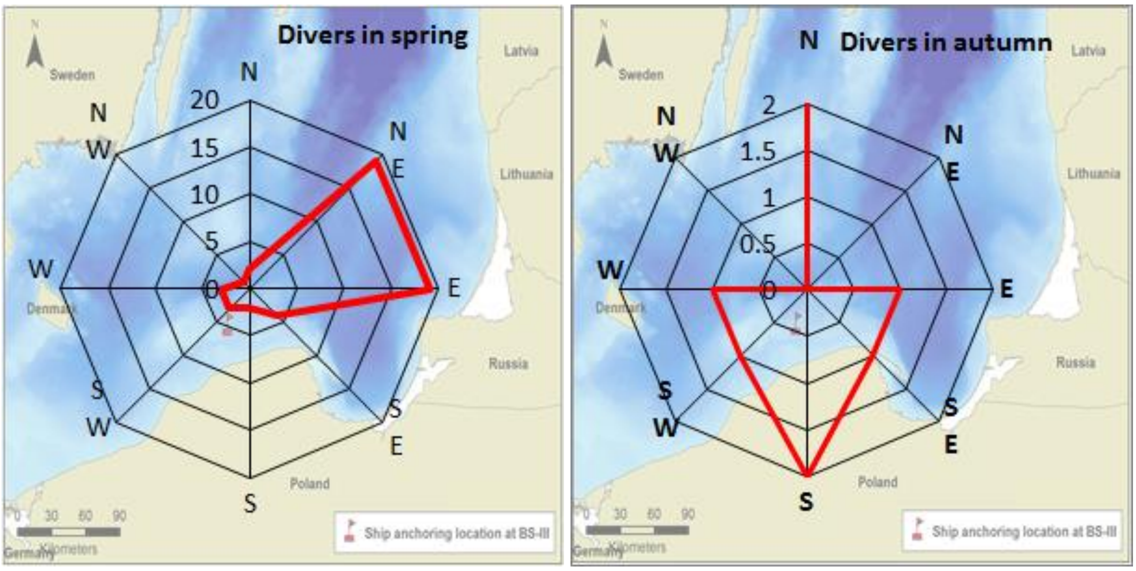


Figure 5.4 Flight directions of divers recorded during visual daytime surveys at BŚ III in spring and autumn 2013.

No divers were recorded during acoustic registration of nocturnal migrants due to silent nature of these species during non-breeding period. It is considered, however, that divers may fly at night during long-distance migrations (Kahlert et al. 2012). Therefore it is possible that some birds of these species were passing BŚ III area at night, the migration which was not possible to identify and quantify with available monitoring tools.

Big proportion of the registered divers flew low during daylight hours, below the potential rotor altitude of typical OWF if to consider 20 m as a threshold (Figure 5.5). After grouping into five altitude bands, 50% of all divers flew between 0-15 m and 15% between 15-20 m and 35% between 20-60 m above sea level in spring, and 87% at 0-15 m and 13% at 15-20 m in autumn (Figure 5.5, Appendix A).

Independent investigations by the Pomarinus group reported 3 Red-throated Divers flying at 1-15 m altitude and 1 at 15-60 m in autumn, 1 Red-throated Diver at 1-15 m and 2 Black-throated Divers at 15-60 m in winter, and 13 Black-throated Divers and 1 Red-throated Diver at 1-15 m and 2 Black-throated Divers at 15-60 m in spring (Meissner 2014).

If divers were migrating at night, they most likely flew at much higher altitude than during the day. According to Kahlert et al. (2012) nocturnally migrating seaducks and divers increase their flight altitude to 300-600 m (410 m on average), which is well above the potential rotor height of offshore wind turbines. Altitude registrations of nocturnal migrants at BŚ III also showed that the majority of passing birds were flying above 200 m.

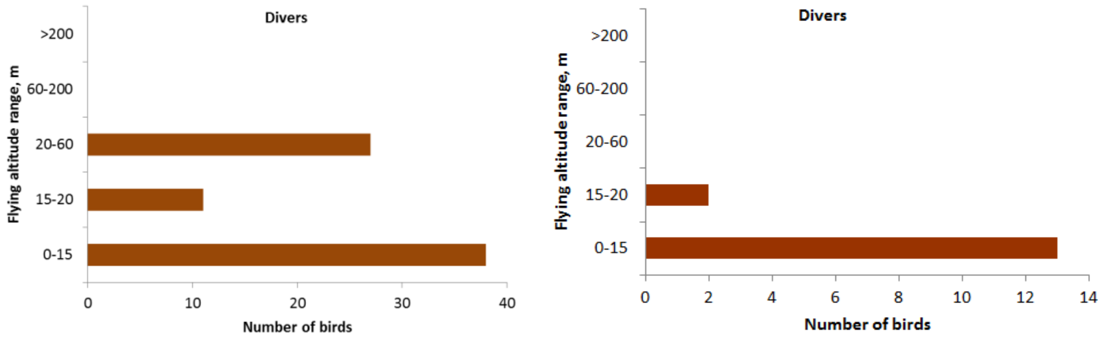
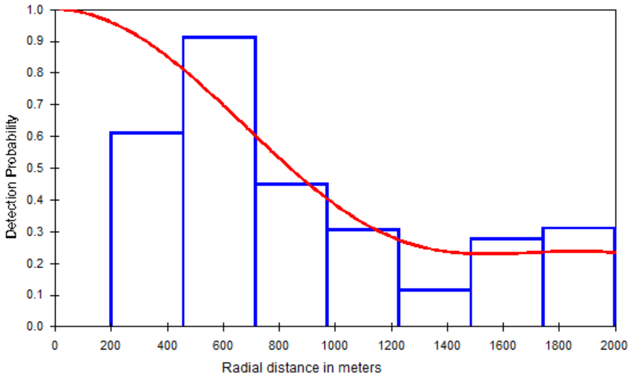


Figure 5.5 Flight altitudes of divers recorded visually at BŚ III area during daylight hours in spring (left chart) and autumn 2013 (right chart).

Part of the diver populations that should be considered in the EIA of BŚ III consists of birds wintering in the immediate vicinity of the wind farm and further south and west, i.e. birds which could potentially pass the wind farm on their seasonal migrations. The size of this population is approximately 4,500 birds considering individuals wintering in the Kattegat, inner Danish waters, Kiel Bay, Mecklenburg Bay and Pomeranian Bay (calculated using Table 5 in Skov et al. 2011).

Results of migrating bird monitoring will be used in the EIA to calculate collision risk of migrants. Namely, migrating bird flux and flying altitude. Migrating bird flux was estimated by first applying correction for distance detection bias within focal range of the species (Figure 5.6), then calculating bird passage rates per linear kilometre per hour separately for tail wind and head wind conditions, then scaling up this number for the daylight hours in a given month while accounting for wind direction (obtaining birds/km/month) and finally multiplying the obtained figure by 14 km, which is the width of the BŚ III wind farm along NW-SE axis that is perpendicular to the main direction of migrating birds (see chapter 4.2.1 for more detailed description).



Number of sightings: 118

Truncation: left 200m, right 2000 m

Model function: Half-normal key with simple polynomial adjustments

ERD (±SE): 1162.5 (±123.39)

CV: 10.61%

Figure 5.6 Distance detection function of divers recorded from anchored ships in Polish offshore waters and main parameters of the model fitting.

Estimates based on daytime visual observations suggest that 939 divers migrate through the BSIII wind farm area in spring and 256 in autumn (Table 5.2, Table 5.31). These numbers represent small proportions (<1%) of the total flyway population but higher 10.9% of the relevant regional population (Table 5.31). In addition to day time passage, some birds could have migrated at night but nocturnal acoustic registrations are not suitable to detect this non-vocal species and vertical radar that was used at night does not allow species identification. Ornithological literature suggests that some divers, similarly to seaducks migrate at high altitude during the night, while on long distance migrations (Kahlert et al. 2012), but this study was based in Estonia and focused on long-distance migration when bird were leaving the Baltic Sea. BŚ III area is located in the southern Baltic Sea and it is unlikely that divers initiate long-distance migrations from there, as recent satellite telemetry study showed that these birds migrate in hopping pattern by using several staging areas on their route (See study "*Seabird telemetry in Lithuania*" on www.movebank.org).

Estimated diurnal migration intensity involves approximately 11% of the relevant population size of these species. This is close to the hypothetical 8.2% if birds were migrating evenly dispersed across the entire width of the Baltic See (see Figure 4.12). Some of the divers wintering in the North Sea, which were not considered when assuming relevant population size, very likely migrate through the Baltic Sea as well (See study "*Seabird telemetry in Lithuania*" on www.movebank.org) and therefore relevant population size assumed in this study might be an underestimate. However, no sufficiently specific data are available on diver distribution and movement routes that would allow more precise figures.

Subsequently it can be concluded that BŚ III does not lie on major migratory route of the diver species.

Table 5.2 Numbers of divers estimated to be migrating through BŚ III in different months.

Month	Total count	Count within focal radius (2000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
March	0	0	0	–	–	–	–	–
April	35	27	46	0.09	0.05	30.7	429	348 – 529
May	42	38	65	0.09	0.06	36.4	510	414 – 629
July	0	0	0	–	–	–	–	–
August	0	0	0	–	–	–	–	–
September	3	3	5	0.01	0.01	3.4	48	39 – 59
October	1	1	2	0.01	0.01	2.7	38	31 – 47
November	11	11	19	0.07	0.04	12.1	169	137 – 209

Long-tailed Duck (*Clangula hyemalis*)

General elements

Long-tailed Duck is listed as Vulnerable in the IUCN Red List (IUCN 2013), due to recently reported dramatic decline of the biogeographic population of the species (Skov et al. 2011).

Size of the Baltic Sea population was estimated at 1,486,000 individuals in 2007-2009, which represents a remarkable decline from 4, 272,000 birds estimated in 1992-1993 (Skov et al. 2011; BirdLife International 2014).

Long-tailed Duck is a circumpolar species breeding in Arctic tundra and migrating to temperate climate zone for the wintering period. The Western Palearctic population breeds in the north of the Scandinavian Peninsula, and Russian Arctic until Taymyr peninsula. Some (or all) birds breeding in Iceland and Greenland possibly migrate to Europe as well. Long-tailed Ducks winter in coastal waters and shallow offshore banks of the Baltic Sea and northeast Atlantic, the majority of wintering population being concentrated in the Baltic Sea (Durinck et al. 1994, BirdLife International 2014). The main spring migration route from the Baltic Sea goes through the Gulf of Finland to the White Sea and then along the coasts of the Arctic Ocean. Autumn migration is reverse. Migrating routes in the Baltic Sea are not well known, some birds are seen flying within visible distances from coastlines but there are probably birds migrating offshore as well.

Long-tailed Duck is benthic feeding species with flexible diet of bottom fauna (Stempniewicz 1995; Žydelis and Ruškytė 2005). They are known to utilize hard and soft bottom habitats down to 35 m deep (Durinck et al. 1994, Skov et al. 2011). Bird mobility during the wintering season and their winter home ranges are poorly known.

Baltic waters of Poland are in the middle of the distribution range of wintering Long-tailed Ducks. Important wintering areas are located further north, with especially high concentration in Riga Bay and Irbe Strait; further south in the Pomeranian Bay, and to the north-west in Midsjö Banks and Hoburgs Bank. Polish coastal waters and offshore Słupsk Bank are also internationally important wintering sites of this species. It is likely that Long-tailed Ducks recorded during seasonal migrations at BŚ III overwinter in these areas located further south and west, mainly on Słupsk Bank and Pomeranian Bay, where several Natura 2000 sites have been designated for protection of this species.

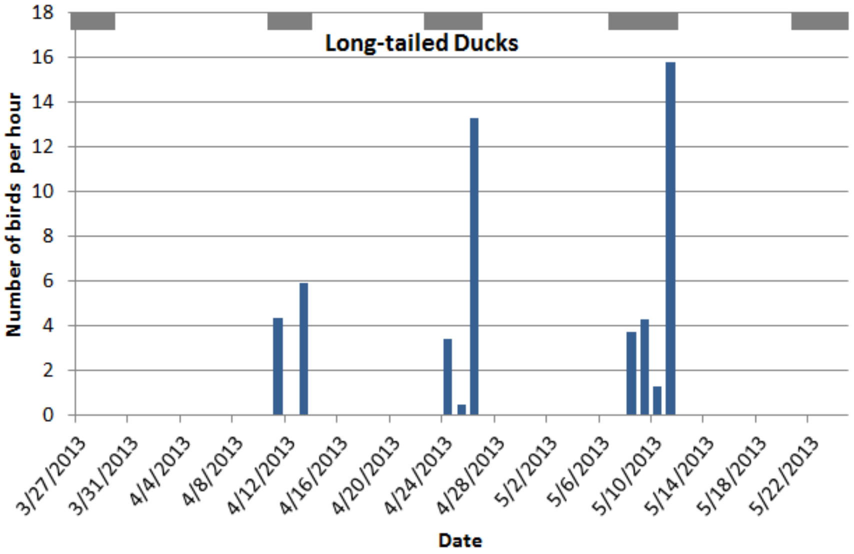
Sensitivity of the species to collisions with wind farms was assessed as low by Chylarecki et al. (2011; category 1 in Table 3.1 in Chylarecki et al. 2011), and similarly low by Furness et al. (2013; score 64 in Table 2 in Furness et al. 2013). EU guidance document on wind energy development (European Union 2011) lists that there is evidence that wintering Long-tailed Ducks are affected by habitat displacement and potential risks of collision, barrier effect and change in habitat structure (Table 5.3).

Table 5.3 Sensitivity of Long-tailed Ducks to wind farms: XXX = Evidence on substantial risk of impact, XX = Evidence or indications of risk or impact, X = Potential risk or impact, x = small or non-significant risk or impact. (Adapted from European Union 2011)

Species	Habitat displacement	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Long-tailed Duck *Clangula hyemalis*	XX	X	X	X	

Elements basing on the results of the monitoring for BŚ III

In total 489 Long-tailed Ducks have been recorded during spring daytime visual observations and 471 in autumn at BŚ III (Appendix A). The species was observed primarily migrating between mid-April and mid-May in spring and late November in autumn (Figure 5.7).



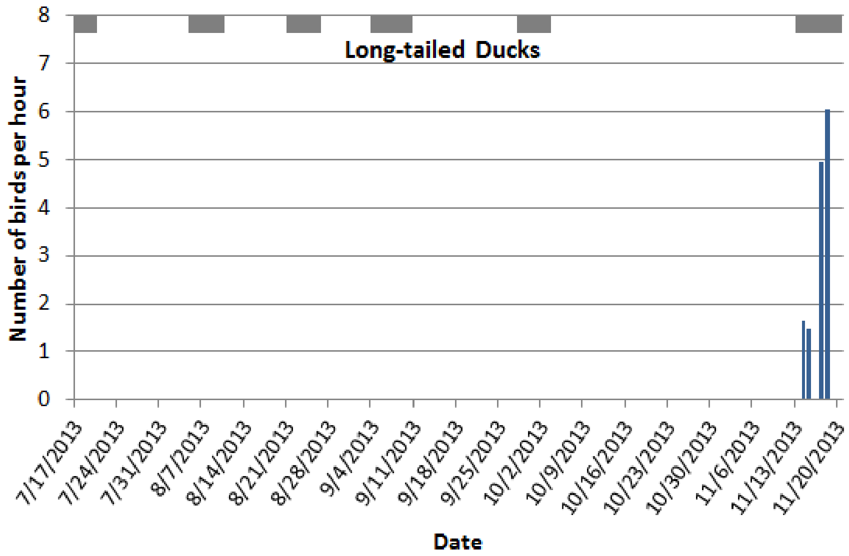


Figure 5.7 Migration periods and observed passage rates (birds/hour) of Long-tailed Ducks recorded at BŚ III area during daylight hours in March – May and July – November 2013. Grey areas on top of the charts indicate periods when observations were conducted.

Using horizontal radar for bird tracking 20 Long-tailed Duck tracks were recorded in spring and 1 in autumn (Figure 5.8, Appendix B). The majority of the recorded Long-tailed Duck tracks were directed NE in spring and one recoded bird flew SW in autumn indicating migratory movements of the species (Figure 5.9). Similarly, flight direction recording during daytime visual observations show that Long-tailed Ducks maintained predominantly NE direction in spring and S-SW direction in autumn (Figure 5.10). The birds were most likely flying from wintering sites (and to them in the autumn) on Słupsk Bank and/or Pomeranian Bay, which represent the major wintering areas for Long-tailed Ducks in the flying direction.

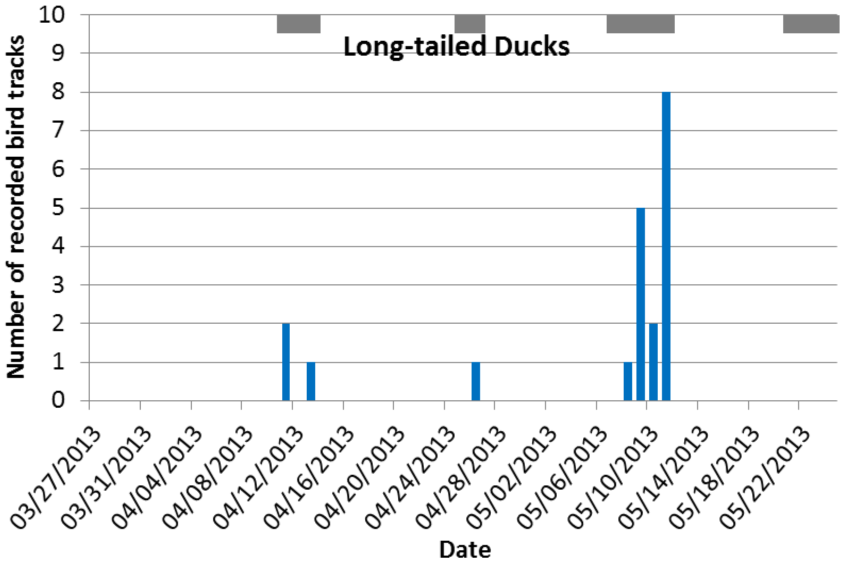


Figure 5.8 Temporal distribution of recorded Long-tailed Duck tracks using horizontal surveillance radar at BŚ III in spring 2013.

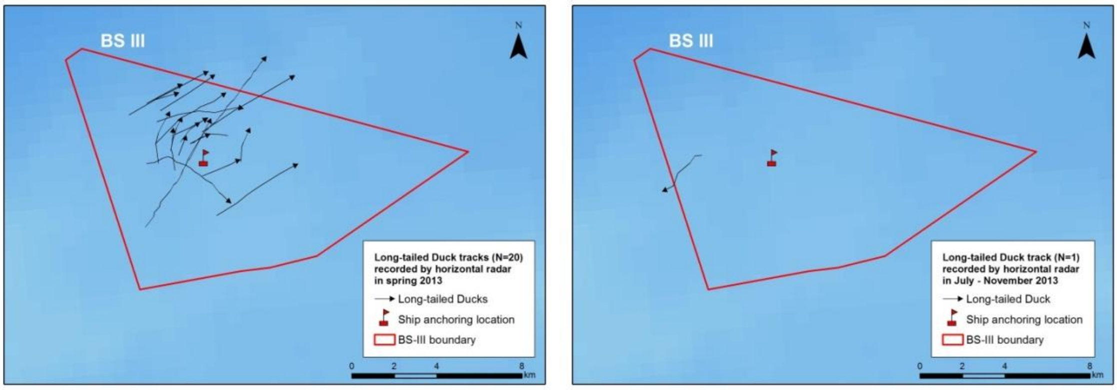


Figure 5.9 Flight trajectories of Long-tailed Ducks recorded using horizontal surveillance radar at BŚ III in spring and autumn 2013.

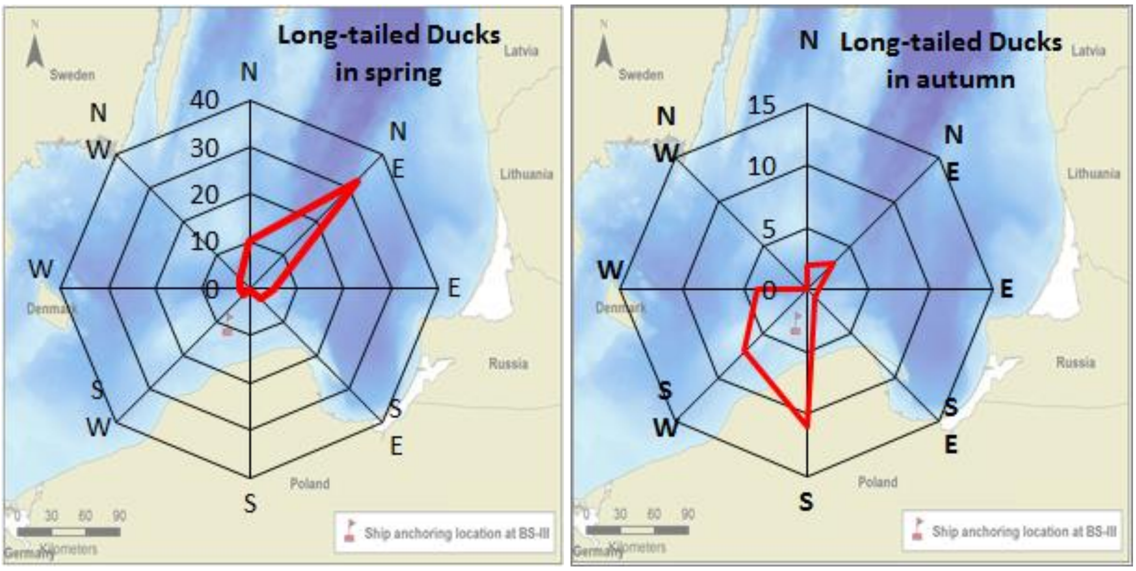


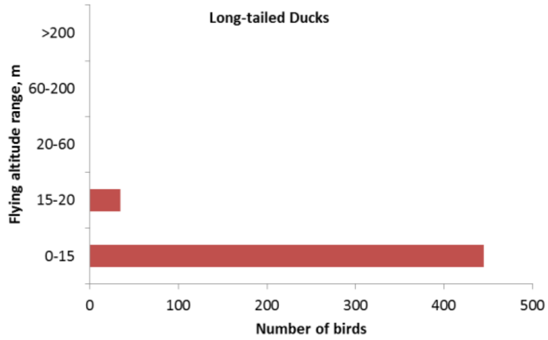
Figure 5.10 Flight directions of Long-tailed Ducks recorded during visual daytime surveys at BŚ III in spring and autumn 2013.

During acoustic registration of nocturnal migrants, Long-tailed Ducks were recorded only in May 2013, when 12 calls of the species were noted (Appendix D). No Long-tailed Duck calls were recorded at night during autumn observations. Nocturnal acoustic registrations do not allow estimating total number of passing migrants due to uncertain detection distance, unknown number of non-calling birds and high dependence of call registration on weather and sea conditions. It is considered, however, that like other sea ducks, some Long-tailed Ducks fly at night during long-distance migrations (Kahlert et al. 2012). Therefore it is likely that some birds of this species were passing BŚ III area at night, the migration which was not possible to identify and quantify with available monitoring tools.

The majority of the registered Long-tailed Ducks flew low, below the potential rotor altitude of typical OWF if to consider 20 m as a threshold (Figure 5.11). After grouping into five altitude bands, 92% of all Long-tailed Ducks flew between 0-15 m and 8% between 15-20 m above sea level in spring, and 97% flew at 0-15 m in autumn. Only 3% of birds were recorded flying at 20-60 m altitude in autumn (Appendix A, Figure 5.11).

Similarly, independent investigations by the Pomarinus group reported 100% of Long-tailed Ducks flying at 1-15 m altitude in autumn (N=261), 99% in winter (N=378), and 100% in spring (N=589) (Meissner 2014).

Long-tailed Ducks migrating at night most likely flew at much higher altitude than during the day. According to Kahlert et al. (2012) nocturnally migrating seaducks increase their flight altitude to 300-600 m (410 m on average), which is well above the potential rotor height of offshore wind turbines. Altitude registrations of nocturnal migrants at BŚ III also showed that the majority of passing birds were flying above 200 m.



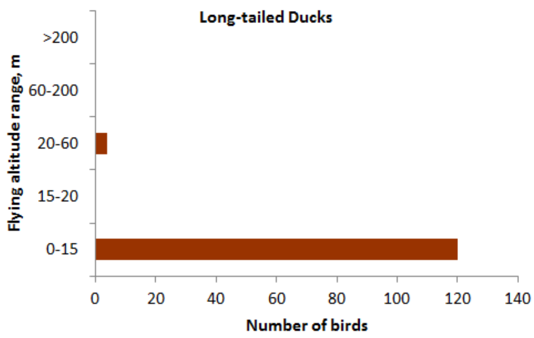


Figure 5.11 Flight altitudes of Long-tailed Ducks recorded visually at BŚ III area during daylight hours in spring (left chart) and autumn 2013 (right chart).

No days of exceptionally high migration events have been recorded, as migratory movements of this species are usually extended over rather long period of time (Figure 5.12).

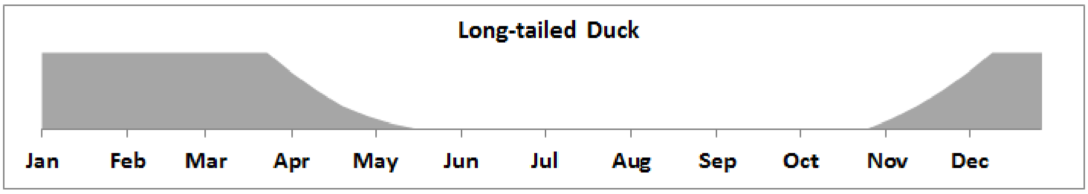
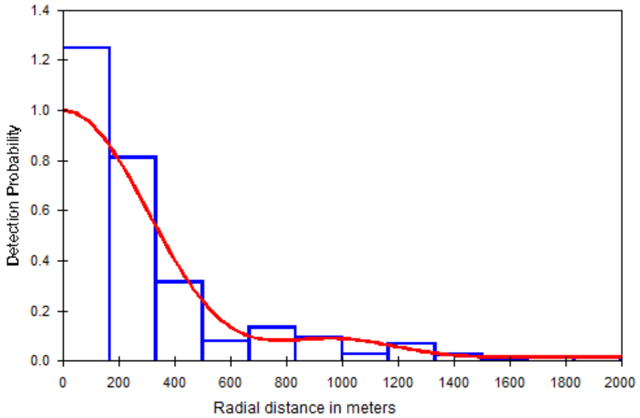


Figure 5.12 Schematic illustration of periods of presence and seasonal migrations (sloping part of the shaded area) of Long-tailed Ducks in the southern Baltic (own opinion based on of multi-year investigations).

Part of the Long-tailed Duck population that should be considered in the EIA of BSIII consists of birds wintering in the immediate vicinity of the wind farm and further S-SW, i.e. birds which could potentially pass the wind farm on their seasonal migrations. The size of this population is approximately 350,000 birds (calculated using Table 17 in Skov et al. 2011).

Results of migrating bird monitoring will be used in the EIA to calculate collision risk of migrants. Namely, migrating bird flux and flying altitude. Migrating bird flux was estimated by first applying correction for distance detection bias within focal range of the species (Figure 5.13), then calculating bird passage rates per linear kilometre per hour for tail wind and head wind conditions, then scaling up this number for the daylight hours in a given month when accounting for wind direction during these days (obtaining birds/km/month) and finally multiplying the obtained figure by 14 km, which is the width of the BŚ III wind farm along NW-SE axis that is perpendicular to the main direction of migrating Long-tailed Ducks (Table X, see chapter 4.2.1 for more detailed description).



Number of sightings: 326

Truncation: right 2000 m

Model function: Uniform key with cosine adjustments

ERD (±SE): 545.40 (±20.69)

CV: 3.79%

Figure 5.13 Distance detection function of Long-tailed Ducks recorded from anchored ships in Polish offshore waters and main parameters of the model fitting.

Estimates based on daytime visual observations suggest that 13,369 Long-tailed Ducks migrate through the BSIII wind farm area in spring and 3,597 in autumn (Table 5.4, Table 5.31). These numbers represent small proportions of the total flyway and relevant populations (Table 5.31). However, some birds also migrate at night, as few Long-tailed Duck calls were registered on one night in May 2013 (Appendix D). Ornithological literature suggests that seaducks, including Long-tailed Ducks migrate at high altitude during the night, while on long distance migrations (Jacoby 1983, Kahlert et al. 2012), but these studies were based in Estonia and focused on long-distance migration events when birds were leaving the Baltic Sea or arriving to it. BŚ III area is located in the southern Baltic Sea and it is unlikely that sea ducks initiate long-distance migrations from there, as recent satellite telemetry studies showed that these birds migrate in a hopping pattern and use several staging areas on their route (See studies "*Seaducks in the Fehmarn Belt (southern Baltic)*" and "*Seabird telemetry in Lithuania*" on www.movebank.org).

Estimated diurnal migration intensity involving approximately 3.8% of the relevant population of the species (Table 5.31) is lower than the hypothetical 8.2% if birds were migrating evenly dispersed across the entire width of the Baltic See (see Figure 4.12).

Subsequently it can be concluded that BŚ III does not lie on major migratory route of the species.

Table 5.4 Numbers of Long-tailed Ducks estimated to be migrating through BŚ III in different months.

Month	Total count	Count within focal radius (2000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
March	0	0	0	–	–	–	–	–
April	265	254	931	1.85	0.95	624.3	8,740	8,112 – 9,417
May	224	166	609	0.94	0.49	330.7	4,630	4,297 – 4,988
July	0	0	0	–	–	-	-	–
August	0	0	0	–	–	-	-	–

Month	Total count	Count within focal radius (2000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
September	0	0	0	–	–	-	-	–
October	0	0	0	–	–	-	-	–
November	124	117	429	1.64	0.84	256.9	3,597	3,339 – 3,876

Common Scoter (*Melanitta nigra*)

General elements

Common Scoter is not listed among strictly protected species in the considered international and Polish national legislation. However, nearly all bird species are fully or partly protected in Poland except for game species.

Size of the flyway population is estimated at 550,000 individuals (Wetlands International 2014), of which about 412,000 spend winter in the Baltic Sea (Skov et al. 2011). Numbers of this species wintering in the Baltic Sea are about 47.5% lower compared to numbers recoded in the 1990s (Skov et al. 2011). However, some recent counts show that numbers of this species wintering in the North Sea are higher than previously thought (Petersen and Nielsen 2011, Petersen et al. 2014), but these estimates have not been incorporated into the official flyway estimates yet.

Common Scoter is migratory species breeding in northern boreal forests and Arctic tundra and migrating to temperate climate zone for the wintering period. The Western Palearctic population breeds in the Scandinavian Peninsula and Russian Arctic until and including Taymyr peninsula. Some (or all) birds breeding in Iceland migrate to Europe as well. Common Scoters winter in coastal waters and shallow offshore banks of the Baltic Sea, North Sea and northeast Atlantic, the majority of wintering population being concentrated in the western Baltic Sea (Durinck et al. 1994, BirdLife International 2014). The main spring migration route from the Baltic Sea goes through the Gulf of Finland to the White Sea and then along the coasts of the Arctic Ocean. Autumn migration is reverse. Migrating routes in the Baltic Sea are not well known, some birds are seen flying within visible distances from coastlines but there are likely birds migrating offshore and overland as well.

Common Scoter is benthic feeding species specialising on the diet of bivalves (Fox 2003). They are known to utilize hard and soft bottom habitats down to 30 m deep (Durinck et al. 1994, Skov et al. 2011). Bird mobility during the wintering season and their winter home ranges are poorly known.

Baltic waters of Poland are in the eastern part of the distribution range of wintering Common Scoters. Important wintering areas are located further west, with especially high concentration in the Pomeranian Bay, Kattegat, inner Danish waters and also the North Sea at Danish, German and Dutch coasts. It is likely that Common Scoters recorded during seasonal migrations at BŚ III overwinter in these areas further south and west, where several Natura 2000 sites have been designated for protection of this species.

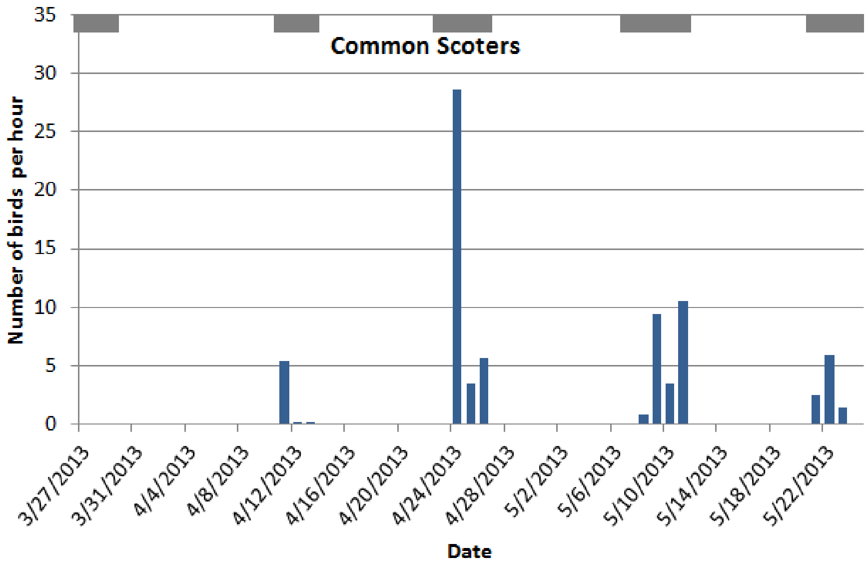
Sensitivity of the species to collisions with wind farms was assessed as low by Chylarecki et al. (2011; category 1 in Table 3.1 in Chylarecki et al. 2011), and similarly low by Furness et al. (2013; score 96 in Table 2 in Furness et al. 2013). EU guidance document on wind energy development (European Union 2011) lists that there is evidence that wintering Common Scoters are affected by habitat displacement and potential risks of collision, barrier effect and change in habitat structure (Table 5.5).

Table 5.5 Sensitivity of Common Scoters to wind farms: XXX = Evidence on substantial risk of impact, XX = Evidence or indications of risk or impact, X = Potential risk or impact, x = small or non-significant risk or impact. (Adapted from European Union 2011)

Species	Habitat displacement	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Common Scoter *Melanitta nigra*	XX	X	X	X	

Elements basing on the results of the monitoring for BŚ III

In total 970 Common Scoters have been recorded during spring daytime visual observations and 173 in autumn at BŚ III (Appendix A). The species was observed migrating in April and May in spring and during all months in autumn (Figure 5.14).



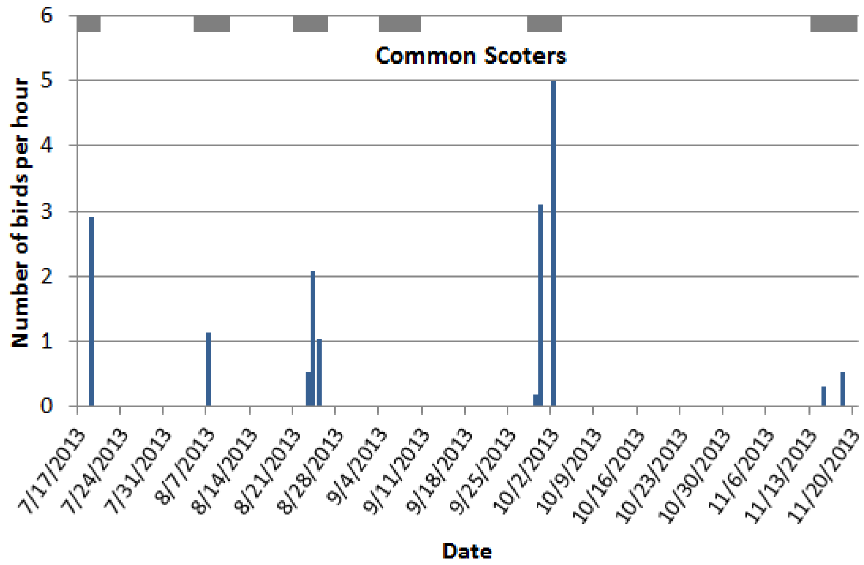
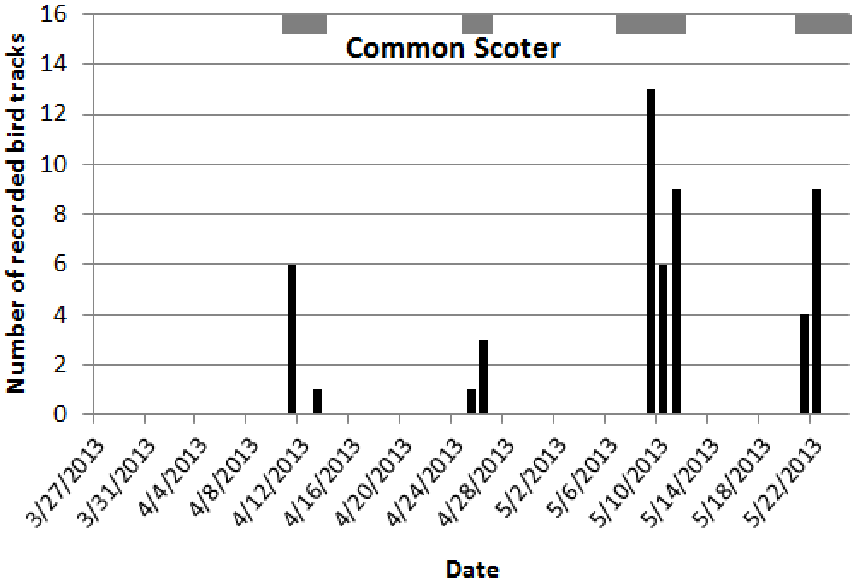


Figure 5.14 Migration periods and observed passage rates (birds/hour) of Common Scoters recorded at BŚ III area during daylight hours in March – May and July – November 2013. Grey areas on top of the charts indicate periods when observations were conducted.

Using horizontal radar for bird tracking 52 Common Scoter tracks were recorded in spring and 9 in autumn (Figure 5.15, Appendix B). The majority of the recorded Common Scoter tracks were directed NE in spring and SW in autumn indicating migratory movements of the species (Figure 5.16). Similarly, flight direction recording during daytime visual observations show that Common Scoters maintained predominantly NE direction in spring and SW direction in autumn (Figure 5.17). The birds were most likely flying from wintering sites (and to them in the autumn) located to the south and west from BŚ III area.



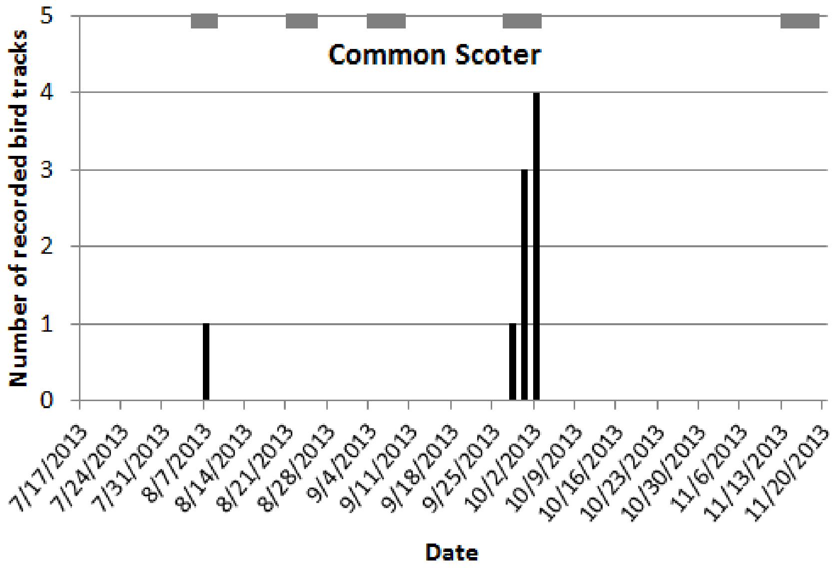


Figure 5.15 Temporal distribution of recorded Common Scoter tracks using horizontal surveillance radar at BŚ III in spring and summer-autumn 2013.

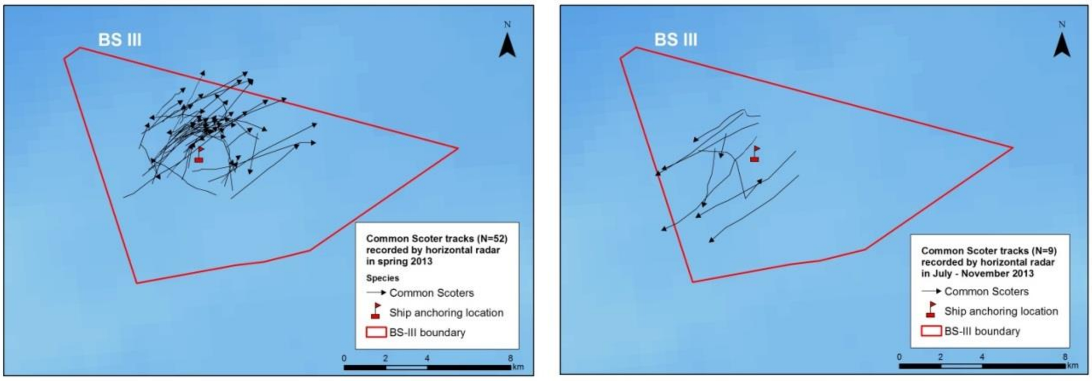


Figure 5.16 Flight trajectories of Common Scoters recorded using horizontal surveillance radar at BŚ III in spring and autumn 2013.

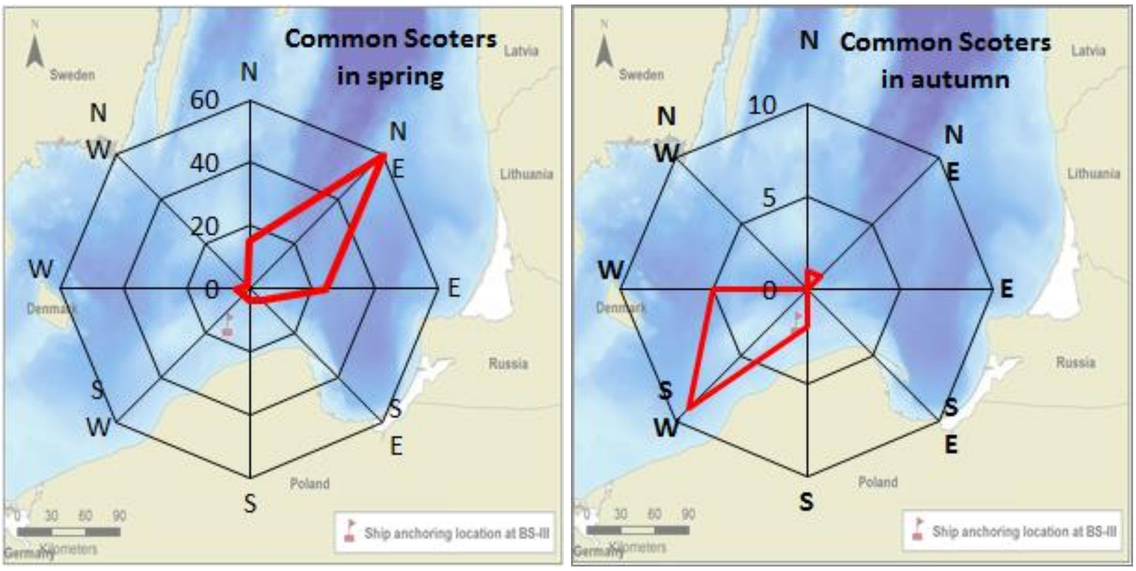


Figure 5.17 Flight directions of Common Scoters recorded during visual daytime surveys at BŚ III in spring and autumn 2013.

During acoustic registration of nocturnal migrants, Common Scoters were recorded during 2 nights in April and May 2013, when 41 calls of the species were noted during the first hour of darkness (Appendix D). No Common Scoter calls were recorded at night during autumn observations. Nocturnal acoustic registrations do not allow estimating total number of passing migrants due to uncertain detection distance, unknown number of non-calling birds and high dependence of call registration on weather and sea conditions.

The majority of the registered Common Scoters flew low, below the potential rotor altitude of typical OWF if to consider 20 m as a threshold (Figure 5.18). After grouping into five altitude bands, 77% of all Common Scoters flew between 0-15 m and 17% between 15-20 m above sea level in spring, and 90% at 0-15 m and 8% at 15-20 m in autumn. Only 7% of birds were recorded flying at 20-60 m altitude in spring and 2% in autumn (Figure 5.18, Appendix A).

Similarly, independent investigations by the Pomarinus group reported 72% of Common Scoters flying at 1-15 m altitude and the rest 28% at 15-60 m in autumn (N=111), 88% at 1-15 m and 12% at 15-60 m in winter (N=51), and 95% at 1-15 m in spring (N=379) (Meissner 2014a).

The majority of nocturnally migrating Common Scoters most likely flew at much higher altitude than during the day. According to Kahlert et al. (2012) nocturnally migrating seaducks increase their flight altitude to 300-600 m (410 m on average), which is well above the potential rotor height of offshore wind turbines. Jacoby (1983) and Žalakevičius (1987) also state that nocturnally migrating Common Scoters fly at few hundred meter height. Altitude registrations of nocturnal migrants at BŚ III also showed that the majority of passing birds were flying above 200 m.

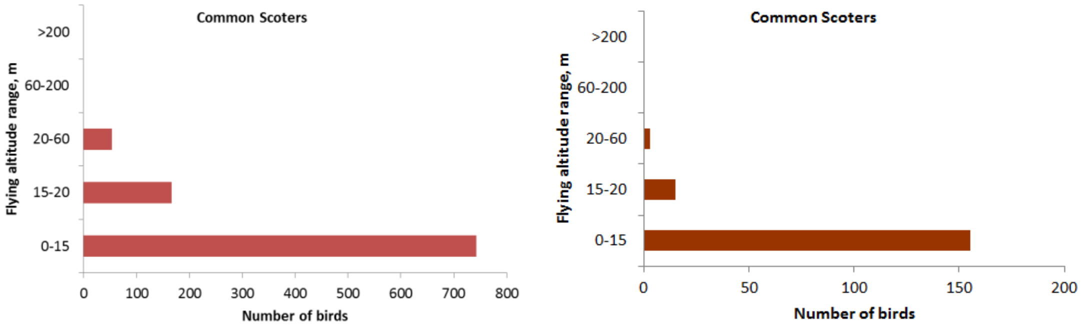


Figure 5.18 Flight altitudes of Common Scoters recorded visually at BŚ III area during daylight hours in spring (left chart) and autumn 2013 (right chart).

No days of exceptionally high migration events have been recorded, as migratory movements of this species are usually extended over rather long period of time (Figure 5.19).

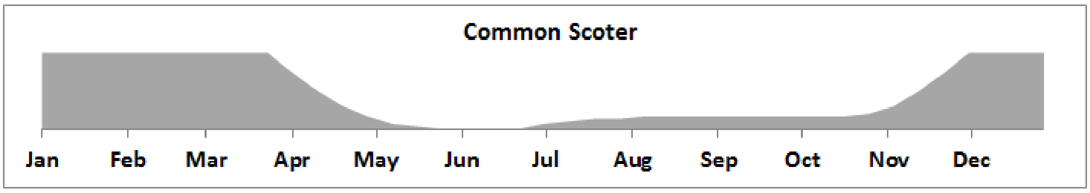
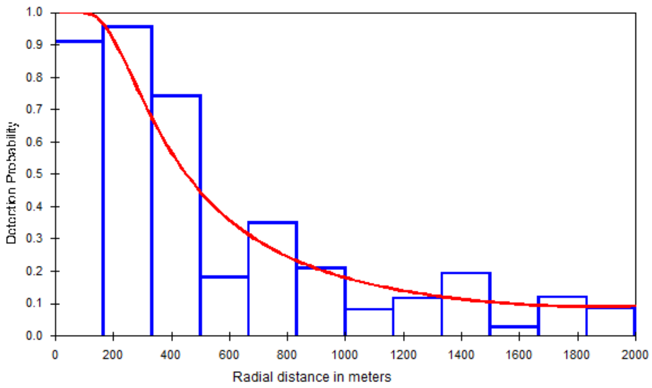


Figure 5.19 Schematic illustration of periods of presence and seasonal migrations (sloping part of the shaded area) of Common Scoters in the southern Baltic (own opinion based on of multi-year investigations).

Part of the Common Scoter population that should be considered in the EIA of BŚ III consists of birds wintering in the immediate vicinity of the wind farm and further S and W, i.e. birds which could potentially pass the wind farm on their seasonal migrations. The size of this population is approximately 500,000 birds (calculated using Table 17 in Skov et al. 2011).

Results of migrating bird monitoring will be used in the EIA to calculate collision risk of migrants. Namely, migrating bird flux and flying altitude. Migrating bird flux was estimated by first applying correction for distance detection bias within focal range of the species (Figure 5.20), then calculating bird passage rates per linear kilometre per hour for different wind conditions (head wind and tail wind), then scaling up this number for the daylight hours in a given month while accounting for wind (obtaining birds/km/month) and finally multiplying the obtained figure by 14 km, which is the width of the BŚ III wind farm along NW-SE axis that is perpendicular to the main direction of migrating Common Scoters (see chapter 4.2.1 for more detailed description).



Number of sightings: 361

Truncation: right 2000 m

Model function: Hazard Rate with Simple Polynomial adjustments

ERD (±SE): 837.29 (±90.74)

CV: 11.2%

Figure 5.20 Distance detection function of Common Scoters recorded from anchored ships in Polish offshore waters and main parameters of the model fitting.

Estimates based on daytime visual observations show that 18,493 Common Scoters migrate through the BSIII wind farm area in spring and 4,712 in autumn (Table 5.6, Table 5.31). These numbers represent rather small proportion of the total flyway and relevant regional populations, about 3.5% (Table 5.31). This species also migrates at night, as Common Scoter calls were registered on two nights in April and May 2013 (Appendix D), but total number of nocturnal migrants cannot be estimated.

Ornithological literature suggests that a lot of seaducks, including Common Scoters migrate at high altitude during the night, while on long distance migrations (Jacoby 1983, Kahlert et al. 2012). According to studies conducted in Lithuania using meteorological radar, about 77% of all migrating Common Scoters fly at night (Žalakevičius 1987). If this proportion of nocturnally flying birds also holds for the Polish offshore waters, it would mean that the total number passing migrants of this species is higher than estimated daytime migration and could reach as many as 60,000 birds (or about 11% of the flyway population). The mentioned studies (Jacoby 1983, Žalakevičius 1987, Kahlert et al. 2012) however were focused on long-distance migration events when birds leave the Baltic Sea or arrive to it. BŚ III area is located in the southern Baltic Sea and it is unlikely that Common Scoters initiate long-distance migration from there, as it is known that sea ducks migrate in a hopping pattern and use several staging areas on their route.

Estimated migration intensity involving approximately 3.7% of the relevant population of the species is lower that the hypothetical 8.2% if birds were migrating evenly dispersed across the entire width of the Baltic See (see Figure 4.12). However, the overall passage of migrating Common Scoters could be higher due to known nocturnal movements of the species.

Subsequently it can be concluded that BŚ III lies on a relatively important migratory route of Common Scoters and few percent and potentially up to 11% of the flyway population may be passing the BŚ III area during seasonal migrations.

Table 5.6 Numbers of Common Scoters estimated to be migrating through BŚ III in different months.

Month	Total count	Count within focal radius (2000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
March	0	0	0	–	–	–	–	–
April	563	533	1,273	3.17	0.65	897.5	12,564	10,088 – 15,648

Month	Total count	Count within focal radius (2000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
May	407	358	855	1.67	0.34	423.5	5,929	4,760 – 7,384
July	16	16	38	0.45	0.09	78.1	1,094	878 – 1,362
August	58	58	139	0.34	0.07	80.2	1,122	901 – 1,398
September	36	16	38	0.11	0.02	26.5	372	298 – 463
October	55	55	131	1.24	0.25	142.9	2,001	1,607 – 2,492
November	8	8	19	0.09	0.02	8.8	123	99 – 153

Velvet Scoter (*Melanitta fusca*)

General elements

Velvet Scoter is listed as Endangered in the IUCN Red List (IUCN 2013), due to recently reported dramatic decline of the biogeographic population of the species (Skov et al. 2011).

Size of the flyway population is estimated at 450,000 individuals (Wetlands International 2014), of which about 373,000 spend winter in the Baltic Sea (Skov et al. 2011). The Baltic Sea population estimated in 2007-2009, represents a remarkable decline from about 1 million birds estimated in 1992-1993 (Skov et al. 2011; BirdLife International 2014).

Velvet Scoter is migratory species breeding in boreal forests and wooded Arctic tundra and migrating to temperate climate zone for the wintering period. The Western Palearctic population breeds in the Scandinavian Peninsula, Estonia and western Siberia to the River Yenisey. Velvet Scoters winter in coastal waters and shallow offshore banks of the Baltic Sea, North Sea and northeast Atlantic, the majority of wintering population being concentrated in the Baltic Sea (Durinck et al. 1994, BirdLife International 2014). The main spring migration route from the Baltic Sea goes through the Gulf of Finland towards the White Sea in the north and eastwards. Autumn migration is reverse. Migrating routes in the Baltic Sea are not well known, some birds are seen flying within visible distances from coastlines but there are likely birds migrating offshore and overland as well.

Velvet Scoter is benthic feeding species specialising on the diet of infaunal bivalves (Fox 2003). They are known to utilize hard and soft bottom habitats down to 30 m deep (Durinck et al. 1994, Skov et al. 2011). Bird mobility during the wintering season and their winter home ranges are poorly known.

Baltic waters of Poland are in the central part of the distribution range of wintering Velvet Scoters. Important wintering areas are located in the Gulf of Riga, Lithuanian and Polish coastal waters, the Pomeranian Bay and Kattegat. It is likely that Velvet Scoters recorded during seasonal migrations at BŚ III overwinter in these areas further south and west, where several Natura 2000 sites have been designated for protection of this species and birds using these areas possibly pass BŚ III when migrating.

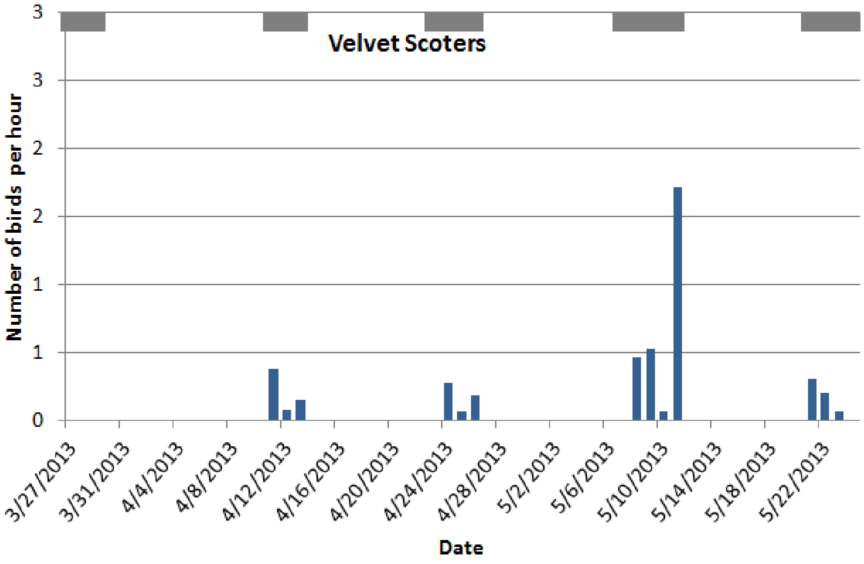
Sensitivity of the species to collisions with wind farms was assessed as low by Furness et al. (2013; score 88 in Table 2 in Furness et al. 2013). EU guidance document on wind energy development (European Union 2011) does not mention Velvet Scoter at all, but considering similar biology and sensitivity to other seaduck species we assume the same anticipated impacts to wintering Velvet Scoters as well: they are affected by habitat displacement and potential risks of collision, barrier effect and change in habitat structure (Table 5.5).

Table 5.7 Sensitivity of Velvet Scoters to wind farms: XXX = Evidence on substantial risk of impact, XX = Evidence or indications of risk or impact, X = Potential risk or impact, x = small or non-significant risk or impact. (Table structure adapted from European Union 2011, sensitivity of Velvet Scoter assumed to be the same as for other seaducks, Long-tailed Duck and Common Scoter)

Species	Habitat displacement	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Velvet Scoter *Melanitta fusca*	XX	X	X	X	

Elements basing on the results of the monitoring for BŚ III

In total 323 Velvet Scoters have been recorded during spring daytime visual observations and 134 in autumn at BŚ III (Appendix A). The species was observed migrating in April and May in spring and mostly in November in autumn (Figure 5.21).



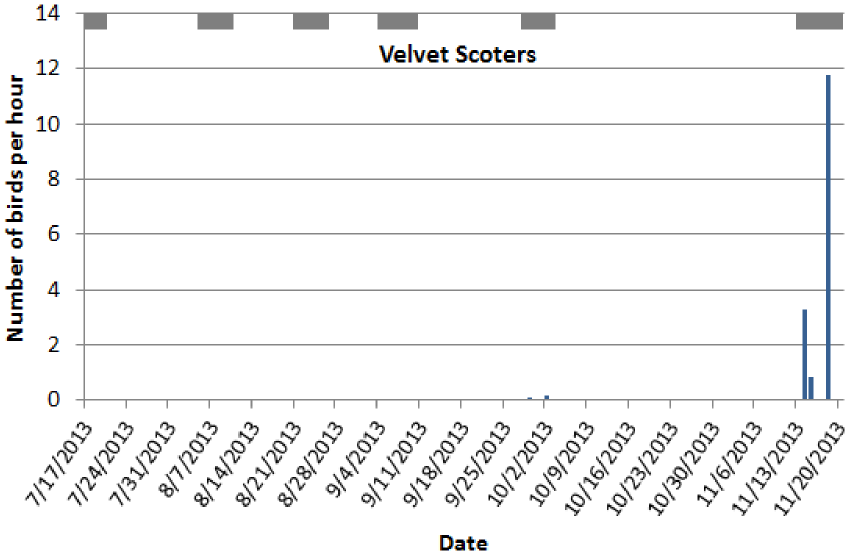


Figure 5.21 Migration periods and observed passage rates (birds/hour) of Velvet Scoters recorded at BŚ III area during daylight hours in March – May and July – November 2013. Grey areas on top of the charts indicate periods when observations were conducted.

Using horizontal radar for bird tracking 19 Velvet Scoter tracks were recorded in spring and 2 in autumn (Figure 5.22, Appendix B). The majority of the recorded Velvet Scoter tracks were directed NE in spring and SW in autumn indicating migratory movements of the species (Figure 5.23). Similarly, flight direction recording during daytime visual observations show that Velvet Scoters maintained predominantly NE direction in spring and SW direction in autumn (Figure 5.24). The birds were most likely flying from wintering sites (and to them in the autumn) located to the south and west from BŚ III area.

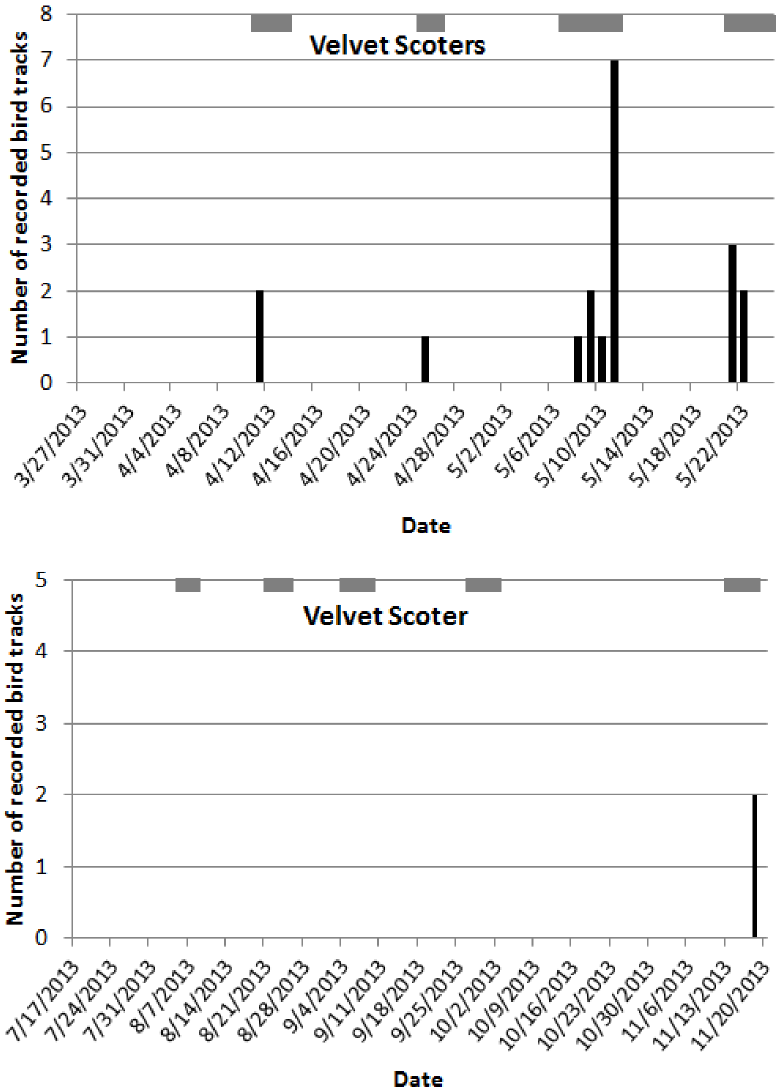


Figure 5.22 Temporal distribution of recorded Velvet Scoter tracks using horizontal surveillance radar at BŚ III in spring and summer-autumn 2013.

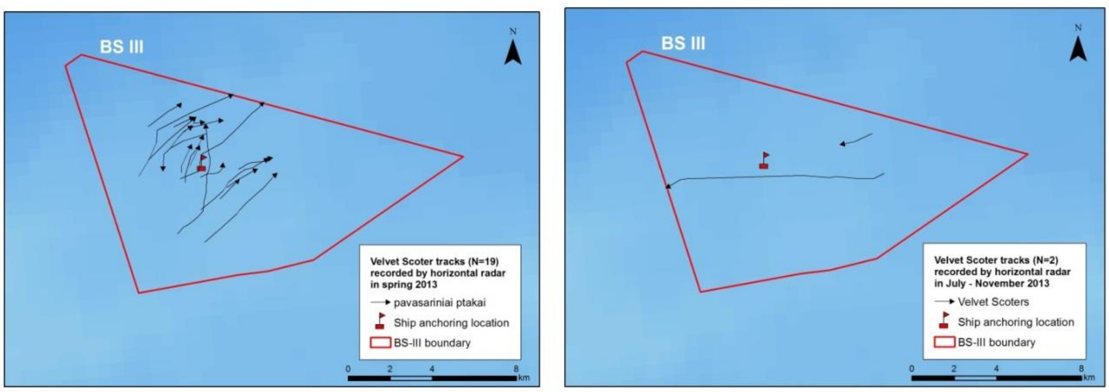


Figure 5.23 Flight trajectories of Velvet Scoters recorded using horizontal surveillance radar at BŚ III in spring and autumn 2013.

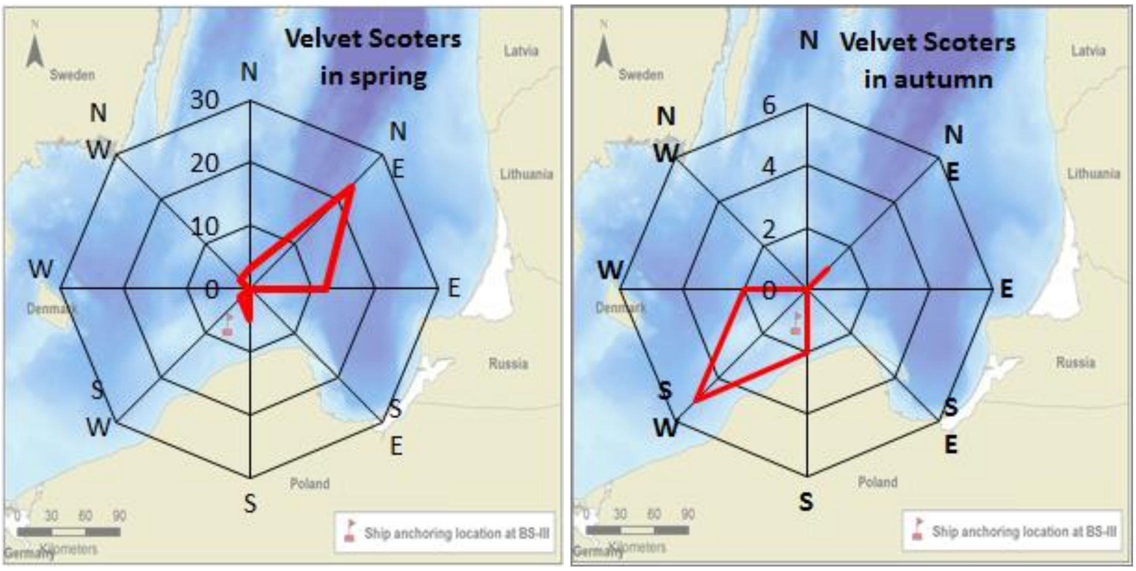


Figure 5.24 Flight directions of Velvet Scoters recorded during visual daytime surveys at BŚ III in spring and autumn 2013.

No Velvet Scoters were recorded during acoustic registration of nocturnal migrants due to generally silent nature of this species. It is considered, however, that like other sea ducks, some Velvet Scoters fly at night during long-distance migrations (Kahlert et al. 2012). Therefore it is likely that some birds of this species were passing BŚ III area at night, the migration which was not possible to identify and quantify with available monitoring tools.

The majority of the registered Velvet Scoters flew low, below the potential rotor altitude of typical OWF if to consider 20 m as a threshold (Figure 5.25). After grouping into five altitude bands, 80% of all Velvet Scoters flew between 0-15 m and 11% between 15-20 m above sea level in spring, and 69% at 0-15 m and 31% at 15-20 m in autumn. Only 9% of birds were recorded flying at 20-60 m altitude in spring and no birds at this altitude in autumn (Figure 5.25, Appendix A).

Similarly, independent investigations by the Pomarinus group reported 51% of Velvet Scoters flying at 1-15 m altitude and the rest 49% at 15-60 m in autumn (N=72), 95% at 1-15 m and 5% at 15-60 m in winter (N=39), and 97% at 1-15 m and 3% at 15-60 m in spring (N=58) (Meissner 2014).

If Velvet Scoters were migrating at night, they most likely flew at much higher altitude than during the day. According to Kahlert et al. (2012) nocturnally migrating seaducks increase their flight altitude to 300-600 m (410 m on average), which is well above the potential rotor height of offshore wind turbines. Altitude registrations of nocturnal migrants at BŚ III also showed that the majority of passing birds were flying above 200 m.

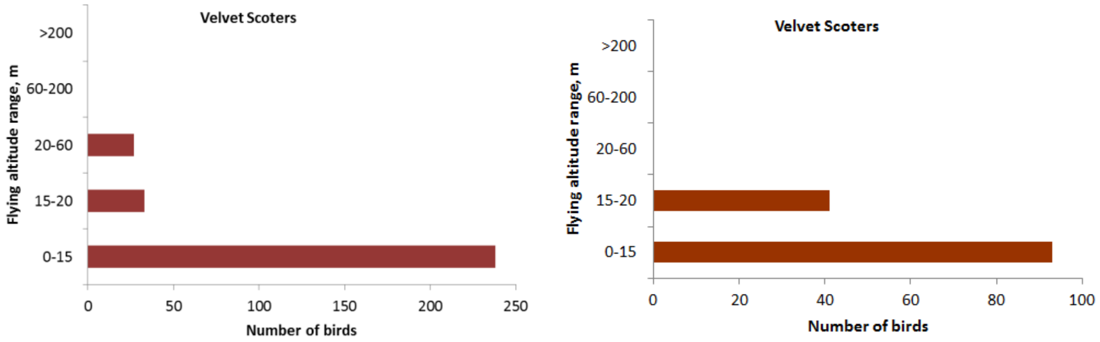


Figure 5.25 Flight altitudes of Velvet Scoters recorded visually at BŚ III area during daylight hours in spring (left chart) and autumn 2013 (right chart).

No days of exceptionally high migration events have been recorded, as migratory movements of this species are usually extended over rather long period of time (Figure 5.26).

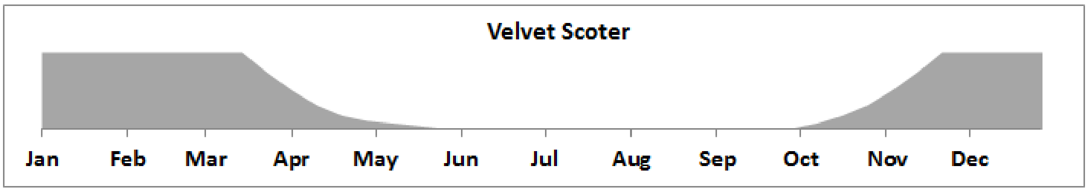
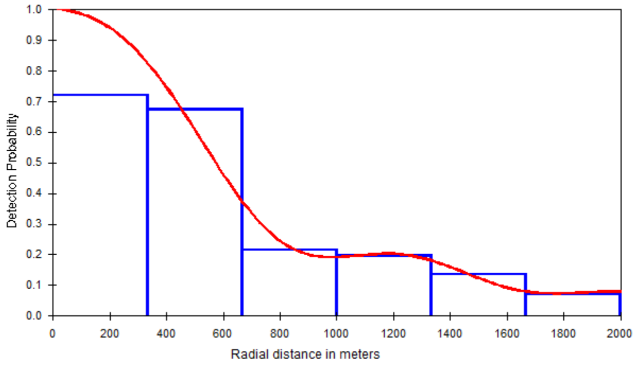


Figure 5.26 Schematic illustration of periods of presence and seasonal migrations (sloping part of the shaded area) of Velvet Scoters in the southern Baltic (own opinion based on of multi-year investigations).

Part of the Velvet Scoter population that should be considered in the EIA of BŚ III consists of birds wintering in the immediate vicinity of the wind farm and further S and W, i.e. birds which could potentially pass the wind farm on their seasonal migrations. The size of this population is approximately 170,000 birds (calculated using Table 17 in Skov et al. 2011).

Results of migrating bird monitoring will be used in the EIA to calculate collision risk of migrants. Namely, migrating bird flux and flying altitude. Migrating bird flux was estimated by first applying correction for distance detection bias within focal range of the species (Figure 5.27), then calculating bird passage rates per linear kilometre per hour for tail wind and head wind conditions, then scaling up this number for the daylight hours in a given month while accounting for wind direction (obtaining birds/km/month) and finally multiplying the obtained figure by 14 km, which is the width of the BŚ III wind farm along NW-SE axis that is perpendicular to the main direction of migrating birds (see chapter 4.2.1 for more detailed description).

DHI



Number of sightings: 100

Truncation: right 2000 m

Model function: Uniform key with Cosine adjustments

ERD (±SE): 894.24 (±87.20)

CV: 9.75%

Figure 5.27 Distance detection function of Velvet Scoters recorded from anchored ships in Polish offshore waters and main parameters of the model fitting.

Estimates based on daytime visual observations suggest that 5,812 Velvet Scoters migrate through the BSIII wind farm area in spring and 2,251 in autumn (Table 5.6, Table 5.31). These numbers represent rather small proportions of the total flyway and relevant regional populations (Table 5.31). In addition to day time passage of the species, some birds could have migrated at night but nocturnal acoustic registrations are not suitable to detect this non-vocal species and vertical radar that was used at night does not allow species identification. Ornithological literature suggests that a lot of seaducks migrate at high altitude during the night, while on long distance migrations (Jacoby 1983, Kahlert et al. 2012). These studies were based in Estonia and focused on long-distance migration events when bird were leaving the Baltic Sea or arriving. BŚ III area is located in the southern Baltic Sea and it is unlikely that sea ducks initiate long-distance migrations from there, as recent satellite telemetry studies showed that these birds migrate in hopping pattern by using several staging areas on their route (See studies "*Seaducks in the Fehmarn Belt (southern Baltic)*" and "*Seabird telemetry in Lithuania*" on www.movebank.org).

Estimated migration intensity involving approximately 3.4% of relevant population of the species is rather lower than the hypothetical 8.2% if birds were migrating evenly dispersed across the entire width of the Baltic See (see Figure 4.12). The difference could be explained by nocturnally migrating scoters, which were not registered at BŚ III.

Subsequently it can be concluded that BŚ III does not lie on major migratory route of the species, but up to few percent of the flyway population likely pass the area during seasonal migrations.

Table 5.8 Numbers of Velvet Scoters estimated to be migrating through BSIII in different months.

Month	Total count	Count within focal radius (2000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
March	0	0	0	–	–	–	–	–
April	39	37	83	0.13	0.12	53.3	746	615 – 905
May	284	279	624	0.78	0.69	361.9	5,066	4,176 – 6,145
July	0	0	0	–	–	–	–	–

Month	Total count	Count within focal radius (2000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
August	0	0	0	–	–	–	–	–
September	1	1	2	0.00	0.00	1.4	20	17 – 25
October	2	2	4	0.03	0.02	7.9	111	92 – 135
November	131	96	215	0.66	0.58	151.4	2,119	1,747 – 2,571

Eurasian Wigeon (*Anas penelope*)

General elements

European Wigeon was most abundant and frequently recorded dabbling duck species during the migration observations at BŚ III.

European Wigeon is not listed as protected species in the considered international and Polish national legislation.

Size of the flyway NE-NW European population is estimated at 1,500,000 individuals (Wetlands International 2014).

Eurasian Wigeon has very large distribution range and breeds in freshwater wetlands of Scandinavian Peninsula, NE Europe and most of Siberia and during the non-breeding season prefers coastal salt-marshes, freshwater, brackish and saline lagoons with the major wintering sites in the Netherlands, Germany and UK (BirdLife International 2004, 2014).

It is migratory species that passes Polish offshore waters on seasonal migrations between breeding grounds in the east and wintering areas in western and southern Europe. The species migrates in a broad front over land and water, therefore it is difficult to estimate the size of relevant proportion of the flyway population that could be passing the study area.

Wigeon is herbivorous species feeding on aquatic vegetation as well as on plants on agricultural fields and meadows (BirdLife International 2014).

Offshore waters of the Baltic Sea do not represent suitable habitat for this species and it therefore only passes the BŚ III area during migrations. Eurasian Wigeon recorded during seasonal migrations at BŚ III overwinter further west and south, where several Natura 2000 sites have been designated for protection of this species.

Sensitivity of this species to collisions with wind farms was not assessed by Chylarecki et al. (2011), but it is likely to low as evaluated for other ducks species (category 1 in Table 3.1 in Chylarecki et al. 2011). EU guidance document on wind energy development (European Union 2011) anticipates small impact due to barrier effect on Eurasian Wigeon (Table 5.9).

Table 5.9 Sensitivity of Eurasian Wigeon to wind farms: XXX = Evidence on substantial risk of impact, XX = Evidence or indications of risk or impact, X = Potential risk or impact, x = small or non-significant risk or impact. (Table structure adapted from European Union 2011, shaded fields indicate irrelevant pressures)

Species	Habitat displacement	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Eurasian Wigeon *Anas penelope*			x		

Elements basing on the results of the monitoring for BŚ III

In total 70 Eurasian Wigeon have been recorded during spring daytime visual observations and 324 in autumn at BŚ III (Appendix A). The species was observed migrating in mid-April in spring and in early September in autumn (Figure 5.28).

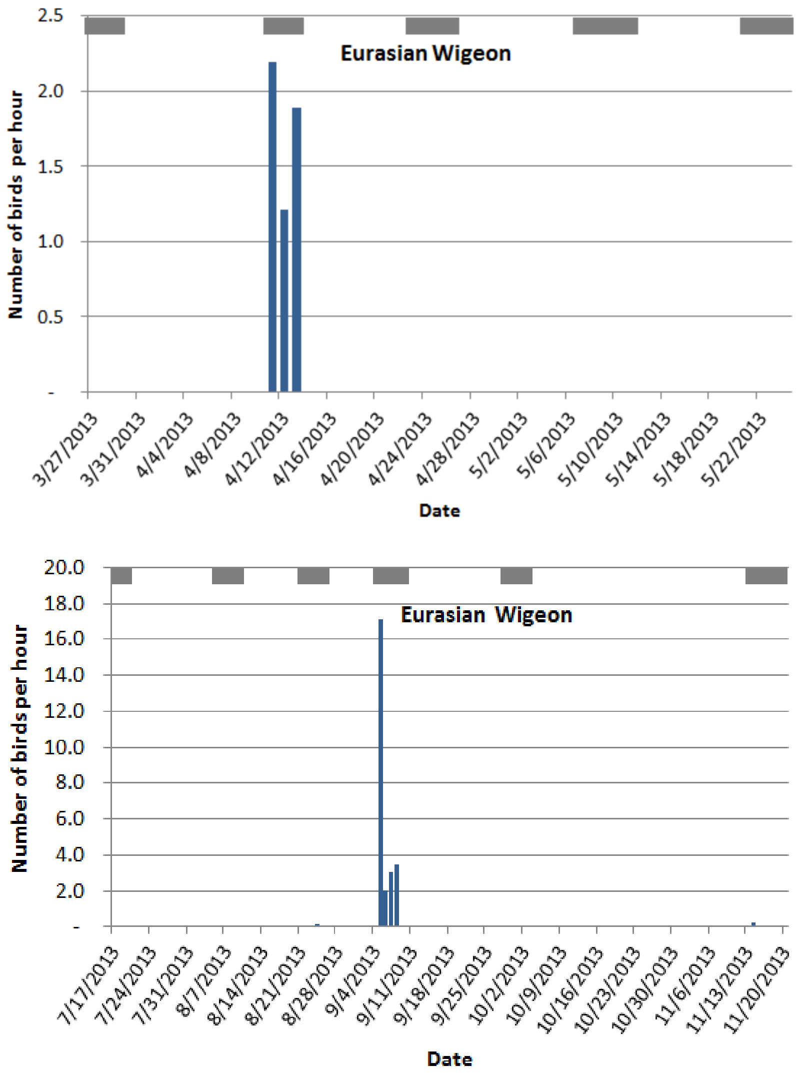


Figure 5.28 Migration periods and observed passage rates (birds/hour) of Eurasian Wigeon recorded at BŚ III area during daylight hours in March – May and July – November 2013. Grey areas on top of the charts indicate periods when observations were conducted.

Using horizontal radar for bird tracking 4 Eurasian Wigeon tracks were recorded in spring and 9 in autumn, the periods being the same as for visual registrations (Figure 5.28, Appendix B). The tracks were directed NE in spring and E-SE in spring and W-SW in autumn (Figure 5.29). Analogous flight directions were recorded during daytime visual observations (Figure 5.30).

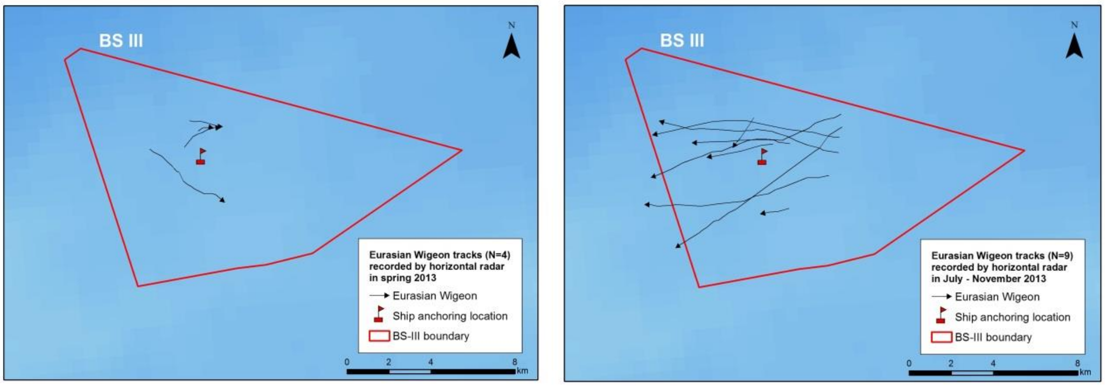


Figure 5.29 Flight trajectories of Eurasian Wigeon recorded using horizontal surveillance radar at BŚ III in spring and autumn 2013.

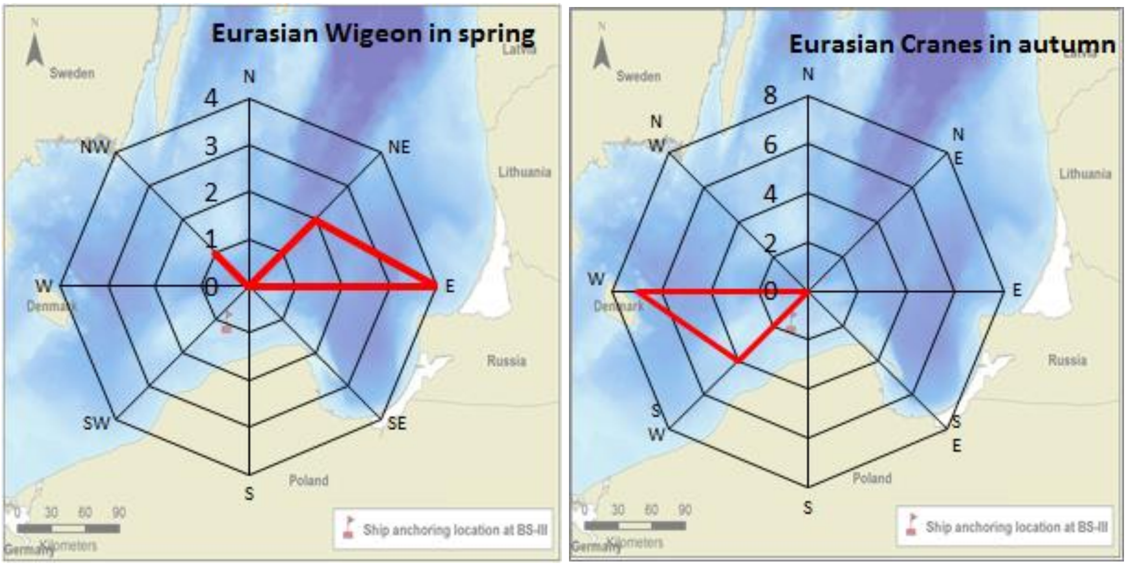


Figure 5.30 Flight directions of Eurasian Wigeon recorded during visual daytime surveys at BŚ III in spring and autumn 2013.

No Wigeon were recorded during acoustic registration of nocturnal migrants.

All of the registered European Wigeon flew low in spring, below the potential rotor altitude of typical OWF if to consider 20 m as a threshold (Figure 5.25). However in autumn, nearly 50% of all birds flew at potential rotor altitude, i.e. between 20-60 m (Figure 5.31, Appendix A).

Independent investigations by the Pomarinus group reported all observed Wigeon (N=14) flying at 1-15 m altitude in autumn, and 68% at 1-15 m, 21% at 15-60 m and 21% at 60-200 m in spring (N=37) (Meissner 2014).

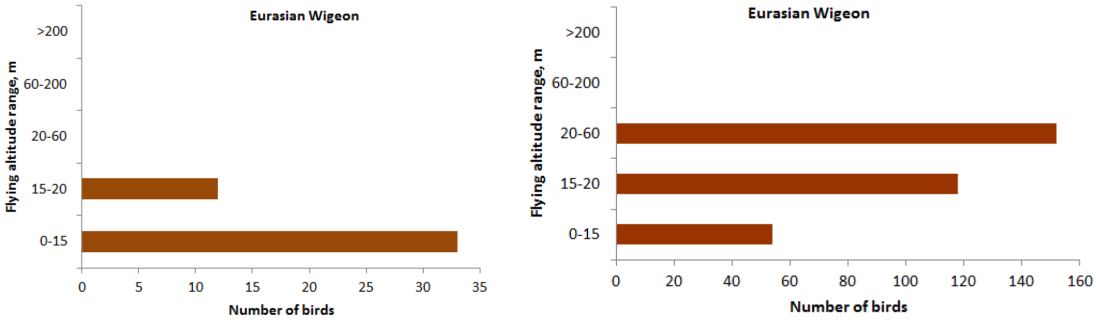
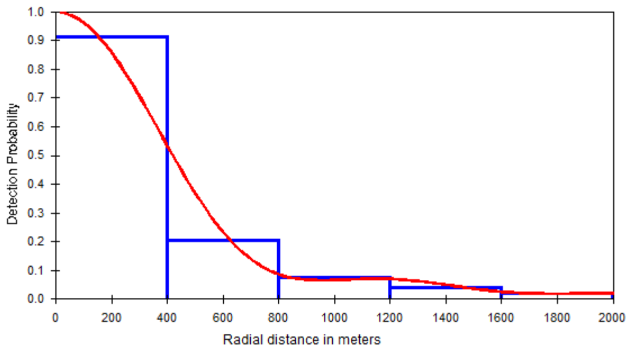


Figure 5.31 Flight altitudes of Eurasian Wigeon recorded visually at BŚ III area during daylight hours in spring (left chart) and autumn 2013 (right chart).

Results of migrating bird monitoring will be used in the EIA to calculate collision risk of migrants. Namely, migrating bird flux and flying altitude. Migrating bird flux was estimated by first applying correction for distance detection bias within focal range of the species, which due to small sample size was estimated by pooling three dabbling duck species together (Figure 5.32), then calculating bird passage rates per linear kilometre per hour for tail wind and head wind conditions, then scaling up this number for the daylight hours in a given month while accounting for wind direction (obtaining birds/km/month) and finally multiplying the obtained figure by 14 km, which is the width of the BŚ III wind farm along NW-SE axis that is perpendicular to the main direction of migrating birds (see chapter 4.2.1 for more detailed description).



Number of sightings: 76

Truncation: right 2000 m

Model function: Uniform key with Cosine adjustments

ERD (±SE): 607.59 (±44.29)

CV: 7.29%

Figure 5.32 Distance detection function of dabbling ducks (Mallard, Northern Pintail and Eurasian Wigeon together) recorded from anchored ships in Polish offshore waters and main parameters of the model fitting.

Estimates based on daytime visual observations suggest that 1,945 Eurasian Wigeon migrate through the BSIII wind farm area in spring and 5,683 in autumn (Table 5.10, Table 5.31). These numbers represent only a small proportion of the total flyway population (Table 5.31).

Subsequently it can be concluded that BŚ III does not lie on major migratory route of the species and only low percent of the flyway population pass the area during seasonal migrations.

Table 5.10 Numbers of Eurasian Wigeon estimated to be migrating through BŚ III in different months.

Month	Total count	Count within focal radius (2000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
March	0	0	0	–	–	–	–	–
April	70	70	230	0.23	0.46	138.9	1,945	1,682 – 2,249
May	0	0	0	-	-	-	-	–
July	0	0	0	-	-	-	-	–
August	2	2	7	0.01	0.01	4.8	67	58 – 78
September	321	196	645	0.72	1.46	398.3	5,576	4,823 – 6,447
October	0	0	0	-	-	-	-	–
November	1	1	3	0.01	0.01	2.9	40	35 – 46

Geese (*Anserini*)

General elements

Migrating geese species in this report are considered together as the majority of geese recorded at sea were not identified to species due to large distance to them , high altitude of flying birds and generally similar morphology of the species. Several identified flocks included Bean Goose *Anser fabalis*, Greylag Goose *Anser anser* and White-fronted Goose *Anser albifrons*.

None of these geese species are protected under the considered international or Polish national legislation.

Sizes of the flyway populations of these geese species are high: population of Bean Goose is 600,000, of White-fronted Goose 1,310,000 and Greylag Goose 610,000 individuals (Wetlands International 2014). Thus there are in total over 2.5 million birds of these there species together.

These three geese species breed mostly in the Scandinavian Peninsula and Western Siberia and spend winter period predominately in agricultural fields of Central and Western Europe (BirdLife International 2014, Wetlands International 2014). All three geese species migrate through Europe to their wintering grounds in the western parts of the continent. In Poland the passage of these geese is observed since the half of February till the half of May and then since September till December (Ławicki & Staszewski 2011). The highest concentrations of these birds are recorded in the western and south-western part of the country, where their number can exceed even 100 thousands of individuals (Tomiałojć & Stawarczyk 2003, Wuczyński et al. 2012).

Geese are long-distant migrants and migrate broadly distributed both over the land and the Baltic Sea. However it is not known the proportion of populations that fly over the Baltic or Polish waters in particular. Considering high numbers of geese observed in major stopover sites in Poland and other countries bordering the Eastern Baltic, it is likely that a few hundreds of thousands geese could be crossing the southern Baltic Sea during the seasonal migrations (Madsen et al. 1999, Ławicki et al. 2013).

Geese are herbivores foraging on vegetation in natural meadows, pastures and crops (Madsen et al. 1999, BirdLife International 2014), therefore the Baltic offshore waters do not represent their habitats and birds only passing the area during seasonal migrations.

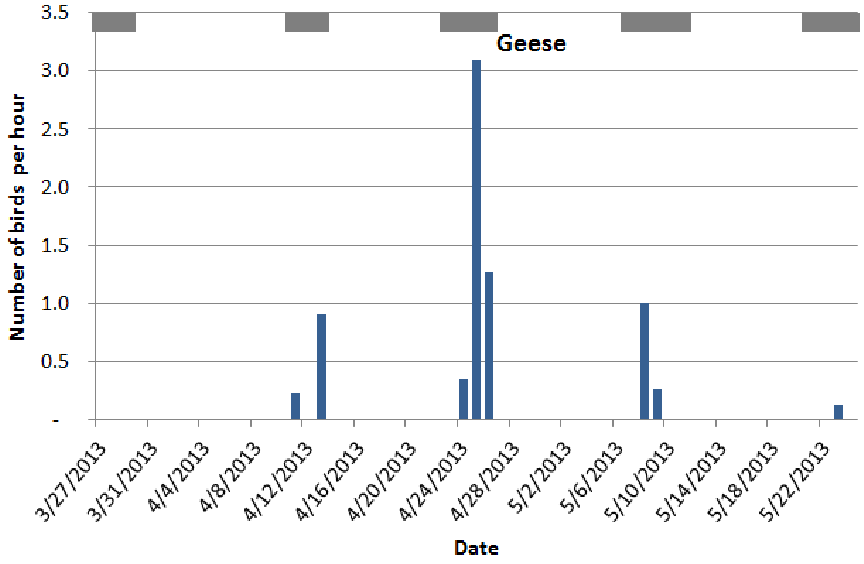
Sensitivity of the species to collisions with wind farms was assessed as medium by Chylarecki et al. (2011; category 2 in Table 3.1 in Chylarecki et al. 2011). EU guidance document on wind energy development (European Union 2011) lists that there is potential risk of collisions to wintering White-fronted Geese, however this is attributed to land-based wind farms in areas supporting wintering geese (Table 5.11). No collision risk is attributed to Bean Geese in the same document, and Greylag Goose is not listed (Table 5.11). Considering information provided in the EU guidance document (European Union 2011) we assume small risk of collisions with offshore wind farms for all geese species.

Table 5.11 Sensitivity of geese species to wind farms: XXX = Evidence on substantial risk of impact, XX = Evidence or indications of risk or impact, X = Potential risk or impact, x = small or non-significant risk or impact. (adapted from European Union 2011; sensitivity of Greylag Goose assumed to be the same as for other geese species; shaded fields indicate irrelevant pressures)

Species	Habitat displacement	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Bean Goose *Anser fabalis*		x			
White-fronted Goose *Anser albifrons*		x			
Greylag Goose *Anser anser*		x			

Elements basing on the results of the monitoring for BŚ III

In total 92 geese have been recorded during spring daytime visual observations and 12,057 in autumn at BŚ III (Appendix A). The species was observed migrating from mid-April to mid-May in spring and in late September-early October in autumn (Figure 5.33).



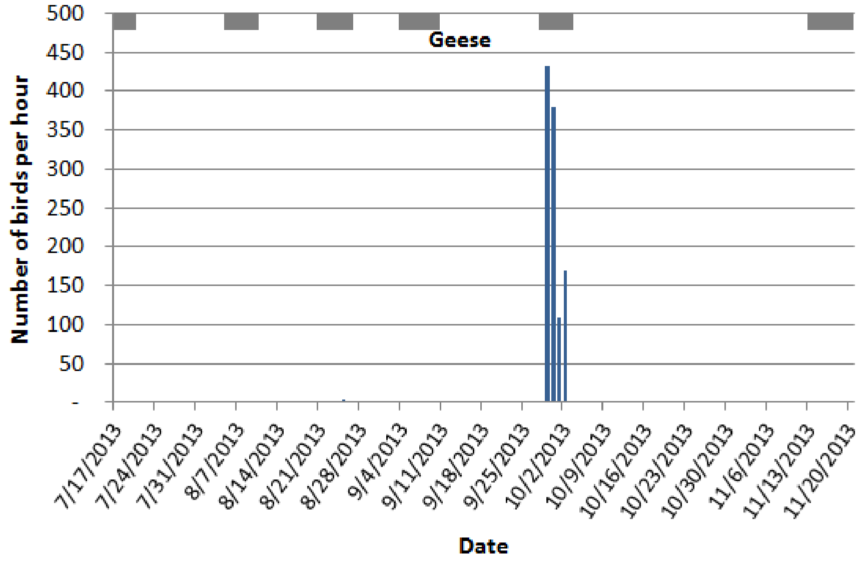


Figure 5.33 Migration periods and passage rates (birds/hour) of geese recorded at BŚ III area during daylight hours in March – May and July-November 2013. Grey areas on top of the charts indicate periods when observations were conducted.

Using horizontal radar for bird tracking 9 geese tracks were recorded in spring and 186 tracks in autumn (Figure 5.34, Appendix B). The majority of the recorded geese tracks were directed NE in spring and SW in autumn indicating migratory movements of the species (Figure 5.35). Similarly, flight direction recording during daytime visual observations show that geese maintained NE direction in spring and SW direction in autumn (Figure 5.36). The birds were most likely flying from/to wintering sites located in NW Europe.

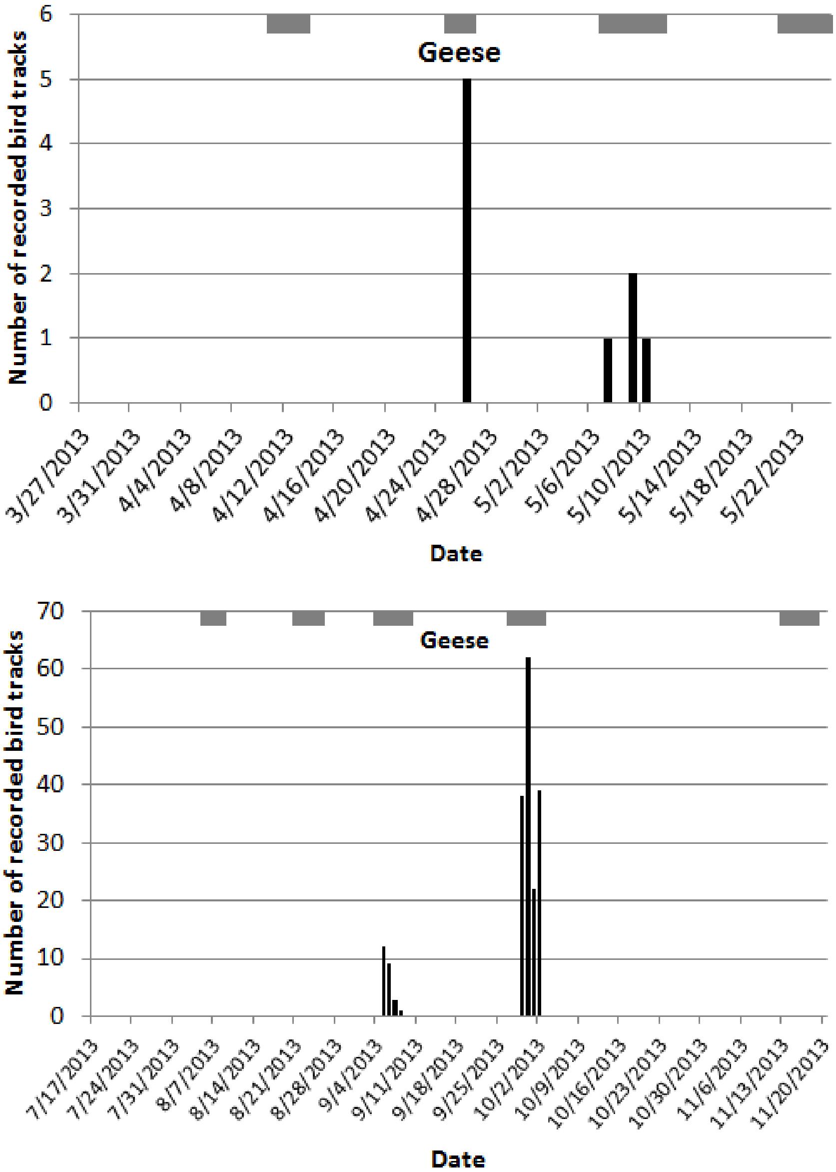


Figure 5.34 Temporal distribution of recorded geese tracks using horizontal surveillance radar at BŚ III in spring and summer-autumn 2013.

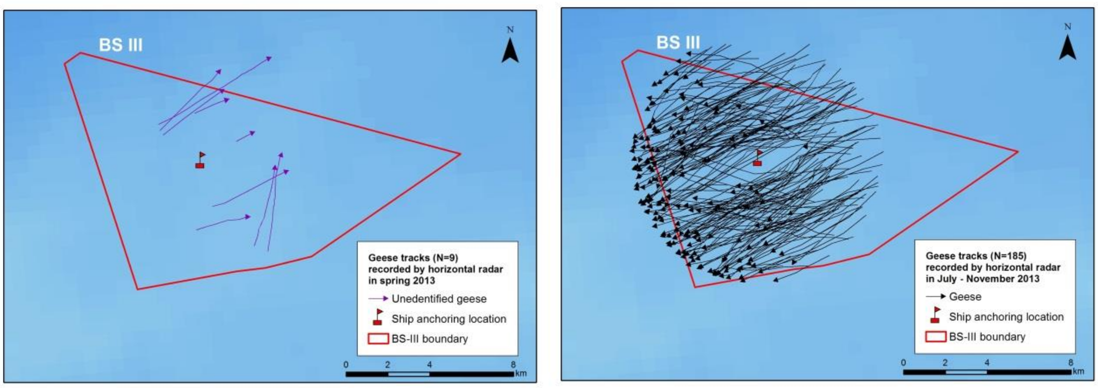


Figure 5.35 Flight trajectories of geese recorded using horizontal surveillance radar at BŚ III in spring 2013.

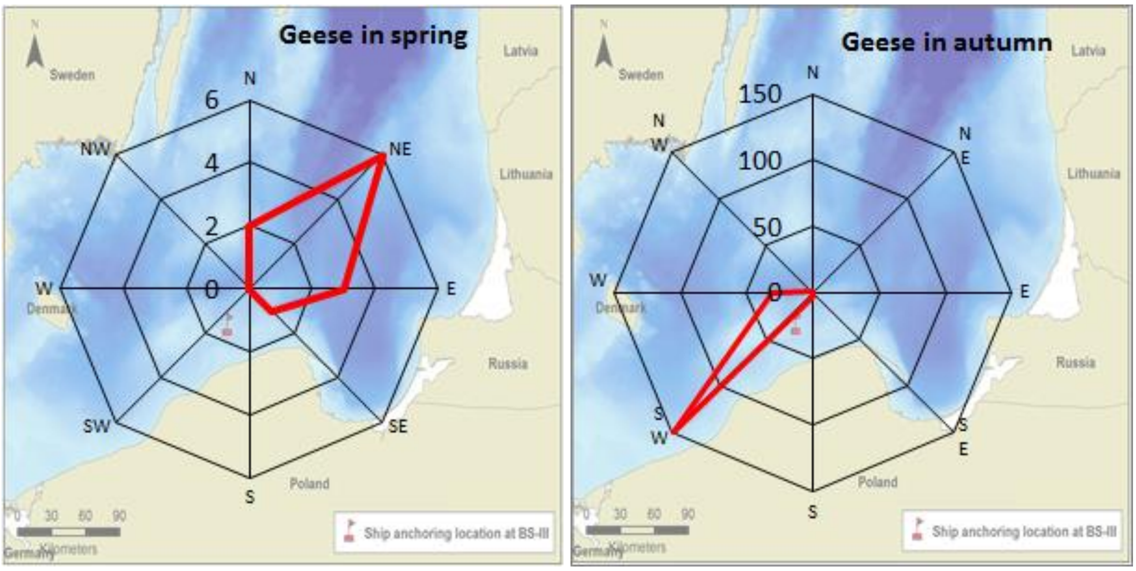


Figure 5.36 Flight directions of geese recorded during visual daytime surveys at BŚ III in spring and autumn 2013.

No geese were recorded during acoustic registration of nocturnal migrants. It is known, however, that geese also fly at night during long-distance migrations. Therefore it is likely that some geese were passing BŚ III area at night, the migration which was not possible to identify and quantify with used monitoring tools.

Altitude distribution of registered geese differed in spring and autumn: large proportion of registered geese flew below the potential rotor altitude in spring, but within the potential rotor altitude during daylight hours in autumn, if to consider 20-200 m as a likely rotor operating range (Figure 5.37). After grouping into five altitude bands, 94% of all geese flew below 20 m in spring; but the majority (73%) between 60-200 m, 15% between 20-60 m and 10% above 200 m in autumn (Figure 5.37, Appendix A).

Independent investigations by the Pomarinus group reported 23% of Bean Geese flew at 1-15 m altitude and the remaining 77 %at 15-60 m (N=84); and all registered White-fronted Geese (N=38) flew at 1-15 m in autumn.

Geese migrating at night likely fly at higher altitudes that registered during the daylight period, well above the potential rotor altitude.

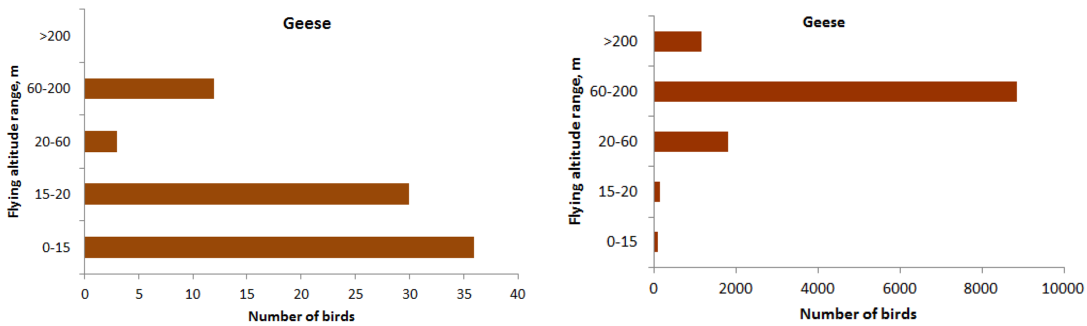
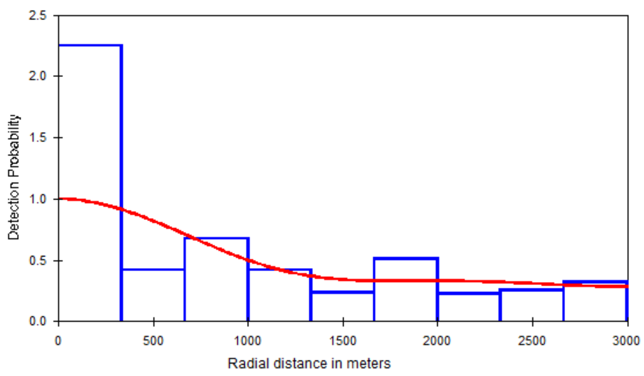


Figure 5.37 Flight altitudes of geese recorded visually at BŚ III area during daylight hours in spring (left chart) and autumn 2013 (right chart).

Results of migrating bird monitoring will be used in the EIA to calculate collision risk of migrants. Namely, migrating bird flux and flying altitude. Migrating bird flux was estimated by first applying correction for distance detection bias within focal range of the species (Figure 5.38), then calculating bird passage rates per linear kilometre per hour separately for tail wind and head wind conditions, then scaling up this number for the daylight hours in a given month while accounting for wind direction (obtaining birds/km/month) and finally multiplying the obtained figure by 14 km, which is the width of the BŚ III wind farm along NW-SE axis that is perpendicular to the main direction of migrating birds (see chapter 4.2.1 for more detailed description).



Number of sightings: 212

Truncation: right 3000 m

Model function: Uniform key with cosine adjustments

ERD (±SE): 1821.0 (±173.81)

CV: 9.54%

Figure 5.38 Distance detection function of geese recorded from anchored ships in Polish offshore waters and main parameters of the model fitting.

Estimates based on daytime visual observations suggest that 703 geese migrate through the BSIII wind farm area in spring and 103,091 in autumn (Table 5.12, Table 5.31). The autumn numbers represent about 4% of the total flyway numbers of all three geese species considered together (Table 5.31). In addition to day time passage, some birds could have migrated at night. Ornithological literature suggests that geese migrate at high altitude during the night, while on long distance migrations (Griffin et al. 2011). However, sufficiently specific data are unavailable on geese movement routes that would allow more precise estimates.

Considering the available information it can be concluded that significant proportions of some geese population (>1%) pass the BŚ III area during seasonal migrations.

Table 5.12 Numbers of geese estimated to be migrating through BŚ III in different months.

Month	Total count	Count within focal radius (3000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
March	0	0	0	–	–	–	–	–
April	71	60	99	0.17	0.03	47.0	658	545 – 794
May	21	6	10	0.01	0.00	3.2	45	37 – 54
July	0	0	0	–	–	–	–	–
August	38	38	63	0.11	0.02	23.7	331	274 – 400
September	8,956	6442	10,613	20.80	3.11	4,958.0	69,412	57,532 – 83,746
October	3,063	2176	3,585	23.63	3.53	2,382.0	33,348	27,641 – 40,235
November	0	0	0	–	–	–	–	–

Swans (*Cygninae*)

General elements

Migrating swan species in this report are considered together as many of swans recorded at sea were not identified to species due to large distance to them. Several identified birds included Mute Swan *Cygnus olor*, Whooper Swan *Cygnus cygnus* and Tundra Swan *Cygnus columbianus*.

Mute Swan is not protected by any of the considered international and Polish national legislation; Whooper Swan is listed in Annex I of the EU Birds Directive and Tundra Swan is listed in Annex I of the EU Birds Directive and has SPEC status SPEC3w indicating that winter population is not concentrated in Europe, but has unfavourable status in Europe.

Mute Swan flyway population size is 250,000, Whooper Swan - 59,000 and Tundra Swan - 21,500 individuals (Wetlands International 2014). Thus there are in total over 300,000 birds of these there species together.

All swan species breed in fresh water wetlands. Mute Swans breed across Europe and overwinter in unfrozen European inland and coastal water bodies. Whooper Swan breeds in northern Europe and western Siberia, and it is migratory species, which spends winter period in Western Europe, primarily Denmark and Germany. Tundra Swans primarily breed in Russia and overwinter in Western Europe with the highs numbers in the Netherlands (BirdLife International 2004, 2014).

Polish offshore waters are potentially on a migratory route of entire Whooper and Tundra Swan populations, which over winter in Western Europe and breed primarily NE from Poland. Therefore their entire populations should be considered as relevant. Mute Swans are only semi migratory, and many of bird migrate overland, but still birds breeding in the countries bordering eastern Baltic should be considered as relevant population, which is at least 10,000 pairs or 25,000 individuals (BirdLife International 2004).

Swans are herbivores foraging on primarily on aquatic vegetation but also in pastures and croplands (BirdLife International 2014). The Baltic offshore waters do not represent swan habitats and birds only pass the area during seasonal migrations.

Sensitivity of swans to collisions with wind farms was assessed as medium by Chylarecki et al. (2011; category 2 in Table 3.1 in Chylarecki et al. 2011). EU guidance document on wind energy development (European Union 2011) assesses only one species, the Whooper Swan, and indicates that there is potential risk of collisions (Table 5.11). Considering information provided in the EU guidance document (European Union 2011) we assume the same potential risk of collisions with offshore wind farms for other swan species as well.

Elements basing on the results of the monitoring for BŚ III

In total 77 swans have been recorded during spring daytime visual observations and 213 in autumn at BŚ III (Appendix A). The species was observed migrating mostly in mid-April and in November (Figure 5.39).

Table 5.13 Sensitivity of swan species to wind farms: XXX = Evidence on substantial risk of impact, XX = Evidence or indications of risk or impact, X = Potential risk or impact, x = small or non-significant risk or impact. (adapted from European Union 2011; sensitivity of Mute Swan and Tundra Swan assumed to be the same as for Whooper Swan; shaded fields indicate irrelevant pressures)

Species	Habitat displacement	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Mute Swan *Cygnus olor*		X			
Whooper Swan *Cygnus cygnus*		X			
Tundra Swan *Cygnus columbianus*		X			

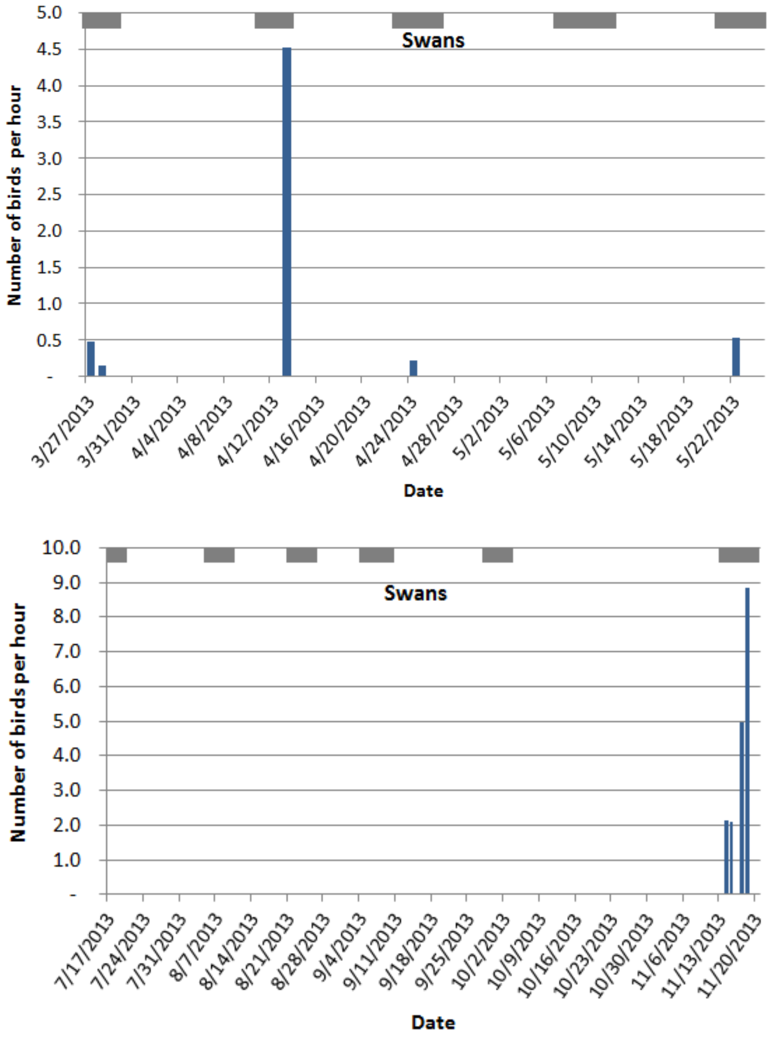


Figure 5.39 Migration periods and passage rates (birds/hour) of swans recorded at BŚ III area during daylight hours in March – May and July-November 2013. Grey areas on top of the charts indicate periods when observations were conducted.

Using horizontal radar for bird tracking 5 swan tracks were recorded in spring and 14 tracks in autumn during the same period as visual observations (Appendix B). Three of the recorded swan tracks were directed NE in spring, one SE and one NW. In autumn the predominant direction was westwards indicating migratory movements (Figure 5.40). Similarly, flight direction recording during daytime visual observations show that swans maintained easterly directions in spring and W direction in autumn (Figure 5.41). The birds were most likely flying from/to wintering sites located in NW Europe.

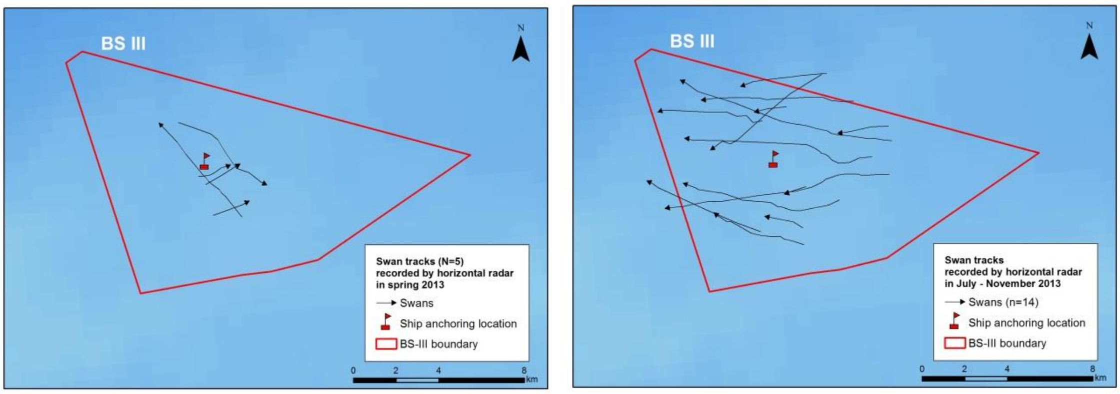


Figure 5.40 Flight trajectories of swans recorded using horizontal surveillance radar at BŚ III in spring 2013.

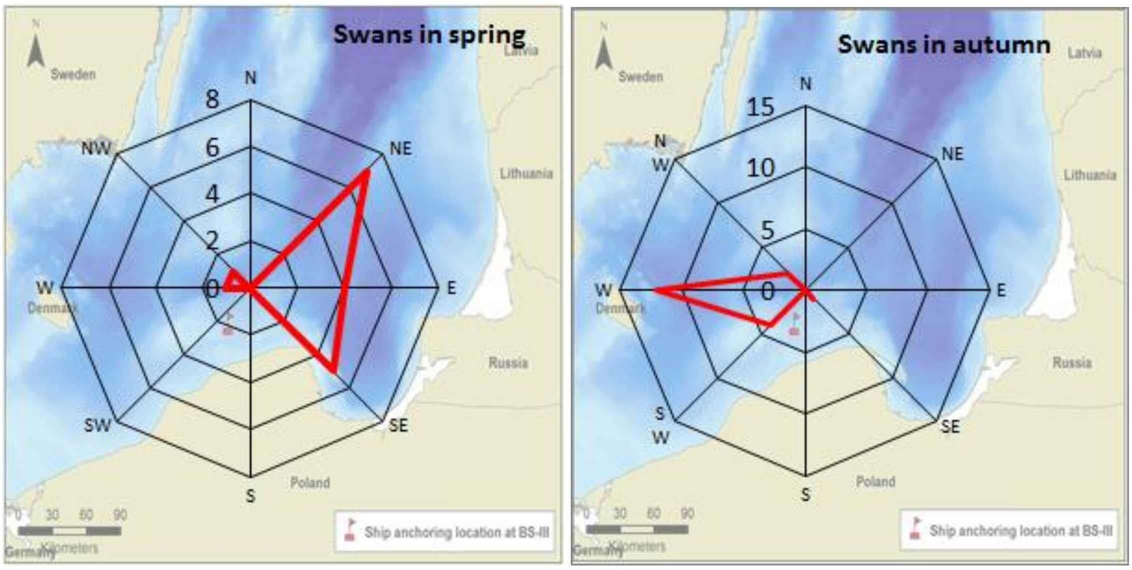


Figure 5.41 Flight directions of swans recorded during visual daytime surveys at BŚ III in spring and autumn 2013.

No swans were recorded during acoustic registration of nocturnal migrants.

Altitude distribution of registered swans was variable with the majority of birds flying low: 61% of bird flew at 0-15 m altitude and the rest at 20-60 m height in spring. Similarly 67% flew at 0-15 m in autumn with the rest of birds recorded at about 10% at each of the altitude bands 15-20m, 20-60m and 60-200 m (Figure 5.37, Appendix A).

Independent investigations by the Pomarinus group reported 4 swans during the autumn migration flying at 1-15 m altitude; and 17 swans flying at the same 1-15 m altitude in autumn (Meissner 2014).

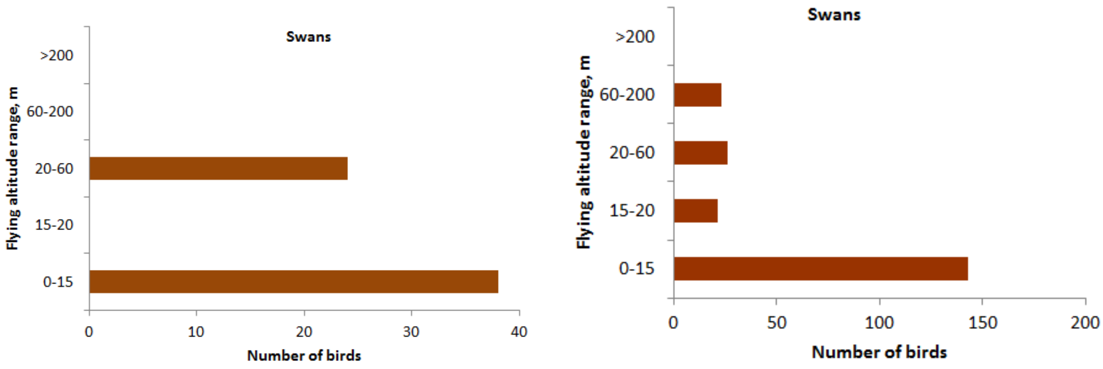


Figure 5.42 Flight altitudes of swans recorded visually at BŚ III area during daylight hours in spring (left chart) and autumn 2013 (right chart).

Results of migrating bird monitoring will be used in the EIA to calculate collision risk of migrants. Namely, migrating bird flux and flying altitude.

Distance analysis results did not yield reliable model for detection function of swans, probably due to small sample size. Considering that swans are large and easy noticeable birds, we assumed that there was no decline in detection within the focal range of 3,000 m. Subsequently, migrating swan flux was estimated by birds flying within focal range of the species (3000 m), then calculating bird passage rates per linear kilometre per hour separately for tail wind and head wind conditions, then scaling up this number for the daylight hours in a given month while accounting for wind direction (obtaining birds/km/month) and finally multiplying the obtained figure by 14 km, which is the width of the BŚ III wind farm along NW-SE axis that is perpendicular to the main direction of migrating birds (see chapter 4.2.1 for more detailed description).

Estimates based on daytime visual observations suggest that 457 swans migrate through the BSIII wind farm area in spring and 1,526 in autumn (Table 5.12, Table 5.31). These number represent only a small fraction of overall flyway population and the autumn numbers represent about 1.5% of the relevant regional population of all three swan species considered together (Table 5.31). This fraction is substantially lower than the hypothetical 8.2% if birds were migrating evenly dispersed across the entire width of the Baltic See (see Figure 4.12). The difference could be explained by large migration of swans overall, or other migratory routes.

Considering the available information it can be concluded that BŚ III area is not located on the important migratory route of swans.

Table 5.14 Numbers of swans estimated to be migrating through BŚ III in different months.

Month	Total count	Count within focal radius (3000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
March	6	6	6	0.01	0.03	4.6	64	na
April	63	63	63	0.03	0.10	24.6	344	na
May	8	8	8	0.00	0.01	3.5	49	na
July	0	0	0	-	-	-	-	na
August	0	2	2	0.00	0.00	1.0	14	na

Month	Total count	Count within focal radius (3000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
September	4	0	0	-	-	-	-	na
October	0	0	0	-	-	-	-	na
November	209	172	172	0.16	0.50	108.0	1,512	na

Razorbill (*Alca torda*)

General elements

Razorbill is not listed among protected species under considered international and Polish national legislation. However, nearly all bird species are fully or partly protected in Poland except for game species.

The world population is estimated at 430-770,000 breeding pairs (BirdLife International 2014), of which about 15,000 pairs breed in the Baltic Sea (BirdLife International 2014). There is a lack of the up-date on the number of Razorbills currently wintering in the Baltic. About 156,000 birds were estimated as wintering in the Baltic Sea in 1988-1993, majority of them in Kattegat and surrounding areas (Durinck et al. 1994, BirdLife International 2004). In the absence of more recent estimates we assumed that the same numbers continue to occur in the Baltic.

Razorbills breed on rocky islands and shores of the northern Atlantic, including islands in the Baltic Sea. After the breeding season Razorbills disperse in the surrounding marine waters up to a few hundred kilometres away from breeding areas. However Razorbills are not long distance migrants and the Baltic breeding population is believed to be wintering within the Baltic Sea. High numbers of wintering birds that occur in the western Baltic Sea (Kattegat) likely include not only Baltic, but also north Atlantic breeding birds (Durinck et al. 1994).

Razorbill diet consists of mostly fish, although crustaceans and polychates were also recorded (Cramp 1985).

Baltic waters of Poland are in within the distribution range of Baltic Razorbill population, which winter widely distributed in the Baltic proper (Durinck et al. 1994). It is likely that Razorbills recorded during seasonal migrations at BŚ III overwinter in areas further south and west.

Sensitivity of the species to collisions with wind farms was assessed as low by Furness et al. (2013; score 32 in Table 2 in Furness et al. 2013). EU guidance document on wind energy development (European Union 2011) lists that there is evidence that wintering Razorbills are affected by habitat displacement and potential risks of collision, and change in habitat structure (Table 5.15).

Table 5.15 Sensitivity of Razorbills to wind farms: XXX = Evidence on substantial risk of impact, XX = Evidence or indications of risk or impact, X = Potential risk or impact, x = small or non-significant risk or impact. (Adapted from European Union 2011)

Species	Habitat displacement	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Razorbill *Alca torda*	XX	X		X	

Elements basing on the results of the monitoring for BŚ III

In total 93 Razorbills have been recorded during spring daytime visual observations and 24 in autumn at BŚ III (Appendix A). The species was observed migrating in all spring months and in late September – early October and November in autumn (Figure 5.43).

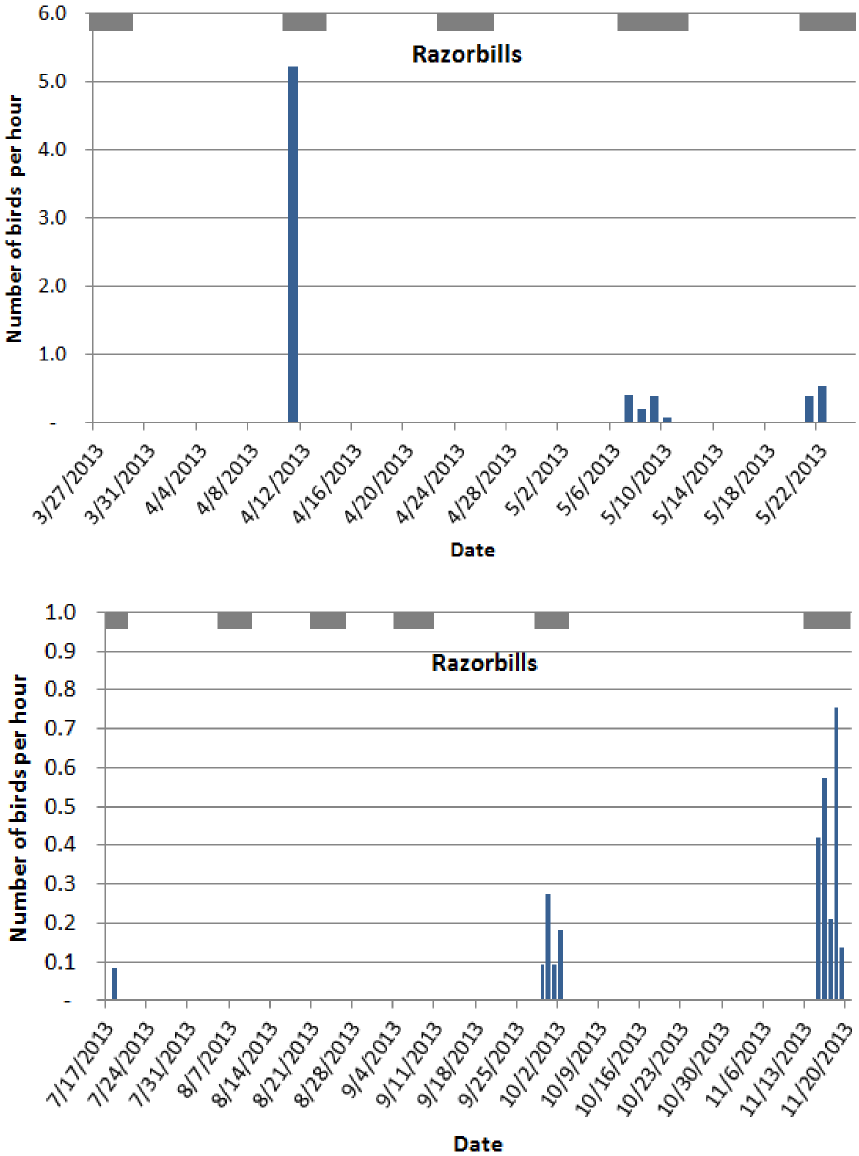


Figure 5.43 Migration periods and passage rates (birds/hour) of Razorbills recorded at BŚ III area during daylight hours in March – May and July – November 2013. Grey areas on top of the charts indicate periods when observations were conducted.

Using horizontal radar for bird tracking 5 Razorbill tracks were recorded in spring and none in autumn (Appendix B). The recorded Razorbill tracks were directed NE, similarly to movement direction of other migrating species (Figure 5.44). Flight direction recording during daytime visual observations shows somewhat different results indicating that Razorbills maintained mostly E direction in spring (Figure 5.45). Flight directions recorded in autumn were variable without clear dominating destination (Figure 5.45).

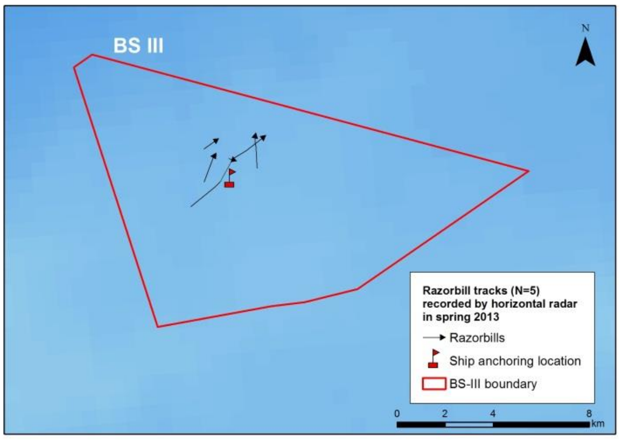


Figure 5.44 Flight trajectories of Razorbills recorded using horizontal surveillance radar at BŚ III in spring 2013.

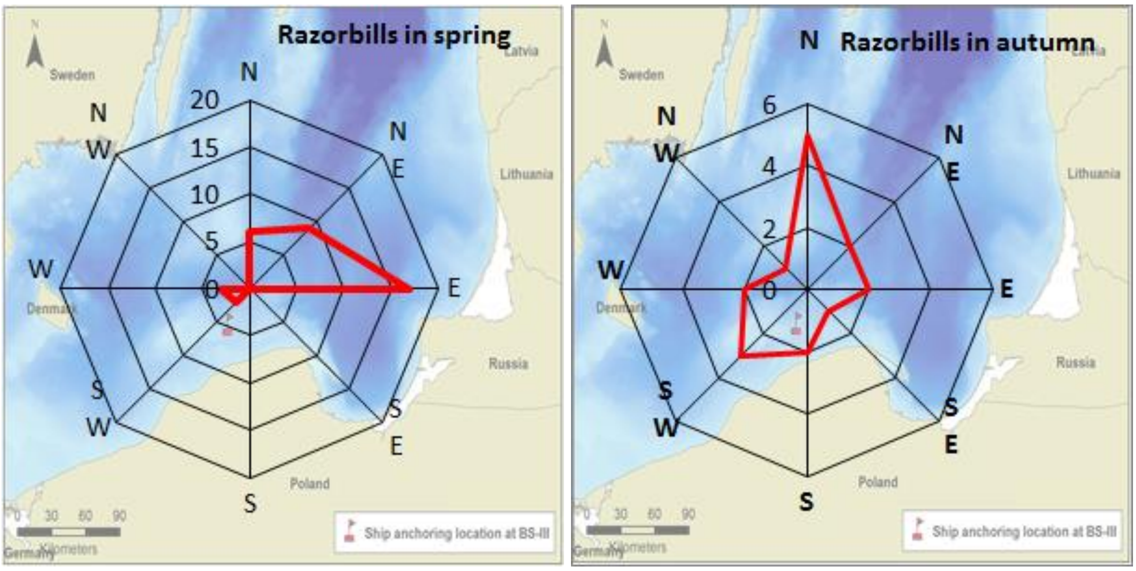


Figure 5.45 Flight directions of Razorbills recorded during visual daytime surveys at BŚ III in spring and autumn 2013.

No Razorbills were recorded during acoustic registration of nocturnal migrants due to silent nature of this species.

All registered Razorbills flew low at altitude 0-15 m, below the potential rotor altitude of typical OWF (Figure 5.46, Appendix A).

Similarly, independent investigations by the Pomarinus group reported 96% of Razorbill flying at 1-15 m altitude in autumn (N=53), 100% at 1-15 m in winter (N=215), and 100% at the same 1-15 m in spring (N=128) (Meissner 2014).

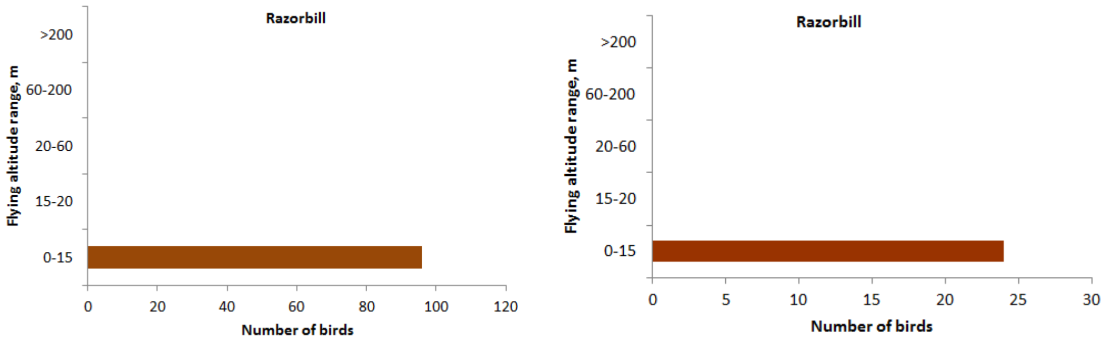
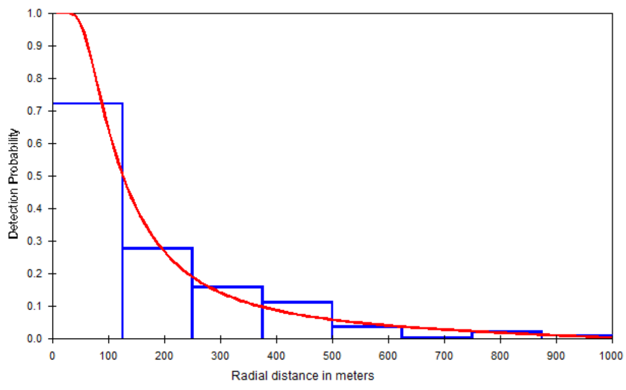


Figure 5.46 Flight altitudes of Razorbills recorded visually at BŚ III area during daylight hours in spring (left chart) and autumn 2013 (right chart).

Part of the Razorbill population that should be considered in the EIA of BSIII consists of birds wintering in the entire Baltic Sea east from the Danish Straits. The size of this population is approximately 23,000 birds (calculated using Razorbill Table on page 103 in Durinck et al. 1994).

Results of migrating bird monitoring will be used in the EIA to calculate collision risk of migrants. Namely, migrating bird flux and flying altitude. Migrating bird flux was estimated by first applying correction for distance detection bias within focal range of the species (Figure 5.47), then calculating bird passage rates per linear kilometre per hour separately for tail wind and head wind conditions, then scaling up this number for the daylight hours in a given month while considering the wind direction (obtaining birds/km/month) and finally multiplying the obtained figure by 14 km, which is the width of the BŚ III wind farm along NW-SE axis that is perpendicular to the main direction of migrating birds (see chapter 4.2.1 for more detailed description).



Number of sightings: 175

Truncation: right 1000 m

Model function: Uniform key with Cosine adjustments

ERD (±SE): 248.29 (±35.27)

CV: 14.21%

Figure 5.47 Distance detection function of auks (Razorbill, Common Guillemot, Black Guillemot and unidentified auks pooled together) recorded from anchored ships in Polish offshore waters and main parameters of the model fitting.

Estimates based on daytime visual observations indicate that 6,294 Razorbills fly through the BSIII wind farm area in spring and about 2,883 in autumn (Table 5.16, Table 5.31). These numbers represent small proportions of the total flyway population but large share of the relevant regional population (Table 5.31).

Estimated migration intensity involving more than 27% of the relevant population of the species (wintering in the Baltic Sea) is very high considering that BŚ III lies at the edge of the Razorbill distribution in the Baltic Proper. Recognizing that no knowledge exists about Razorbill movements during non-breeding seasons (which could only be revealed by telemetry data), we speculate that high number of estimated Razorbill crossings through the potential wind farm area represents communing flights of locally staging birds but not migratory movements. This is supported by the absence of clearly dominant flight direction of the species both during spring and autumn periods (Figure 5.44, Figure 5.45).

Subsequently it can be concluded that BŚ III probably does not lie on major migratory route of the species, but is important area for locally staging and locally commuting birds.

Table 5.16 Numbers of Razorbill estimated to be migrating through BŚ III in different months.

Month	Total count	Count within focal radius (1000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
March	0	0	0	–	–	–	–	–
April	69	67	270	0.32	1.30	311.1	4,355	3,295 – 5,756
May	27	23	93	0.09	0.35	124.7	1,746	1,321 – 2,308
July	1	1	4	0.02	0.09	13.8	193	146 – 256
August	0	0	0	-	-	-	-	–
September	4	4	16	0.02	0.09	19.2	269	204 – 356
October	3	3	12	0.05	0.22	61.1	855	647 – 1,130
November	16	16	64	0.15	0.60	125.6	1,759	1,331 – 2,325

Great Cormorant (*Phalacrocorax carbo*)

General elements

Great Cormorant is not listed among protected species under considered international and Polish national legislation.

The flyway population of the relevant subspecies *Phalacrocorax carbo sinensis* is estimated at 380-405,000 individuals (Wetlands International 2014), of which about 25,000 pairs reside in countries bordering E-SE Baltic Sea (BirdLife International 2014). About 54,000 cormorants are estimated to winter in the Baltic Sea (Skov et al. 2011). Considering the number of breeding pairs in the E-SE Baltic region it could be roughly assumed that about 100,000 Great Cormorants could be residing in the area if to account for non-breeding birds.

Great Cormorants of subspecies *P.c. sinensis* breeding in colonies settled in trees that could be up to several thousand nests in size. The majority of such colonies are situated in the coastal areas, but there also some farther inland. Great cormorants usually stay in the coastal zone, and their highest winter concentrations are recorded along the coasts of Denmark, western part of the Pomeranian Bay and Puck Bay (Skov et al. 2011). This species primarily feeds on fish (Cramp & Simmons 1977).

Coastal waters of Poland are in within the core distribution range of regional Great Cormorant population, with several large colonies situated there. Typically, cormorants do not use marine habitats more than 20-30 km away from land, as these birds have permeable plumage and need to dry it while perched out of water regularly. Great Cormorants recorded during seasonal migrations at BŚ III could be either migrants or occasional resident birds that ventured far offshore.

Sensitivity of the species to collisions with wind farms was assessed as low by Chylarecki et al. (2011; category 1 in Table 3.1 in Chylarecki et al. 2011), and similarly as low-medium by Furness et al. (2013; score 103 in Table 2 in Furness et al. 2013). EU guidance document on wind energy development (European Union 2011) lists that Great Cormorants face potential risk from habitat displacement and small or non-significant risk from collisions and barrier effect (Table 5.17).

Table 5.17 Sensitivity of Great Cormorants to wind farms: XXX = Evidence on substantial risk of impact, XX = Evidence or indications of risk or impact, X = Potential risk or impact, x = small or non-significant risk or impact. (Adapted from European Union 2011)

Species	Habitat displacement	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Great Cormorant *Phalacrocorax carbo*	X	x	x		

Elements basing on the results of the monitoring for BŚ III

In total 123 Great Cormorants have been recorded during spring daytime visual observations and 71 in autumn at BŚ III (Appendix A). The species was registered during most of the observation cruises with the highest numbers recorded in late April and late August (Figure 5.48).

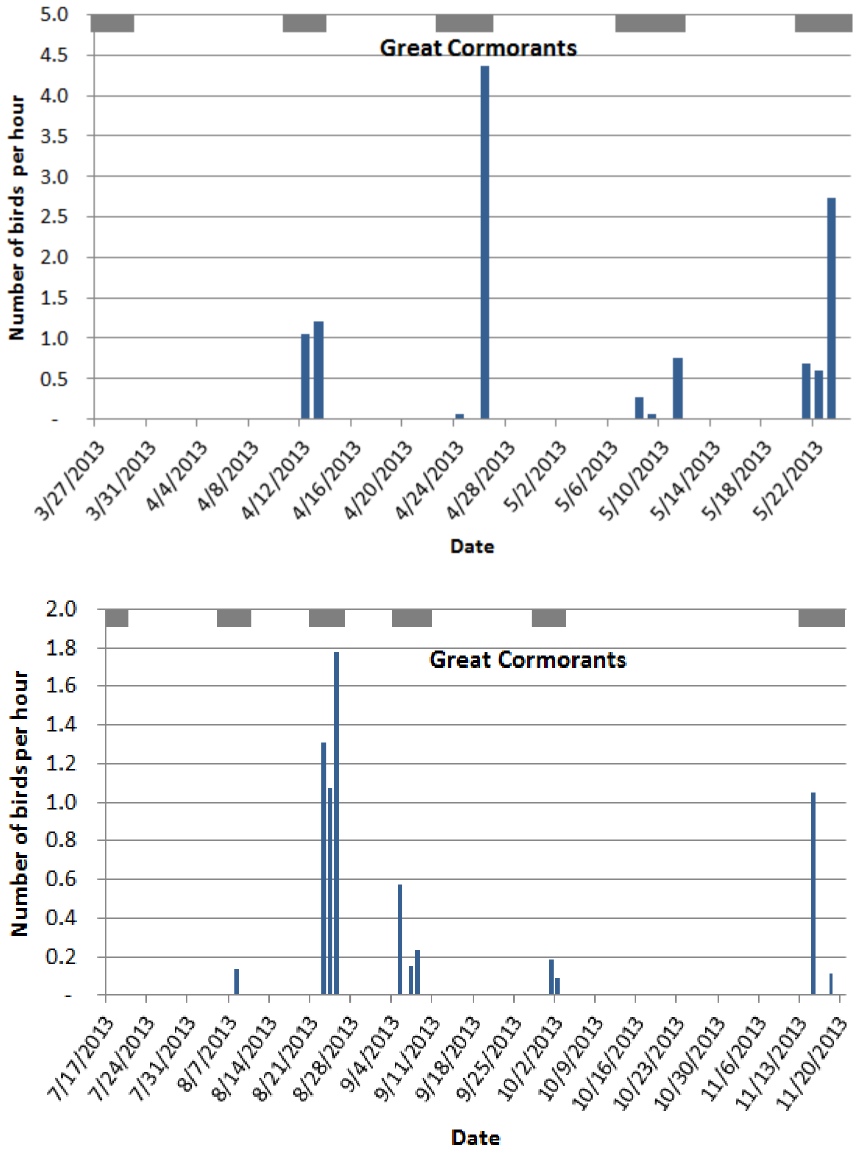


Figure 5.48 Migration periods and passage rates (birds/hour) of Great Cormorants recorded at BŚ III area during daylight hours in March – May and July – November 2013. Grey areas on top of the charts indicate periods when observations were conducted.

Using horizontal radar for bird tracking 6 Great Cormorant tracks were recorded in spring and 8 in autumn (Appendix B). The recorded Great Cormorant tracks were directed N-NE in spring and mostly SW, except the two tracks, in summer-autumn (Figure 5.49). Flight direction recording during daytime visual observations shows similar results indicating that Great Cormorant flew mostly N-NE-E in spring (Figure 5.50). Flight directions recorded in autumn were more variable with the dominating SW destination (Figure 5.50).

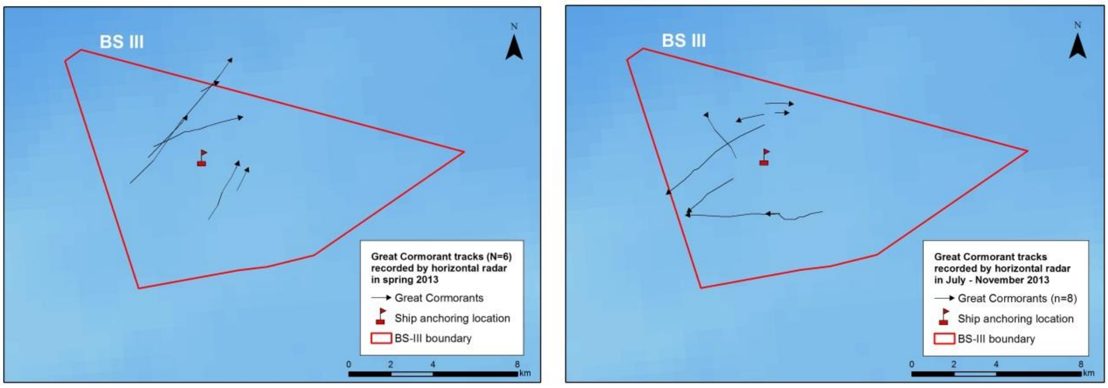


Figure 5.49 Flight trajectories of Great Cormorants recorded using horizontal surveillance radar at BŚ III in spring and summer-autumn 2013.

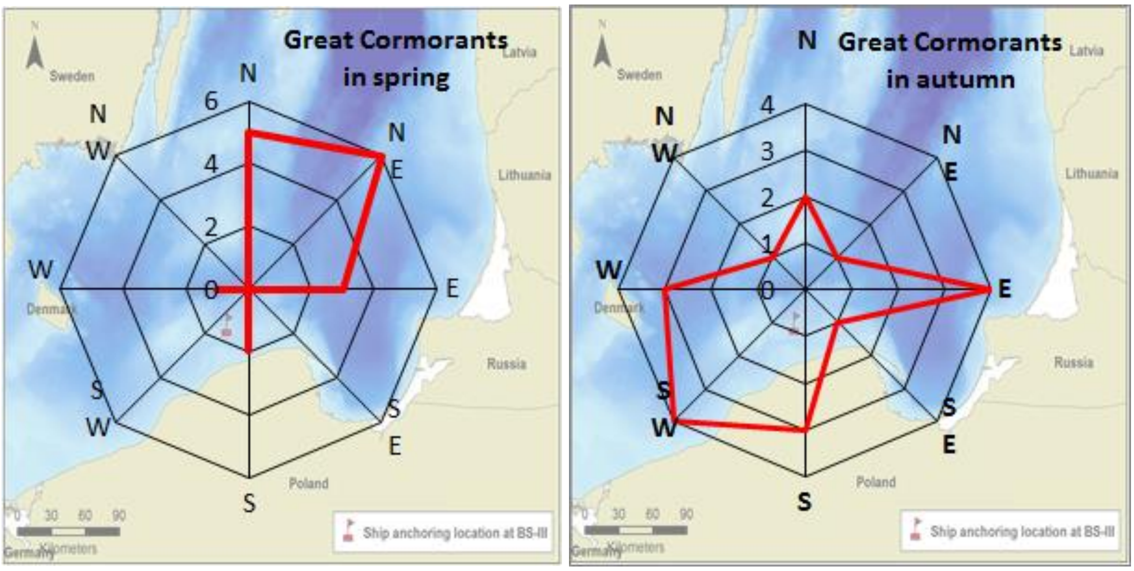


Figure 5.50 Flight directions of Great Cormorants recorded during visual daytime surveys at BŚ III in spring and summer-autumn 2013.

No Great Cormorants were recorded during acoustic registration of nocturnal migrants due to silent nature of this species.

Great Cormorants had rather wide range of flight altitudes: about 40% of them were recorded below 20 m and the remaining 60% between 20-60 m in spring and about 50% were recorded below 20 m, 36% between 20-60 m and the rest between 60-200 m in autumn (Figure 5.51, Appendix A).

Similarly, independent investigations by the Pomarinus group reported 100% of Great Cormorants flying at 60-200 m altitude in autumn (N=6), 100% at 1-15 m in winter (N=2), and 30% at same 1-15 m and the remaining 70% at 15-60 m in spring (N=10) (Meissner 2014).

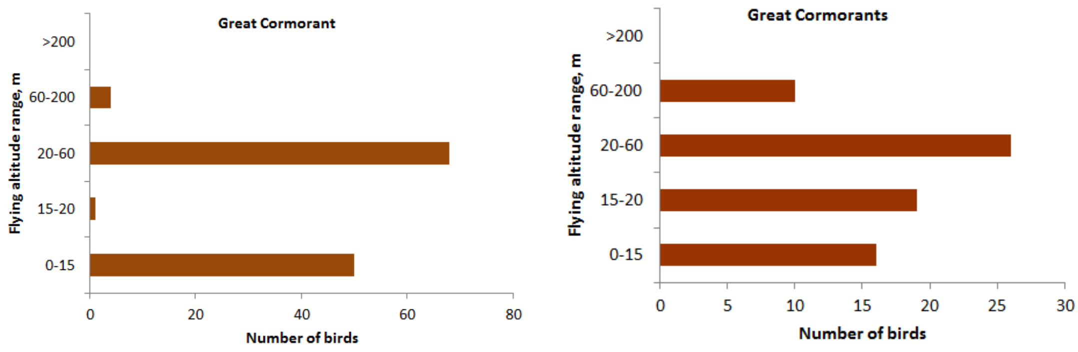


Figure 5.51 Flight altitudes of Great Cormorants recorded visually at BŚ III area during daylight hours in spring (left chart) and autumn 2013 (right chart).

Part of the Great Cormorant population that should be considered in the EIA of BSIII consists of birds residing in the E-SE Baltic Sea region that could potentially migrate past the study area. The size of this population is approximately 100,000 birds (calculated using assumptions stated in the text above).

Results of migrating bird monitoring will be used in the EIA to calculate collision risk of migrants. Namely, migrating bird flux and flying altitude.

Distance analysis results did not yield reliable model for species-specific detection function of Great Cormorants, probably due to rather small sample size of observations. We therefore used ERD of 1,200 m assuming focal range of 2,000 m, which is similar to the Distance analysis results obtained for divers, which are similar size birds to cormorants.

Migrating bird flux was estimated by first applying the assumed correction for distance detection bias within focal range of the species (2,000 m), then calculating bird passage rates per linear kilometre per hour separately for tail wind and head wind conditions, then scaling up this number for the daylight hours in a given month while considering the wind direction (obtaining birds/km/month) and finally multiplying the obtained figure by 14 km, which is the width of the BŚ III wind farm along NW-SE axis that is perpendicular to the main direction of migrating birds (see chapter 4.2.1 for more detailed description).

Estimates based on daytime visual observations indicate that 959 Great Cormorants fly through the BSIII wind farm area in spring and about 651 in autumn (Table 5.18, Table 5.31). These numbers represent small proportions of the total flyway and relevant regional populations (Table 5.31).

Estimated diurnal migration intensity involves approximately 1% of the relevant population size of this species. This is substantially lower compared to the hypothetical 8.2% if birds were migrating evenly dispersed across the entire width of the Baltic See (see Figure 4.12). This could be explained by the generally coastal distribution of the species. However, no sufficiently specific data are available on Great Cormorant distribution and movement routes in the Baltic Sea that would allow more precise figures.

Subsequently it can be concluded that BŚ III does not lie on major migratory route of the species.

Table 5.18 Numbers of Great Cormorants estimated to be migrating through BŚ III in different months.

Month	Total count	Count within focal radius (2000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
March	0	0	0	–	–	–	–	–
April	55	40	67	0.17	0.03	47.5	666	na
May	68	26	43	0.09	0.01	21.0	294	na
July	0	0	0	–	–	–	–	–
August	45	37	62	0.16	0.02	34.9	489	na
September	12	5	8	0.02	0.00	5.8	82	na
October	3	3	5	0.05	0.01	5.0	70	na
November	11	1	2	0.01	0.00	0.7	10	na

Little Gull (*Larus minutus*)

General elements

Little Gull listed in Annex I of the EU Birds directive, they are also SPEC3 category species (species not concentrated in Europe, but with unfavourable conservation status in Europe) considering status of EU Conservation Concern (BirdLife International 2004), and listed in Annex 1 of the list of strictly protected species in Poland (Journal of Laws of 2011).

The European breeding population of the species is estimated at 72-174,000 individuals (or 23,500-60,500 pairs) (Wetlands International 2014). About 2,000 Little Gulls were estimated to winter in the Baltic Sea in early 1990s (Durinck et al. 2004). The majority of the Little Gulls breed in taiga zone of Russia with sizable population also occurring in Finland, Estonia and Belarus (BirdLife International 2004), therefore we assume that about 70% of the European population could be considered as relevant regional population which could be passing the BŚ III area. Considering minimum estimates this comprises at least 50,000 birds.

Autumn migration of the species starts in the middle of July and lasts until the end of October, while return migration towards the breeding grounds starts in March and continues until the end of May (Neubauer et al. 2011). During winter the Little Gull prefers open sea areas of Western Europe (Atlantic coast and Mediterranean Sea). It feeds on insects and other invertebrates, as well as small fish (Cramp & Simmons 1983).

Offshore and coastal waters of Poland are in within the main migratory route of this species as birds breeding in the NE Europe and Russia migrate towards Atlantic Ocean for wintering.

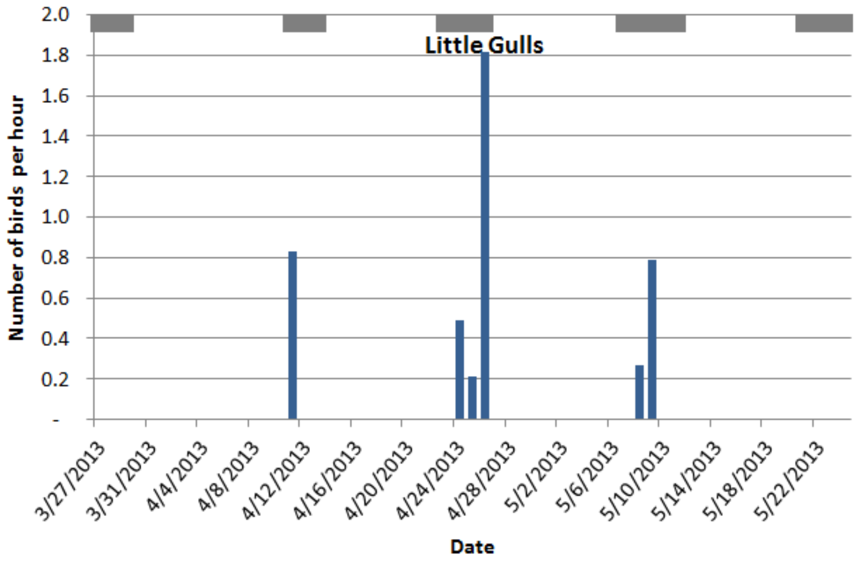
EU guidance document on wind energy development (European Union 2011) suggests that Little Gulls are not at any risk wind farm development which could even have a positive on the species (Table 5.19).

Table 5.19 Sensitivity of Little Gulls to wind farms: XXX = Evidence on substantial risk of impact, XX = Evidence or indications of risk or impact, X = Potential risk or impact, x = small or non-significant risk or impact. (Adapted from European Union 2011).

Species	Habitat displacement	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Little Gull *Larus minutus*					x

Elements basing on the results of the monitoring for BŚ III

In total 47 Little Gulls have been recorded during spring daytime visual observations and 43 in autumn at BŚ III (Appendix A). The species was registered during April-early May cruises in spring and during most of the surveys in autumn with the highest numbers recorded in August – early September (Figure 5.52).



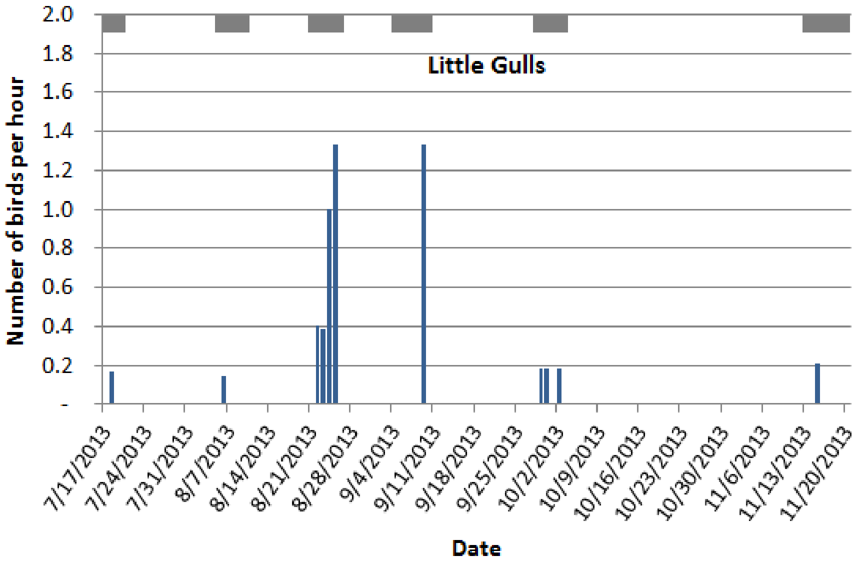


Figure 5.52 Migration periods and passage rates (birds/hour) of Little Gulls recorded at BŚ III area during daylight hours in March – May and July – November 2013. Grey areas on top of the charts indicate periods when observations were conducted.

Using horizontal radar for bird tracking 6 Little Gull tracks were recorded in spring and none in autumn (Appendix B). The recorded Little Gull tracks were directed E in spring (Figure 5.53). Flight direction recording during daytime visual observations shows similar results indicating that Little Gulls flew mostly E in spring and W in autumn (Figure 5.54).

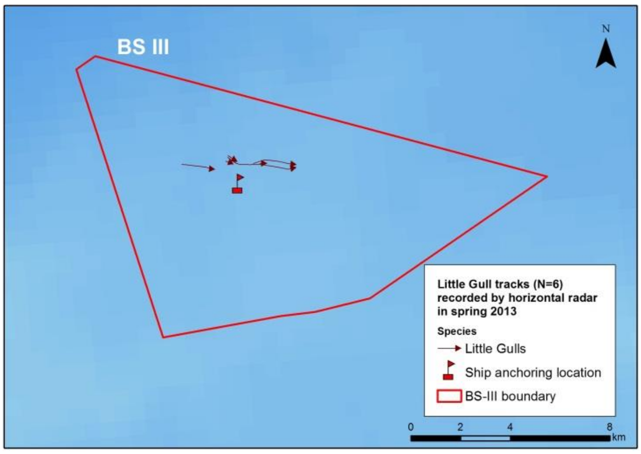


Figure 5.53 Flight trajectories of Little Gulls recorded using horizontal surveillance radar at BŚ III in spring 2013.

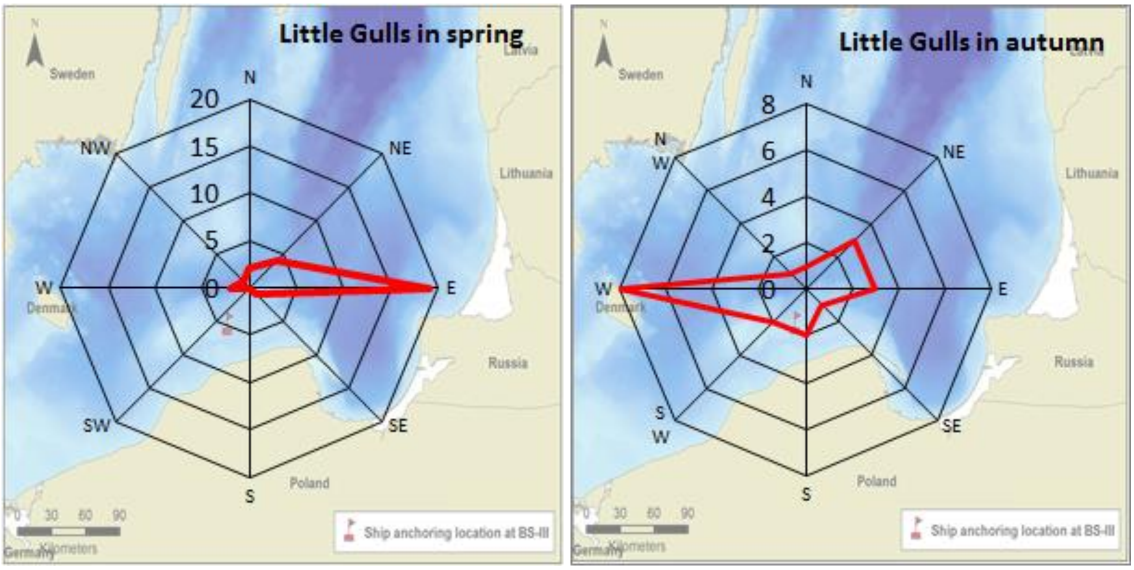


Figure 5.54 Flight directions of Little Gulls recorded during visual daytime surveys at BŚ III in spring and summer-autumn 2013.

No Little Gulls were recorded during acoustic registration of nocturnal migrants

Little Gulls had rather wide range of flight altitudes, but the majority of birds flew low: about 75% of them were recorded between 0-15 m in spring 83% in autumn (Figure 5.55, Appendix A).

Similarly, independent investigations by the Pomarinus group reported 95% of Little Gulls flying at 1-15 m altitude in autumn (N=22), 67% at 1-15 m in winter (N=6), and 67% at same 1-15 m in spring (N=3) (Meissner 2014).

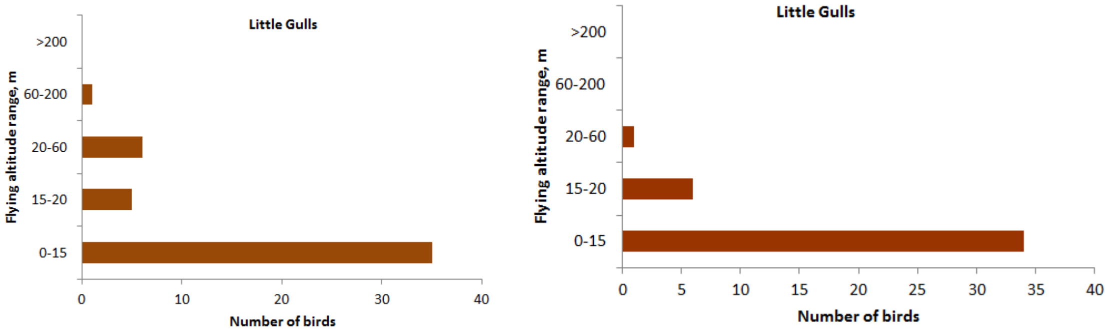


Figure 5.55 Flight altitudes of Little Gulls recorded visually at BŚ III area during daylight hours in spring (left chart) and autumn 2013 (right chart).

Results of migrating bird monitoring will be used in the EIA to calculate collision risk of migrants. Namely, migrating bird flux and flying altitude.

Distance analysis results did not yield reliable model for species-specific detection function of Little Gulls, probably due to rather small sample size of observations. We therefore used ERD of 500 m assuming focal range of 1,000 m, which is a little smaller to the Distance analysis results obtained for the Long-tailed Ducks, which is a light coloured small duck recorded during the observations, although has different flight pattern compared to a gull.

Migrating bird flux was estimated by first applying the assumed correction for distance detection bias within focal range of the species (1,000 m), then calculating bird passage rates per linear kilometre per hour separately for tail wind and head wind conditions, then scaling up this number for the daylight hours in a given month while considering the wind direction (obtaining birds/km/month) and finally multiplying the obtained figure by 14 km, which is the width of the BŚ III wind farm along NW-SE axis that is perpendicular to the main direction of migrating birds (see chapter 4.2.1 for more detailed description).

Estimates based on daytime visual observations indicate that 1,004 Little Gulls fly through the BSIII wind farm area in spring and 1,514 in autumn (Table 5.20, Table 5.31). These numbers represent small proportions of the total flyway and relevant regional populations (Table 5.31).

Estimated diurnal migration intensity involves approximately 3.1% of the relevant population size of this species. This is lower than the hypothetical 8.2% if birds were migrating evenly dispersed across the entire width of the Baltic See (see Figure 4.12). But possibly distribution of this species is not even. However, no sufficiently specific data are available on Little Gull distribution and movement routes in the Baltic Sea that would allow more precise assessment.

Subsequently it can be concluded that BŚ III does not lie on the major migratory route of the species.

Table 5.20 Numbers of Little Gulls estimated to be migrating through BŚ III in different months.

Month	Total count	Count within focal radius (1000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
March	0	0	0	–	–	–	–	–
April	31	17	34	0.16	0.05	47.1	659	na
May	16	12	24	0.09	0.03	24.6	344	na

Month	Total count	Count within focal radius (1000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
July	2	2	4	0.09	0.03	16.1	225	na
August	32	27	54	0.24	0.07	64.4	902	na
September	5	5	10	0.05	0.02	13.7	192	na
October	2	2	4	0.07	0.02	9.8	137	na
November	2	2	4	0.04	0.01	4.1	57	na

Black-headed Gull (*Larus ridibundus*)

General elements

Black-headed Gull is not listed as protected species by the considered international legislation, but it is included in Annex 1 of the list of strictly protected species in Poland (Journal of Laws of 2011).

The European breeding population of the species is estimated at 4.77-6.8 million birds but has been declining recently (BirdLife International 2014, Wetlands International 2014). The species has large distribution range and breeds within most of Europe and Asia except for the north of the continent (BirdLife International 2014). It spends winter in open inland waters and within entire east Atlantic, including NW African coast and Mediterranean Sea, but winter numbers in the Baltic are low (BirdLife International 2014). Birds breeding in the countries along the eastern coast of the Baltic and Poland were assumed to comprise the relevant population, which could be passing the BŚ III area (not considering the Russian population). Considering minimum estimates, the size of this population is about 450,000 breeding pairs (BirdLife International 2004) or about 1,350,000 individuals if to account for non-breeding birds.

Offshore and coastal waters of Poland could be within the migratory route of this species although specific knowledge is lacking.

Sensitivity of the species to collisions with wind farms was assessed as medium by Chylarecki et al. (2011; category 3 in Table 3.1 in Chylarecki et al. 2011), and similarly medium by Furness et al. (2013; score 288 in Table 2 in Furness et al. 2013). EU guidance document on wind energy development (European Union 2011) does not list Black-headed Gull, but if to assume the same impacts as defined for other gull species, Black-headed Gulls are not at any risk wind farm development and wind farms could even have a positive on the species (Table 5.21).

Table 5.21 Sensitivity of Black-headed Gulls to wind farms: XXX = Evidence on substantial risk of impact, XX = Evidence or indications of risk or impact, X = Potential risk or impact, x = small or non-significant risk or impact. (Adapted from European Union 2011 using assessment for other gull species).

Species	Habitat displacement	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Black-headed Gull *Larus ridibundus*					x

Elements basing on the results of the monitoring for BŚ III

In total 34 Black-headed Gulls have been recorded during spring daytime visual observations and 16 in autumn at BŚ III (Appendix A). The species was mostly registered in early April in spring and in November in autumn (Figure 5.56).

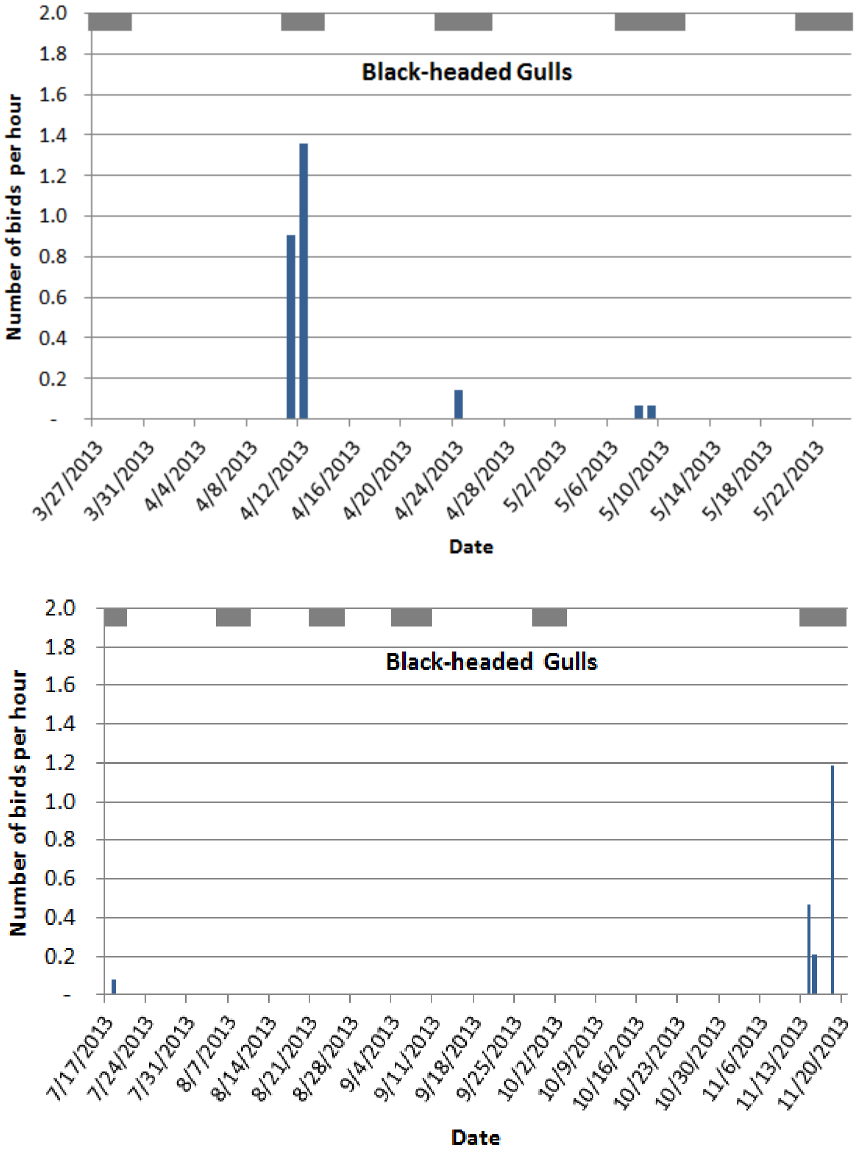


Figure 5.56 Migration periods and passage rates (birds/hour) of Black-headed Gulls recorded at BŚ III area during daylight hours in March – May and July – November 2013. Grey areas on top of the charts indicate periods when observations were conducted.

No Black-headed Gulls were tracked using horizontal radar. Flight direction recording during daytime visual observations shows that Black-headed Gulls flew mostly SE in spring and SW in autumn, although the sample sizes were small (Figure 5.57).

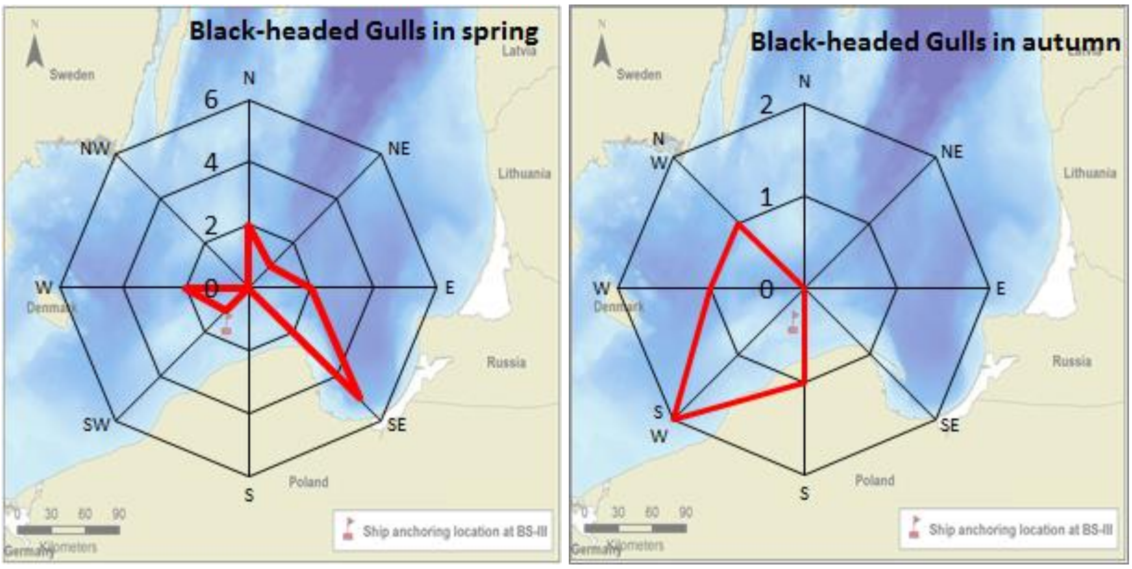


Figure 5.57 Flight directions of Black-headed Gulls recorded during visual daytime surveys at BŚ III in spring and summer-autumn 2013.

One Black-headed Gull was registered during acoustic registration of nocturnal migrants in spring.

Black-headed Gulls had rather wide range of flight altitudes, but the majority of birds flew low: about 71% of them were recorded between 0-15 m in spring 88% in autumn (Figure 5.58, Appendix A).

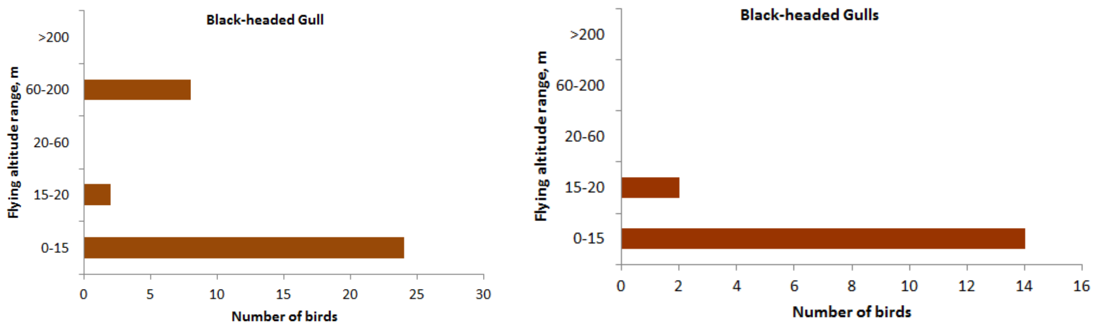


Figure 5.58 Flight altitudes of Black-headed Gulls recorded visually at BŚ III area during daylight hours in spring (left chart) and autumn 2013 (right chart).

Results of migrating bird monitoring will be used in the EIA to calculate collision risk of migrants. Namely, migrating bird flux and flying altitude.

Distance analysis results did not yield reliable model for species-specific detection function of Black-headed Gulls, likely due to small sample size of observations. We therefore used ERD of 500 m assuming focal range of 1,000 m, which is a little smaller to the Distance analysis results obtained for the Long-tailed Ducks, which is a light coloured small duck recorded during the observations, although has different flight pattern compared to a gull.

Migrating bird flux was estimated by first applying the assumed correction for distance detection bias within focal range of the species (1,000 m), then calculating bird passage rates per linear kilometre per hour separately for tail wind and head wind conditions, then scaling up this number for the daylight hours in a given month while considering the wind direction (obtaining birds/km/month) and finally multiplying the obtained figure by 14 km, which is the width of the BŚ

III wind farm along NW-SE axis that is perpendicular to the main direction of migrating birds (see chapter 4.2.1 for more detailed description).

Estimates based on daytime visual observations indicate that 1,170 Black-headed Gulls fly through the BSIII wind farm area in spring and 928 in autumn (Table 5.22, Table 5.31). These numbers represent very small proportions of the total flyway and relevant regional populations (Table 5.31).

Estimated diurnal migration intensity involves less than 0.1% of the relevant population size of this species. This is substantially lower than the hypothetical 8.2% if birds were migrating evenly dispersed across the entire width of the Baltic See (see Figure 4.12) and therefore clearly indicates that the species has different migration routes than over the open Baltic.

Subsequently it can be concluded that BŚ III does not lie on the major migratory route of the species.

Table 5.22 Numbers of Black-headed Gulls estimated to be migrating through BŚ III in different months.

Month	Total count	Count within focal radius (1000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
March	0	0	0	–	–	–	–	–
April	32	31	62	0.07	0.31	71.0	994	na
May	2	2	4	0.00	0.02	5.4	76	na
July	1	1	2	0.01	0.05	6.8	95	na
August	0	0	0	–	–	–	–	–
September	0	0	0	–	–	–	–	–
October	0	0	0	–	–	–	–	–
November	15	15	30	0.06	0.28	59.5	833	na

Common Crane (*Grus grus*)

General elements

Common crane listed in Annex I of the EU Birds directive, it is also SPEC2 category species (species concentrated in Europe and with unfavourable conservation status in Europe) considering status of EU Conservation Concern (BirdLife International 2004), and listed in Annex 1 of the list of strictly protected species in Poland (Journal of Laws of 2011).

The European flyway population of Common Cranes is estimated at 410,000 individuals (Wetlands International 2014). The European crane population, including its large fraction breeding in Poland, has been increasing consistently during the recent decades (Kuczyński and Chylarecki 2012, BirdLife International 2014).The species has very large breeding distribution range stretching from NE Europe through most of Siberia. Cranes nest in wetland habitats of the boreal zone (BirdLife International 2014). Common Cranes winter in southern Europe, northern Africa and the Middle East, but can also overwinter as far north as Germany during mild winters (BirdLife International 2014). Spring migration to the breeding grounds typically takes place in March-April and autumn migration in September-October.

It is not well established how many cranes could be crossing southern Baltic through the Polish waters to/from major roosting grounds of the species on Rügen Island and further west. Most likely these birds represent part of the population that breeds in Finland, Estonia, Latvia, Lithuania and Poland, but it is also known that many of birds from these populations migrate directly south without crossing the Baltic Sea (Prange 2010, Leito et al. 2011). If to assume that 50% of breeding populations of these countries fly west and possibly cross the southern Baltic Sea, the size of the relevant crane population would be about 40,000 birds (50% of at least 27,000 breeding pairs or about 80,000 individuals; BirdLife International 2004).

Common Cranes are wetland birds, which breed in various wetlands of the boreal zone and use agricultural fields for feeding during winter but usually aggregate to wetlands for night roosting. Cranes are rather omnivorous and feed on plant material, seeds, berries as well as earthworms, insects and other invertebrates and small vertebrates (frogs, lizards, rodents) (BirdLife International 2014). Obviously, offshore waters of Poland do not represent crane habitat but are on their migratory route.

Sensitivity of the species to collisions with wind farms was assessed as low by Chylarecki et al. (2011; category 1 in Table 3.1 in Chylarecki et al. 2011). EU guidance document on wind energy development (European Union 2011) suggests that cranes are at potential risk of collision, and small risk of barrier effect (Table 5.23).

Table 5.23 Sensitivity of Common Cranes to wind farms: XXX = Evidence on substantial risk of impact, XX = Evidence or indications of risk or impact, X = Potential risk or impact, x = small or non-significant risk or impact. (Adapted from European Union 2011; shaded fields indicate irrelevant pressures from offshore wind farms).

Species	Habitat displacement	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Common Crane *Grus grus*		X	x		x

Elements basing on the results of the monitoring for BŚ III

In total 31 Common Cranes have been recorded during spring daytime visual observations and 1,483 in autumn at BŚ III (Appendix A). The species was registered April and early May cruises in spring and in late September – early October in autumn (Figure 5.59).

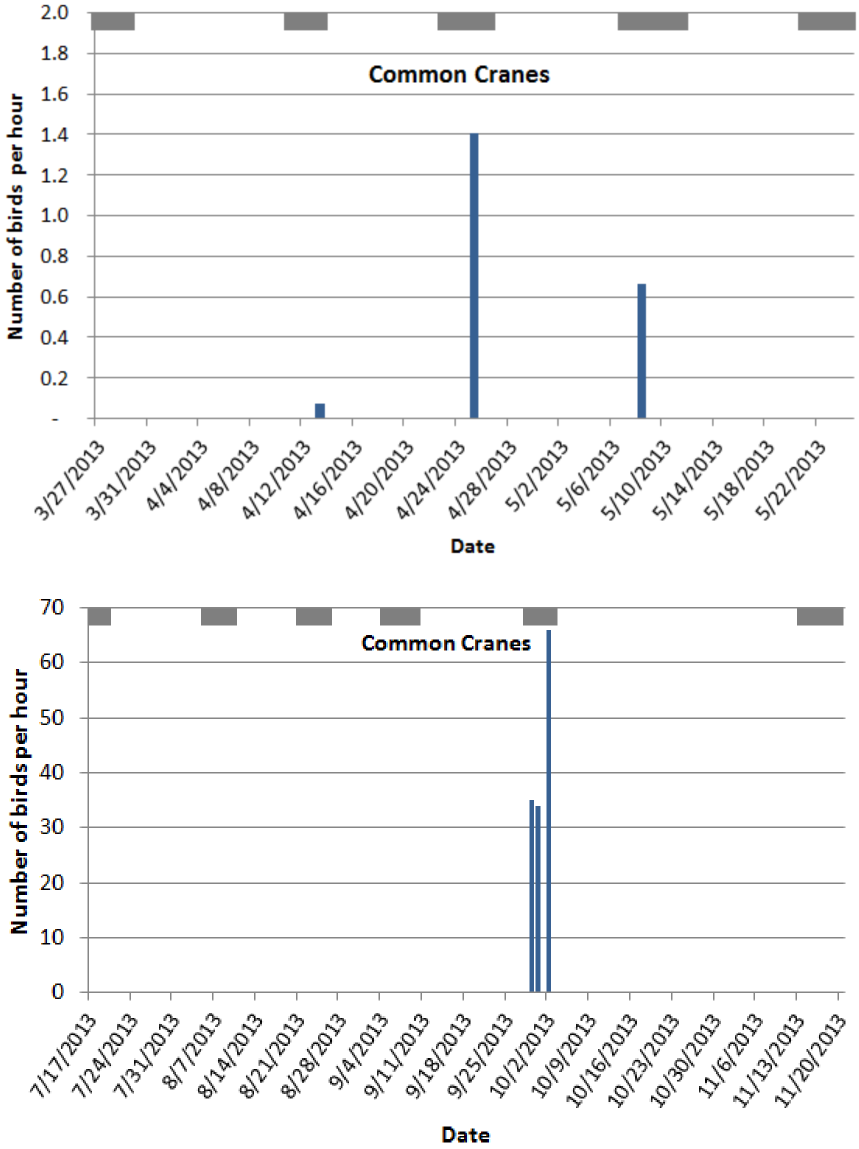


Figure 5.59 Migration periods and passage rates (birds/hour) of Common Cranes recorded at BŚ III area during daylight hours in March – May and July – November 2013. Grey areas on top of the charts indicate periods when observations were conducted.

Using horizontal radar for bird tracking 2 Common Crane tracks were recorded in spring and 25 in autumn (Appendix B). In spring one of the recorded tracks was directed N and one E, and in autumn all cranes flew SW-W (Figure 5.60). Flight directions recording during daytime visual observations show similar results indicating that Common Cranes flying N-E in spring and SW in autumn (Figure 5.61).

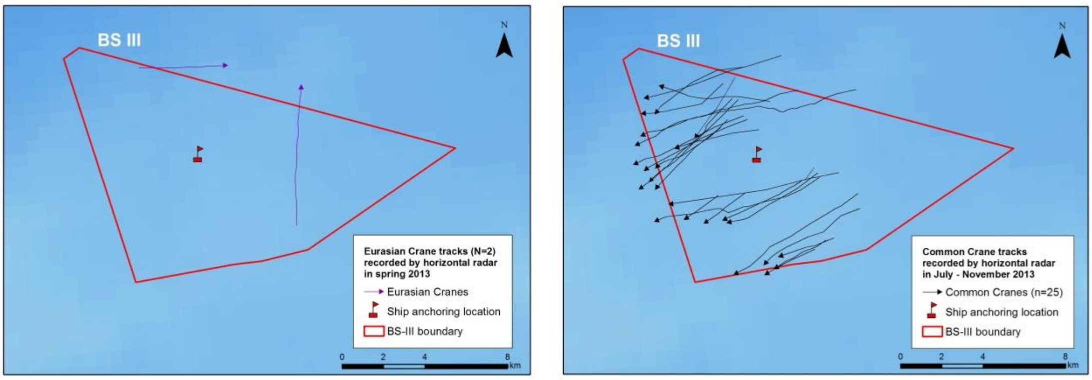


Figure 5.60 Flight trajectories of Common Cranes recorded using horizontal surveillance radar at BŚ III in spring 2013.

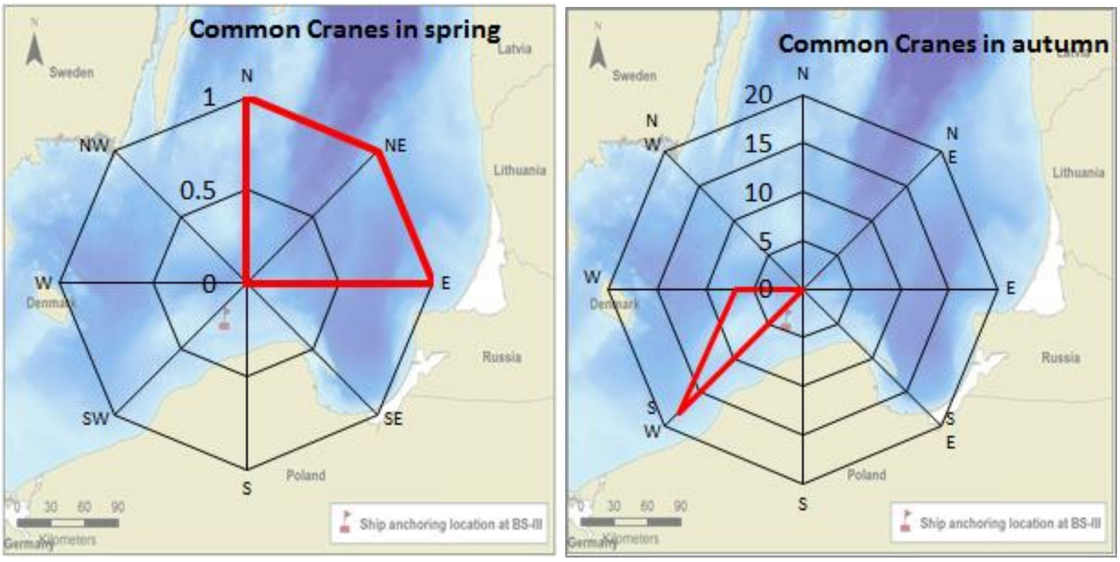


Figure 5.61 Flight directions of Common Cranes recorded during visual daytime surveys at BŚ III in spring and summer-autumn 2013.

No Common Cranes were recorded during acoustic registration of nocturnal migrants, as these birds are typical daytime migrants (Alerstam 1975).

Common Cranes have rather wide range of flight altitudes, often flying relatively high: 21 bird was recorded flying at 200 m height and the remaining 10 above that in spring; about 53% were assessed as flying above 200 m, 39% between 60-200 m, and 4% each at 15-20 m and 20-60 m (Figure 5.62, Appendix A). Of birds flying within potential collision altitude between 60-200m, about 68% flew at about 100 m, 19% at 80 m and 13% at 150 m. Flying altitude of cranes highly depends on wind direction: they fly higher in tail winds and lower in head-winds. Easterly winds predominated in late September – early October 2013, therefore migrating birds had favourable tail winds and maintained high flight altitude.

Independent investigations by the Pomarinus group reported 9 Common Cranes flying at 1-15 m altitude in in spring (Meissner 2014).

Our data agree with results of other studies reporting broad altitude range of migrating cranes (e.g. Pettersson 2005). The most detailed study on migrating cranes has been conducted for Krieger's Flak offshore wind farm EIA, which suggested that depending on wind direction cranes fly in average at altitudes between 150-250 m in offshore areas, but the range is very broad – between 5-1,000 meters (Skov et al. 2014).

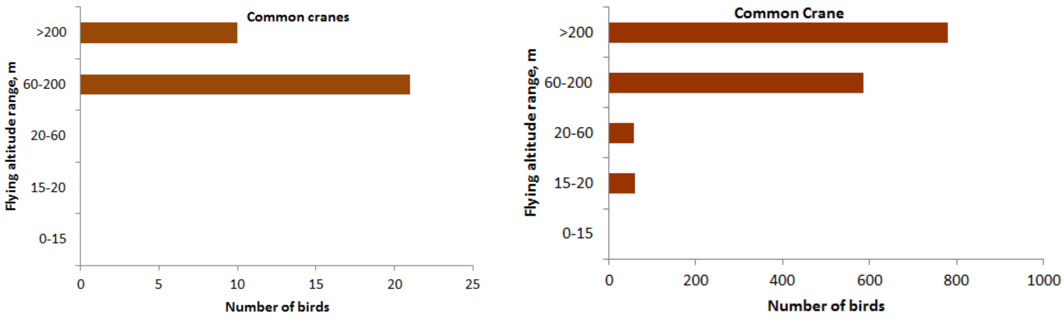
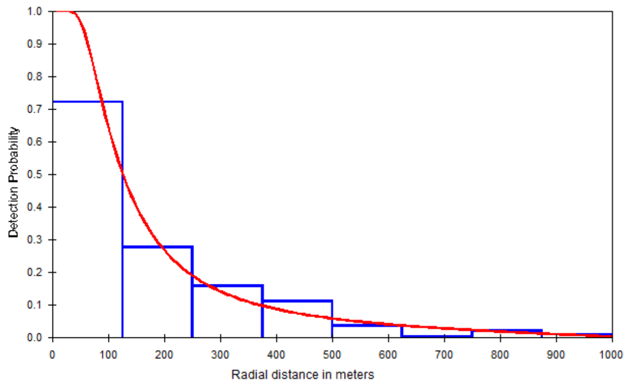


Figure 5.62 Flight altitudes of Common Cranes recorded visually at BŚ III area during daylight hours in spring (left chart) and autumn 2013 (right chart).

Results of migrating bird monitoring will be used in the EIA to calculate collision risk of migrants. Namely, migrating bird flux and flying altitude.

Distance analysis results did not yield reliable model for species-specific detection function of cranes, probably due to rather small sample size of observations and indicated that detectability of cranes did not decline within the focal range of 3,000 m (Figure 5.63). Because cranes are large birds migrating in flocks and also often call while flying, we assumed that there was no distance detection bias and that all birds were detected that flew within the focal range of 3,000 m.



Number of sightings: 23

Truncation: right 3000 m

Model function: Uniform key

ERD (±SE): 3000 (±0)

CV: 0%

Figure 5.63 Distance detection function of Common Cranes recorded from anchored ships in Polish offshore waters and main parameters of the model fitting.

Migrating bird flux was estimated by first applying the assumed correction for distance detection bias within focal range of the species (3,000 m), then calculating bird passage rates per linear kilometre per hour separately for tail wind and head wind conditions, then scaling up this number for the daylight hours in a given month while considering the wind direction (obtaining birds/km/month) and finally multiplying the obtained figure by 14 km, which is the width of the BŚ III wind farm along NW-SE axis that is perpendicular to the main direction of migrating birds (see chapter 4.2.1 for more detailed description).

Estimates based on daytime visual observations suggest that 6 cranes fly through the BSIII wind farm area in spring and 8,311 in autumn (Table 5.24, Table 5.31). Numbers of passing cranes were somewhat larger in spring as 31 individual was actually counted during the surveys, but most of the counted bird flew beyond 3000 km and therefore were not included into the estimates subsequently resulting in misleading total estimates due to very small sample size. The numbers of autumn migrants represent small proportion of the total flyway, but rather substantial 20% of the assumed relevant regional population (Table 5.31).

Estimated migration intensity involving approximately 20% of the relevant population is higher than the hypothetical 8.2% if birds were migrating evenly dispersed across the entire width of the Baltic See (see Figure 4.12). But it is unlikely that cranes distribute themselves evenly across the Baltic Sea and are more likely be concentrated in the southern part (including the BŚ III area) when heading for staging areas on Rügen Island. However, no sufficiently specific data are available on Common Crane movement routes over the Baltic Sea that would allow more precise assessment.

Subsequently it can be concluded that BŚ III area is located on the major migratory route of the species.

Table 5.24 Numbers of Common Cranes estimated to be migrating through BŚ III in different months.

Month	Total count	Count within focal radius (3000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
March	0	0	0	–	–	–	–	–
April	21	1	1	0.00	0.00	0.4	6	na
May	10	0	0	–	–	–	–	na
July	0	0	0	–	–	–	–	na
August	0	0	0	–	–	–	–	na
September	758	655	655	0.93	0.55	289.8	4,057	na
October	725	295	295	1.41	0.83	303.8	4,254	na
November	0	0	0	–	–	–	–	na

Common Wood Pigeon (*Columba palumbus*)

General elements

Common Wood Pigeon is not protected under considered international or Polish national legislation.

European population is estimates at 9-17 million breeding pairs of 27-51 million individuals and the population trend is increasing (BirdLife International 2004). The Common Wood Pigeon breeds in woodland of the entire Europe until Ural Mountains in the east. The species spends winter in SW Europe and northern Africa (BirdLife International 2014). Population part breeding E-NE from BSIII is at least 2 million breeding pairs or 6 million individuals (BirdLife International 2004), however specific migration routes are not well defined and it is therefore unknown how many individuals could be passing the Polish marine area.

Sensitivity of pigeons to collisions with wind farms was assessed as medium by Chylarecki et al. (2011; category 2 in Table 3.1 in Chylarecki et al. 2011). EU guidance document on wind energy development (European Union 2011) suggests that pigeons are at potential risk of collisions (Table 5.25).

Table 5.25 Sensitivity of Common Wood Pigeons to wind farms: XXX = Evidence on substantial risk of impact, XX = Evidence or indications of risk or impact, X = Potential risk or impact, x = small or non-significant risk or impact. (Adapted from European Union 2011; shaded fields indicate irrelevant pressures from offshore wind farms).

Species	Habitat displacement	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Common Wood Pigeon *Columba palumbus*		x			x

Elements basing on the results of the monitoring for BŚ III

In total 390 Common Wood Pigeons have been recorded during spring daytime visual observations and only 1 in autumn at BŚ III (Appendix A). The species was registered during the early April cruise in spring (Figure 5.64).

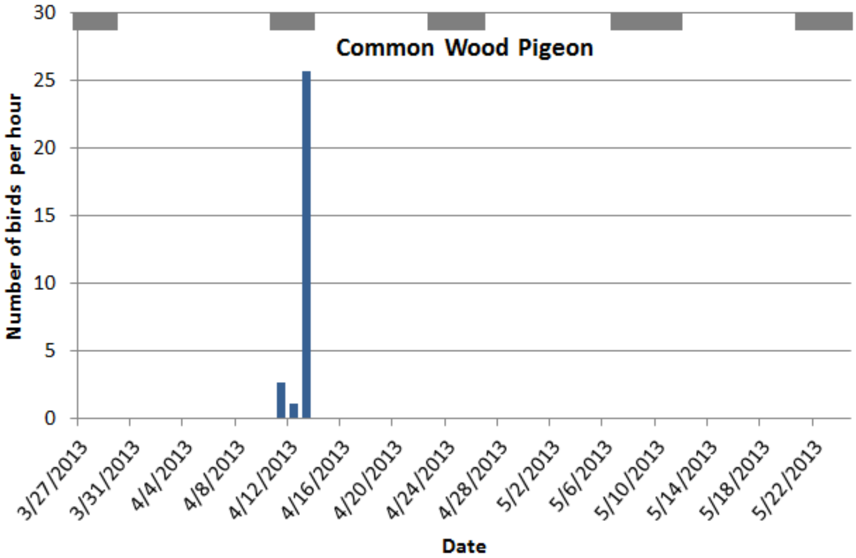


Figure 5.64 Migration periods and passage rates (birds/hour) of Common Wood Pigeons recorded at BŚ III area during daylight hours in March – May 2013. Grey areas on top of the charts indicate periods when observations were conducted.

Using horizontal radar for bird tracking 7 Common Wood Pigeon tracks were recorded in spring and none in autumn (Appendix B). In spring one of the recorded tracks had rather odd direction and 5 out of 7 birds were flying SW and two heading eastwards towards the land (Figure 5.65). Flight directions recording during daytime visual observations show similar results indicating S-SW flying direction in spring (Figure 5.66). These directions are mostly opposite of what could be expected during the spring passage and either represent the reverse migration or flights of confused birds.

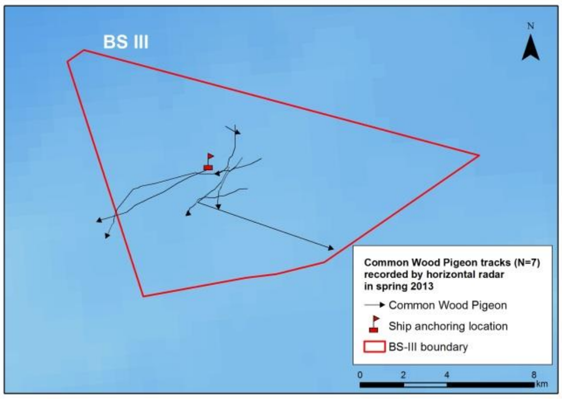


Figure 5.65 Flight trajectories of Common Wood Pigeons recorded using horizontal surveillance radar at BŚ III in spring 2013.

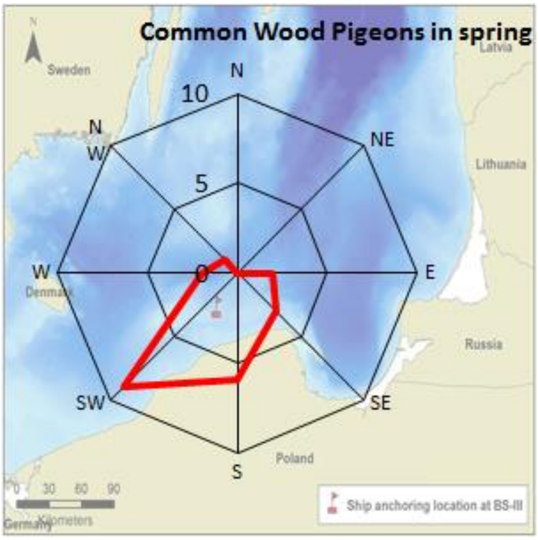


Figure 5.66 Flight directions of Common Wood Pigeons recorded during visual daytime surveys at BŚ III in spring 2013.

No Common Wood Pigeons were recorded during acoustic registration of nocturnal migrants.

Migrating Wood Pigeons flew at different altitudes: 66% were recorded flying at 0-15 m; 9% at 15-20 m and the remaining 25% between 20-60 m (Figure 5.67, Appendix A).

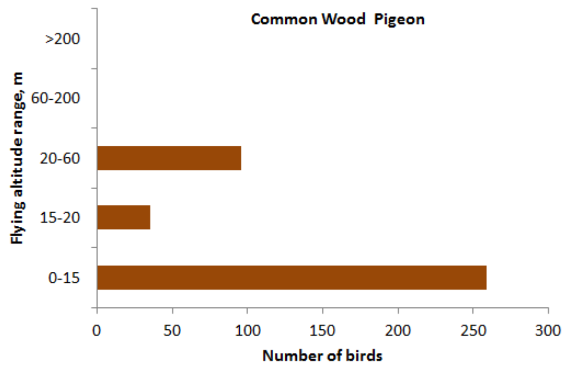


Figure 5.67 Flight altitudes of Common Wood Pigeons recorded visually at BŚ III area during daylight hours in spring (left chart) and autumn 2013 (right chart).

Results of migrating bird monitoring will be used in the EIA to calculate collision risk of migrants. Namely, migrating bird flux and flying altitude.

Distance analysis results did not yield reliable model for species-specific detection function of pigeon due to small sample size. Because Common Wood Pigeons are relatively big birds, often migrating in flocks we assumed similar distance detection bias as for the dabbling ducks, i.e. EDR=600 m and the focal range of 2,000 m.

Migrating bird flux was estimated by first applying the assumed correction for distance detection bias within focal range of the species (2,000 m), then calculating bird passage rates per linear kilometre per hour separately for tail wind and head wind conditions, then scaling up this number for the daylight hours in a given month while considering the wind direction (obtaining birds/km/month) and finally multiplying the obtained figure by 14 km, which is the width of the BŚ III wind farm along NW-SE axis that is perpendicular to the main direction of migrating birds (see chapter 4.2.1 for more detailed description).

Estimates based on daytime visual observations suggest that 13,126 Wood Pigeons fly through the BSIII wind farm area in spring and 33 in autumn (Table 5.24, Table 5.31). These numbers represent very small proportion of the total flyway and relevant regional population (Table 5.31).

Subsequently it can be concluded that BŚ III area is not located on the important migratory route of the species.

Table 5.26 Numbers of Common Wood Pigeons estimated to be migrating through BŚ III in different months.

Month	Total count	Count within focal radius (2000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
March	0	0	0	–	–	–	–	–
April	390	390	1,300	3.55	0.35	937.6	13,126	na
May	0	0	0	–	–	–	–	–
July	0	0	0	–	–	–	–	–
August	0	0	0	–	–	–	–	–
September	1	1	3	0.01	0.00	2.4	33	na
October	0	0	0	–	–	–	–	–
November	0	0	0	–	–	–	–	–

Golden Plover (*Pluvialis apricaria*)

General elements

Golden Plover is listed in Annex I of the EU Birds directive.

The NW European population of the species is estimated at 140-210,000 individuals (Wetlands International 2014). The majority of Golden Plovers breed in the Scandinavian Peninsula, Finland and Russia, and we assume that about 50% of this population could be considered as relevant regional population which could be passing the BŚ III area (BirdLife International 2004). Considering minimum estimates this comprises at least 70,000 birds.

The species breeds in open bogs of different type in the forest zone and in tundra zone further north. During winter period the majority of birds concentrate in Western Europe and northern Africa. Spring migration typically takes place in April – May and autumn migration is in September-October. The diet consists primarily of insects, earthworms and other invertebrates (BirdLife International 2004).

Offshore and coastal waters of Poland are in within the migratory route of this species as birds breeding in the NE Europe and Russia migrate towards Western Europe for wintering and back.

EU guidance document on wind energy development (European Union 2011) suggests that Golden Plovers are at potential risk from collisions and barrier effect (Table 5.27).

Table 5.27 Sensitivity of Golden Plovers to wind farms: XXX = Evidence on substantial risk of impact, XX = Evidence or indications of risk or impact, X = Potential risk or impact, x = small or non-significant risk or impact. (Adapted from European Union 2011).

Species	Habitat displacement	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Golden Plover *Pluvialis apricaria*		X	X		

Elements basing on the results of the monitoring for BŚ III

Golden Plover was the most abundant wader species recorded at BŚ III with registered 7 flocks consisting of 325 individuals during the spring migration (Appendix A). Few individuals of the species were registered in April and several large flocks were seen migrating during late May cruises (Figure 5.68). No migrating Golden Plovers were registered in autumn.

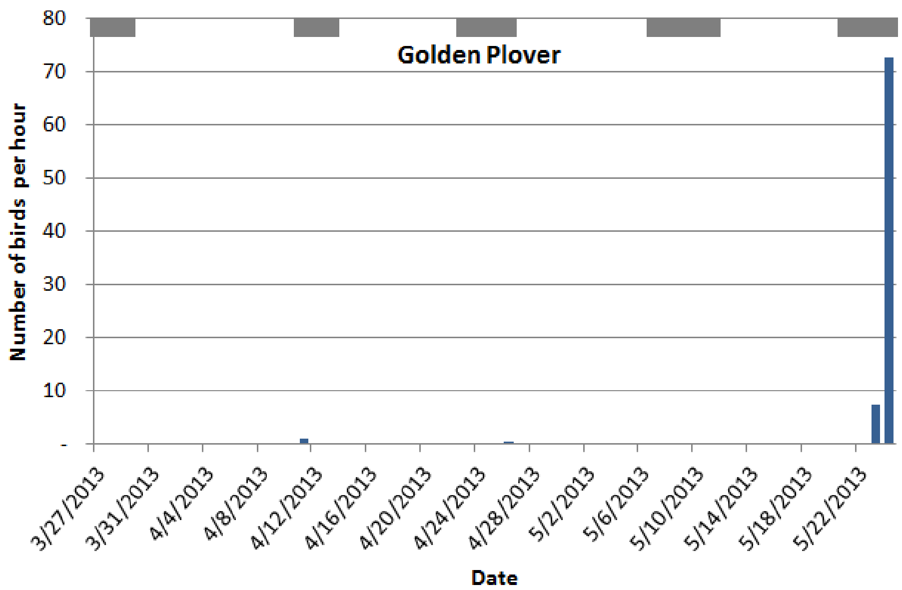


Figure 5.68 Migration periods and passage rates (birds/hour) of Golden Plovers recorded at BŚ III area during daylight hours in March – May 2013. Grey areas on top of the charts indicate periods when observations were conducted.

Using horizontal radar for bird tracking 2 Golden Plover tracks were recorded in spring and none in autumn (Appendix B). The recorded Golden Plover tracks were directed E (Figure 5.69). Flight direction recording during daytime visual observations shows similar results indicating that Golden Plovers flew mostly E in spring and only one flock headed north (Figure 5.70).

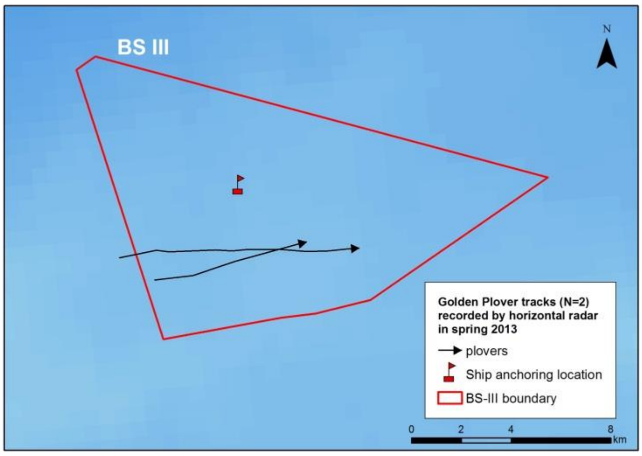


Figure 5.69 Flight trajectories of Golden Plovers recorded using horizontal surveillance radar at BŚ III in spring 2013.

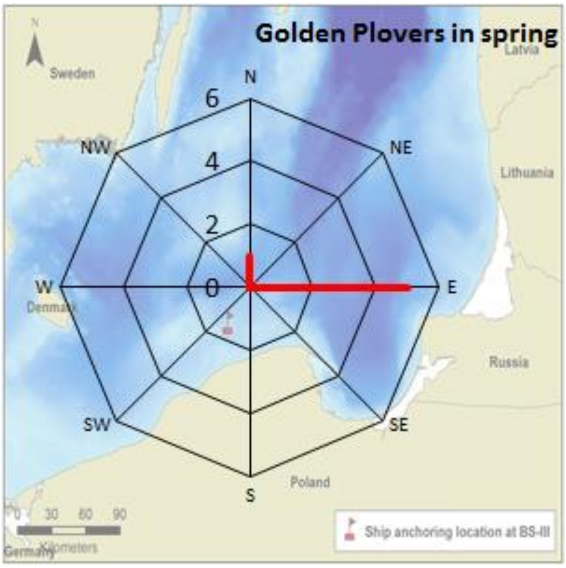


Figure 5.70 Flight directions of Golden Plovers recorded during visual daytime surveys at BŚ III in spring 2013.

No Golden Plovers were recorded during acoustic registration of nocturnal migrants

Golden Plovers had wide range of flight altitudes, but the majority of birds (96%) flew high, at an altitude band between 60-200 m: (Figure 5.55, Appendix A), all of them being registered in the upper part between 120-200m.

Independent investigations by the Pomarinus group reported all Golden Plovers flying at 1-15 m altitude in spring (N=5) (Meissner 2014).

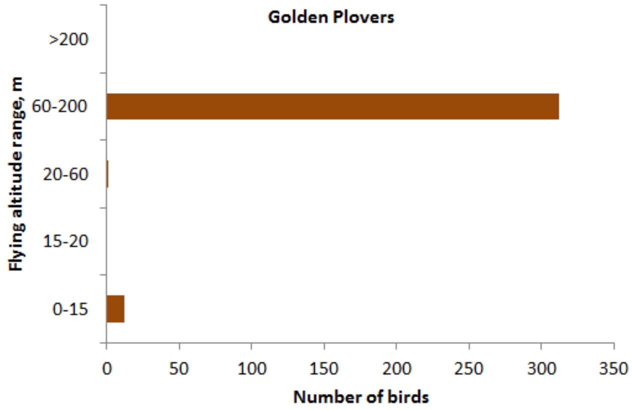


Figure 5.71 Flight altitudes of Golden Plovers recorded visually at BŚ III area during daylight hours in spring 2013.

Results of migrating bird monitoring will be used in the EIA to calculate collision risk of migrants. Namely, migrating bird flux and flying altitude.

Distance analysis could not produce reliable model for species-specific detection function of Golden Plovers due to small sample size of observations. We therefore used ERD of 500 m assuming focal range of 1,000 m, similar as used for other species of comparable size such as Little Gull.

Migrating bird flux was estimated by first applying the assumed correction for distance detection bias within focal range of the species (1,000 m), then calculating bird passage rates per linear kilometre per hour separately for tail wind and head wind conditions, then scaling up this number for the daylight hours in a given month while considering the wind direction (obtaining birds/km/month) and finally multiplying the obtained figure by 14 km, which is the width of the BŚ III wind farm along NW-SE axis that is perpendicular to the main direction of migrating birds (see chapter 4.2.1 for more detailed description).

Estimates based on daytime visual observations indicate that 5,236 Golden Plovers fly through the BSIII wind farm area in spring (Table 5.28, Table 5.31). These numbers represent relatively large proportions of the total flyway and relevant regional populations (Table 5.31).

Estimated diurnal migration intensity involves approximately 7.5% of the relevant population size of this species. This is close to the hypothetical 8.2% if birds were migrating evenly dispersed across the entire width of the Baltic See (see Figure 4.12). However, no sufficiently specific data are available on Golden Plover distribution and movement routes over the Baltic Sea that would allow more precise assessment.

Subsequently it can be concluded that BŚ III is on the migration path of this species, which presumably migrates in a broad front.

Table 5.28 Numbers of Golden Plovers estimated to be migrating through BŚ III in different months.

Month	Total count	Count within focal radius (1000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
March	0	0	0	–	–	–	–	–
April	15	15	30	0.17	0.01	43.9	614	na

Month	Total count	Count within focal radius (1000 m)	Distance-corrected number	Birds/ km/hour		Birds/ km/ month	Total passage through BŚ III	95% confidence intervals
				Tail wind	Head wind			
May	310	180	360	1.62	0.07	330.1	4,622	na
July	0	0	0	–	–	–	–	–
August	0	0	0	–	–	–	–	–
September	0	0	0	–	–	–	–	–
October	0	0	0	–	–	–	–	–
November	0	0	0	–	–	–	–	–

Waders

Observations of migrating waders were few and for none of the species exceeded 10 sightings per migration season (Table 5.32, Table 5.33). In total 7 wader species have been recorded during the spring migration (including Golden Plover reported above) and 4 species during the autumn (Appendix A). Few registrations of other wader species do not allow for species-specific estimates of overall passage of these birds. Waders migrate both during the day and night, but few records of these birds during the day and night observations indicate that BŚ III area does not lie on an important migration route of waders.

Sensitivity of waders to collisions with wind farms was assessed as low for most wader species by Chylarecki et al. (2011; category 1 in Table 3.1 in Chylarecki et al. 2011). EU guidance document on wind energy development (European Union 2011) suggests that waders are at light or potential risk of collisions and small impact due to barrier effect.

Songbirds: passerines and thrushes

Relatively high diversity of migrating songbirds has been registered at BSIII: at least 40 species in spring and 20 species in autumn. Recorded abundance and frequency of registrations, however were low (Table 5.32, Table 5.33), especially if to consider their very large populations (Table 5.29). Migration flux has not been quantified for the SE Baltic region, but for example it was estimated that well over 100 million songbirds migrate every year in the neighbouring area from Sweden to the south across the southern Baltic Sea (Alerstam 1975b, 1978, 1990). Different species of passerines migrate mainly at night and in a broad front over land and sea and primarily at high altitudes, as was shown by night time investigations at BSIII and has been demonstrated by multiple other studies (Alerstam 1975b, 1978, 1990; IfAÖ 2003; Krijgsveld et al. 2011, FEBI 2013).

Low number of registrations, short detections distances and primarily nocturnal migration does not allow quantifying numbers of songbirds passing the BŚ III area.

Population sizes of passerine species most frequently registered at BSIII (number of registration events exceeding 10; Appendix A) are very large (Table 5.29). Overall number of migrating songbirds is more than twice larger in autumn compared to the spring migration, as survival rates of many song bird species are low, especially among the first year birds.

Table 5.29 Flyway population sizes of most commonly recorded songbird species at BŚ III during migration observations. Only species with more than 10 observations per migration season are included; population sizes are taken from BirdLife International (2004).

Species	European population size, individuals
Common Chaffinch *Fringilla coelebs*	390,000,000 – 720,000,000
Brambling *Fringilla montifringilla*	39,000,000 – 66,000,000
Common Starling *Sturnus vulgaris*	69,000,000 – 168,000,000
Great Tit *Parus major*	138,000,000 – 273,000,000
White Wagtail *Motacilla alba*	39,000,000 – 78,000,000
Eurasian Skylark *Alauda arvensis*	120,000,000 – 240,000,000
Meadow Pipit *Anthus pratensis*	21,000,000 – 48,000,000
Barn Swallow *Hirundo rustica*	48,000,000 – 108,000,000
European Robin *Erithacus rubecula*	129,000,000 – 249,000,000
Common Blackbird *Turdus merula*	120,000,000 – 246,000,000
Song Thrush *Turdus philomelos*	60,000,000 – 108,000,000
Redwing *Turdus iliacus*	48,000,000 – 63,000,000
Fieldfare *Turdus pilaris*	42,000,000 – 72,000,000

Registered migration directions of most frequently registered songbirds indicate that bird primarily migrated to the east in spring but some of the Chaffinch were also heading NW towards Sweden, and SW in autumn, which is consistent with overall direction of seasonal migrations (Figure 5.72, Figure 5.73).

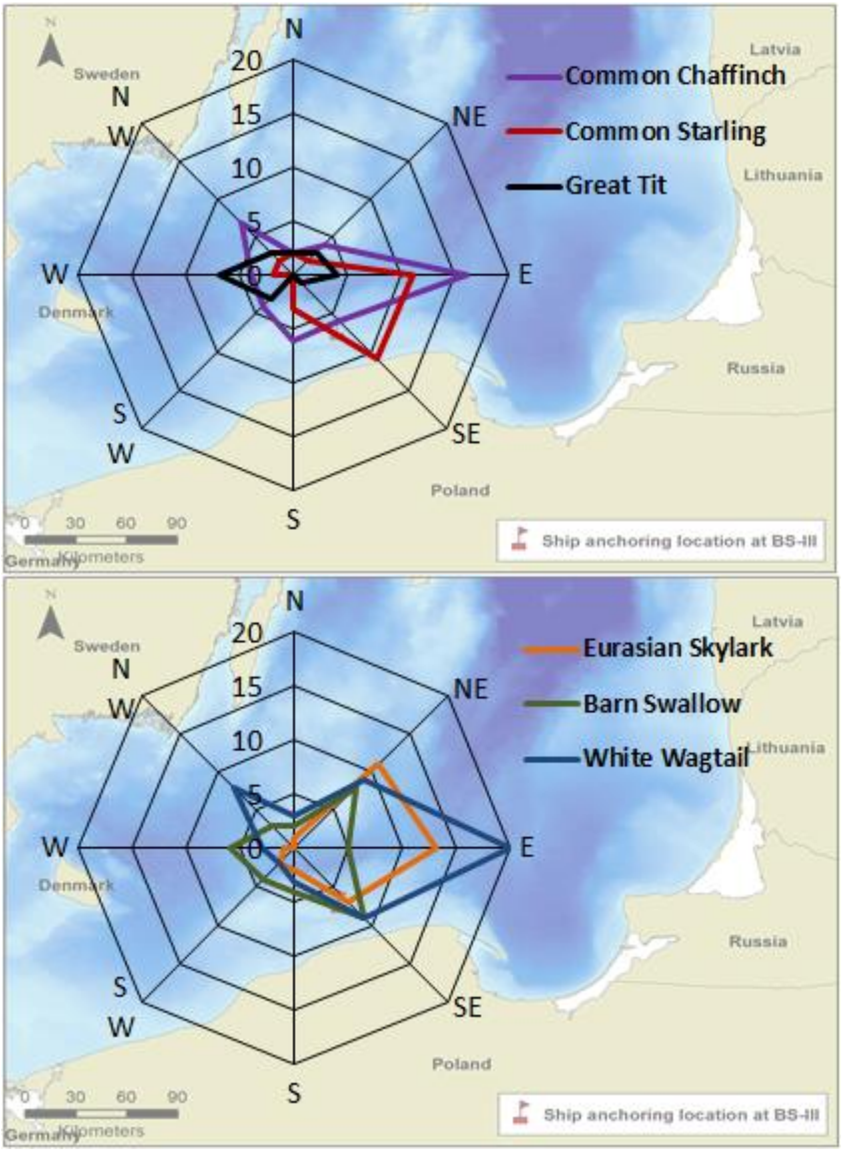


Figure 5.72 Flight directions of frequently registered songbird species during visual daytime surveys at BŚ III in spring 2013.

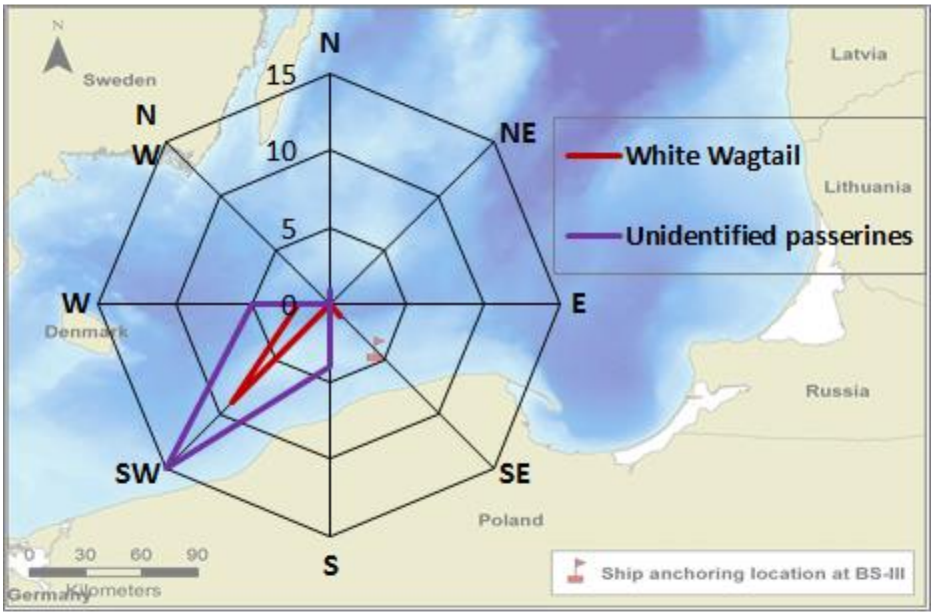


Figure 5.73 Flight directions of frequently registered songbird species during visual daytime surveys at BŚ III in summer-autumn 2013.

Flight altitudes of passerine birds registered during daytime observations show that the majority of observed bird flew low, below 20 m altitude (Figure 5.74). However, these observations are likely biased by the observer ability to detect small birds when they fly high.

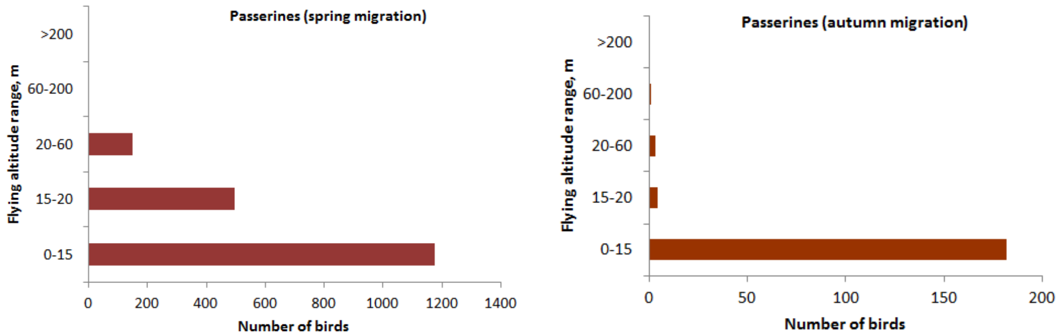


Figure 5.74 Flight altitude of passerine birds registered during visual daytime surveys at BŚ III in spring and summer-autumn 2013.

Sensitivity of passerine birds to collisions with wind farms was assessed as medium for most species by Chylarecki et al. (2011; category 2 in Table 3.1 in Chylarecki et al. 2011). EU guidance document on wind energy development (European Union 2011) also suggests that passerines are at potential risk of collisions and barrier effect.

Some migrating songbirds inevitably collide with wind turbines, as they do with towers, tall buildings and power lines (e.g., Loss et al. 2013). However, considering their very large abundance, the registered collision of passerine birds with wind turbines are rather rare and constitute only about 25% of all carcasses found under the land wind turbines in Germany (Rydell et al. 2012).

Table 5.30 Sensitivity of passerines to wind farms: XXX = Evidence on substantial risk of impact, XX = Evidence or indications of risk or impact, X = Potential risk or impact, x = small or non-significant risk or impact. (Adapted from European Union 2011; shaded fields indicate irrelevant pressures from offshore wind farms).

Species	Habitat displacement	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Passerines		X	X		

In summary, daytime migrating songbirds are not numerous at BŚ III but night time migration is likely intensive during the peak migration periods. Different songbird species differ in their migration time, but it is characteristic that there are days of massive migration when timing and suitable conditions correspond (e.g. Nowakowski et al. 2005). Due to its geographic location the BŚ III area does not aggregate migrating songbirds and therefore is not avian migratory hot-spot (Desholm et al. 2014). Nocturnally migrating songbirds that fly at high altitude in a broad front likely occur in similar densities as elsewhere in the region.

Birds of prey: raptors and owls

Raptors receive particular attention in wind farm studies due to high collision risk of these birds (Rydell et al. 2012).

Only 8 migrating raptors and 2 owls have been recorded in spring: 2 Sparrowhawks (on April 13), 2 Eurasian Hobbys (on May 9 and May 10), 1 Common Buzzard (on May 21), 1 Northern Harrier (on May 8), 1 Common Kestrel (on May 9) and 1 Osprey (on May 7) and 2 Long-eared Owls (on April 11 and April 26). Only 1 migrating raptor and 4 owls have been recorded during the autumn migration: unidentified falcon was recorded on September 8 and 3 Short-eared Owls and 1 (one on September 7 and two on September 30) Long-eared Owl (on November 15) (Appendix A).

Raptors migrate during the day and use thermal air currents for gliding flights. Thermals form over land during sunny days when air heated by the sun raises up and provides a lift for soaring birds. Over water, however, thermals of sufficient strength usually do not form and soaring birds loose altitude and have to rely on flapping flight, which is energetically expensive for large birds. Due to this reason, the majority of soaring land-birds try minimizing their migration distances over water. Therefore it is not surprising that only few raptors were recorded at BŚ III as the majority of these migrate over land and do not cross the Baltic but fly around. Studies of raptor migration in Poland indicated that a very important migration route follows the coastline of the Baltic Sea (Polakowski et al. 2014), thus clearly supporting the notion raptors perceive the Baltic Sea as a barrier and do not fly over it but around.

Raptors generally flew low: out of eight individuals observed, five flew below 15 m, two at 20 m and one at 25 m altitude.

In summary, the BŚ III area does not represent important site used by migrating raptors and owls and only occasional single individuals of different species pass the area during seasonal migrations.

Table 5.31 Numbers of selected relevant estimated bird species to be migrating through BSIII in spring and autumn seasons.

Species	Flyway population	Relevant population	Migration season	Migration estimate	Lower 95% CI	Upper 95% CI	% of flyway population	% of relevant population
Long-tailed Duck *Clangula hyemalis*	1,600,000	350,000	spring	13,369	12,408	14,405	0.8	3.8
			autumn	3,597	3,339	3,876	0.2	1.0
Common Scoter *Melanitta nigra*	550,000	500,000	spring	18,493	14,894	23,032	3.4	3.7
			autumn	4,712	3,784	5,869	0.8	0.9
Velvet Scoter *Melanitta fusca*	450,000	170,000	spring	5,812	4,791	7,050	1.3	3.4
			autumn	2,251	1,855	2,730	0.5	1.3
Eurasian Wigeon *Anas penelope*	1,500,000	?	spring	1,945	1,682	2,249	0.13	?
			autumn	5,683	4,915	6,571	0.38	?
Geese (*Anserini*)	>2,500,000	?	spring	703	582	848	0.03	?
			autumn	103,091	85,448	124,381	4.1	?
Swans (*Cygninae*)	300,000	100,000	spring	457	na	na	0.15	0.46
			autumn	1,526	na	na	0.51	1.5
Red-throated Diver *Gavia stellata*	>400,000	8,600	spring	939	762	1,158	0.2	10.9
Black-throated Diver *Gavia arctica*			autumn	256	207	315	0.05	3.0
Razorbill *Alca torda*	>1,000,000	23,000	spring	6,294	4,762	8,320	0.6	27.6
			autumn	2,883	2,181	3,811	0.3	12.6
Great Cormorant *Phalacrocorax carbo*	405,000	100,000	spring	959	na	na	0.24	1.0
			autumn	651	na	na	0.16	0.7

Species	Flyway population	Relevant population	Migration season	Migration estimate	Lower 95% CI	Upper 95% CI	% of flyway population	% of relevant population
Little Gull *Larus minutus*	>72,000	50,000	spring	1,004	na	na	1.4	2.0
			autumn	1,514	na	na	2.1	3.1
Black-headed Gull *Larus ridibundus*	>4,770,000	1,350,000	spring	1,170	na	na	0.03	0.09
			autumn	928	na	na	0.02	0.06
Common Crane *Grus grus*	410,000	40,000	spring	6	na	na	<0.1	<0.1
			autumn	8,311	na	na	2.0	21%
Common Wood Pigeon *Columba palumbus*	27,000,000	6,000,000	spring	13,126	na	na	<0.1	0.2
			autumn	33	na	na	<0.1	<0.1
Golden Plover *Pluvialis apricaria*	>140,000	>70,000	spring	5,236	na	na	3.74	7.48
			autumn	--	na	na	--	--

5.3 Species of birds recorded during the monitoring of migrating birds

High diversity of migrating birds was registered and included 97 identified species (32 waterbirds and 65 landbirds) during spring and 56 identified species (25 waterbirds and 31 landbirds) during autumn migration (Table 5.32, Table 5.33). Actual number of species was likely somewhat higher, as there were birds of different taxonomic groups not identified to species level (Table 5.32, Table 5.33). It should be noted that both with respect to the landbird and waterbird migration the species composition at BŚ III should be expected to be comparable to all other sites located in the same coastal zone along the Baltic mainland coast.

Visual daytime surveys, which were the main source of species identification and quantification, yielded 7,136 birds registered during the spring period (Table 5.32) and 17,569 during the late summer – autumn migration (Table 5.33).

In spring 60% of all registered daytime migrants were waterbirds and the remaining 40% landbirds. Among waterbirds, duck species were dominant, the most numerous being Long-tailed Ducks, Common Scoters, Velvet Scoters, Great Cormorants and Razorbills (Table 5.34). Landbird species composition was dominated by small passerines, the most abundant being Common Chaffinch, Common Starling and Great Tits. Also Wood Pigeons and Golden Plovers were relatively numerous (Table 5.34). Nocturnal acoustic registrations indicated intensive migration of Skylarks, different thrush species and European Robin. Large landbirds, which usually receive particular attention in wind farm studies due to high collision risk, were not numerous in spring: 8 raptors of different species were recorded and 3 small flocks of cranes consisting of 31 individuals were recorded in total (Table 5.34).

In autumn the majority of registered daytime migrants were waterbirds making up 90% of all counted birds during visual observations. Among waterbirds, the most numerous were geese (over 12,000 birds), of which mass migration was recorded mostly during a single survey cruise in late September-early October. Other relatively numerous waterbirds included seaducks, namely Long-tailed Ducks, Common Scoter and Velvet Scoter, swans and European Wigeon (Table 5.34). Cranes dominated the composition of diurnally migrating landbirds and were registered in high numbers during the same period as the migrating geese (Table 5.34). The autumn of 2013 was generally very windy and days suitable for migrating birds were few. Late September-early October represented a small ‘window’ of calm weather when mass migration of many bird species took place.

Table 5.32 Numbers of recorded birds of different species by survey method at BŚ III in spring 2013.

English name	Scientific name	Method of investigations			
		Visual surveys, number	Horizontal radar tracks, number	Vertical radar records, number	Night time acoustic records, number
Waterbirds / marine birds					
Unidentified ducks	*Anatinae*	1,363	78		
Common Scoter	*Melanitta nigra*	970	52		41
Long-tailed Duck	*Clangula hyemalis*	489	20		12
Velvet Scoter	*Melanitta fusca*	323	19		

English name	Scientific name	Method of investigations			
		Visual surveys, number	Horizontal radar tracks, number	Vertical radar records, number	Night time acoustic records, number
Black/Velvet Scoter	*Melanitta sp.*	293	16		
Great Cormorant	*Phalacrocorax carbo*	123	6		
Razorbill	*Alca torda*	96	5		
Northern Pintail	*Anas acuta*	92			
Unidentified geese	*Anserini*	75	9		
Mallard	*Anas platyrhynchos*	74			2
Eurasian Wigeon	*Anas penelope*	70	4		
Whooper Swan	*Cygnus cygnus*	52	2		
Unidentified divers	*Gavia sp.*	47	14		
Little Gull	*Larus minutus*	47	6		
Black-Headed Gull	*Larus ridibundus*	34			1
Black-throated Diver	*Gavia arctica*	21	2		
Common/Arctic Tern	*Sterna hirundo / paradisea*	19			
Unidentified swans	*Cygnidae*	13	2		
Greater White-fronted Goose	*Anser albifrons*	12			
Mute Swan	*Cygnus olor*	11	1		
Common Tern	*Sterna hirundo*	11			
Goosander	*Mergus merganser*	10	1		
Arctic Skua	*Stercorarius parasiticus*	10			
Northern Shoveler	*Anas clypeata*	9			
Red-throated Loon	*Gavia stellata*	9	2		
Eurasian Teal	*Anas crecca*	8			24
Red-breasted Merganser	*Mergus serrator*	8	1		
Common Guillemot	*Uria aalge*	7			
Greylag Goose	*Anser anser*	5			

English name	Scientific name	Method of investigations			
		Visual surveys, number	Horizontal radar tracks, number	Vertical radar records, number	Night time acoustic records, number
Black Guillemot	*Cepphus grylle*	5			
Common Eider	*Somateria mollissima*	4	1		
Unidentified tern	*Sterninae*	4			
Common Gull	*Larus canus*	3	1		
Common Goldeneye	*Bucephala clangula*	2			
Unidentified auk	*Alcidae*	2			
Whiskered Tern	*Chlidonias hybrida*	1			
Tundra Swan	*Cygnus columbianus*	1			
Great Crested Grebe	*Podiceps cristatus*	1			
Parasitic/Pomarine Skua	*Stercorarius parasiticus / pomarinus*	1			
Unidentified gull	*Laridae*		6		
Eurasian Coot	*Fulica atra*				11
Total waterbirds		***4,325***	***248***		***91***
Landbirds					
Common Chaffinch	*Fringilla coelebs*	500	1		
Common Starling	*Sturnus vulgaris*	429			10
Common Wood Pigeon	*Columba palumbus*	390	7		
European Golden Plover	*Pluvialis apricaria*	325	2		
Great Tit	*Parus major*	295			
White Wagtail	*Motacilla alba*	175			1
Unidentified passerines	*Passeriformes*	115			
Eurasian Skylark	*Alauda arvensis*	101			1,291
Meadow Pipit	*Anthus pratensis*	69			
Barn Swallow	*Hirundo rustica*	59			
Common Blackbird	*Turdus merula*	54			3,344
Eurasian Siskin	*Carduelis spinus*	51			

English name	Scientific name	Method of investigations			
		Visual surveys, number	Horizontal radar tracks, number	Vertical radar records, number	Night time acoustic records, number
Common Crane	*Grus grus*	31	2		
Song Thrush	*Turdus philomelos*	18			333
European Greenfinch	*Carduelis chloris*	15			
Brambling	*Fringilla montifringilla*	13			
Unidentified thrushes	*Turdidae*	13			
European Robin	*Erithacus rubecula*	12			646
Rook	*Corvus frugilegus*	10			
Common Swift	*Apus apus*	9	1		
Dunnock	*Prunella modularis*	9			
Redwing	*Turdus iliacus*	9			589
Common Reed Bunting	*Emberiza schoeniclus*	7			
Wood Lark	*Lullula arborea*	7			
Northern Lapwing	*Vanellus vanellus*	7			
Long-tailed Bushtit	*Aegithalos caudatus*	4			
Tree Pipit	*Anthus trivialis*	4			
Red Knot	*Calidris canutus*	4			
Common Linnet	*Carduelis cannabina*	4			
Twite	*Carduelis flavirostris*	4			
Common Pigeon	*Columba livia*	4			
Red-breasted Flycatcher	*Ficedula parva*	4			
Chaffinch/Brambling	*Fringilla sp.*	4	1		
Eurasian Wren	*Troglodytes troglodytes*	4			
Fieldfare	*Turdus pilaris*	4			105
Grey Heron	*Ardea cinerea*	3	1		
Common House Martin	*Delichon urbica*	3			
Eurasian Sparrowhawk	*Accipiter nisus*	2			

English name	Scientific name	Method of investigations			
		Visual surveys, number	Horizontal radar tracks, number	Vertical radar records, number	Night time acoustic records, number
Long-eared Owl	*Asio otus*	2			
Lapland Bunting	*Calcarius lapponicus*	2			
Eurasian Hobby	*Falco subbuteo*	2			
Yellow Wagtail	*Motacilla flava*	2			
Whimbrel	*Numenius phaeopus*	2			
Blue Tit	*Parus caeruleus*	2			
Black Redstart	*Phoenicurus ochruros*	2			
Common Chiffchaff	*Phylloscopus collybita*	2			
Wood Warbler	*Phylloscopus sibilatrix*	2			
Eurasian Woodcock	*Scolopax rusticola*	2			
Eurasian Blackcap	*Sylvia atricapilla*	2			
Unidentified *Acrocephalus* warbler	*Acrocephalus sp.*	1			
Common Buzzard	*Buteo buteo*	1			
European Goldfinch	*Carduelis carduelis*	1			
Western Marsh Harrier	*Circus aeruginosus*	1			
Stock Dove	*Columba oenas*	1			
Unidentified pigeon	*Columba sp.*	1	1		
Carrion Crow	*Corvus corone*	1			
Yellowhammer	*Emberiza citrinella*	1			
Common Kestrel	*Falco tinnunculus*	1			
Eurasian Pied Flycatcher	*Ficedula hypoleuca*	1			
Common Snipe	*Gallinago gallinago*	1			
Common Grasshopper Warbler	*Locustella naevia*	1			
Unidentified Pipit	*Motacillidae.*	1			
Osprey	*Pandion haliaetus*	1			

English name	Scientific name	Method of investigations			
		Visual surveys, number	Horizontal radar tracks, number	Vertical radar records, number	Night time acoustic records, number
Eurasian Tree Sparrow	*Passer montanus*	1			1
Goldcrest	*Regulus regulus*	1			
Sand Martin	*Riparia riparia*	1			
Common Redshank	*Tringa totanus*	1			
Little Ringed Plover	*Charadrius dubius*				7
Eurasian Oystercatcher	*Haematopus ostralegus*				4
Spotted Redshank	*Tringa erythropus*				1
Total landbirds		***2,811***	***16***		***6,332***
Unidentified bird	*Aves*			1,102	
GRAND TOTAL		**7,136**	**264**	**1,102**	**6,423**

Table 5.33 Numbers of recorded birds of different species by survey method at BŚ III in summer-autumn 2013.

English name	Scientific name	Method of investigations			
		Visual surveys, number	Horizontal radar tracks, number	Vertical radar records, number	Night time acoustic records, number
Waterbirds / marine birds					
Unidentified Geese	*Anserini*	11,969	185		
Unidentified Ducks	*Anatinae*	2,108	51		
Eurasian Wigeon	*Anas penelope*	324	9		
Unidentified swan	*Cygnus sp.*	179	11		
Common Scoter	*Melanitta nigra*	173	9		
Common/Velvet Scoter	*Melanitta sp.*	139	9		
Velvet Scoter	*Melanitta fusca*	134	2		
Long-tailed Duck	*Clangula hyemalis*	124	1		
Great Cormorant	*Phalacrocorax carbo*	71	8		

English name	Scientific name	Method of investigations			
		Visual surveys, number	Horizontal radar tracks, number	Vertical radar records, number	Night time acoustic records, number
Greater White-fronted Goose	*Anser albifrons*	53	1		
Little Gull	*Larus minutus*	43			
Bean Goose	*Anser fabalis*	35			
Whooper Swan	*Cygnus cygnus*	32	3		
Eurasian Teal	*Anas crecca*	31	1		
Razorbill	*Alca torda*	24			
Black-headed Gull	*Larus ridibundus*	16			
Unidentified Tern	*Sterninae*	15			
Common Shelduck	*Tadorna tadorna*	15	1		
Unidentified Gull	*Larus sp.*	15	7		6
Common Guillemot	*Uria aalge*	13			
Red-throated Diver	*Gavia stellata*	11			
Gadwall	*Anas strepera*	8			
Common Eider	*Somateria mollissima*	4			
Black-throated Diver	*Gavia arctica*	3			
Common Gull	*Larus canus*	3			
Unidentified Merganser	*Mergus sp.*	3			
Common/Arctic Tern	*Sterna hirundo / paradisaea*	2			
Mute Swan	*Cygnus olor*	2			
Razorbill/Guillemot	*Alca torda / Uria aalge*	2			
Unidentified auk	*Alcidae*	1			
Common Tern	*Sterna hirundo*	3			
Mallard	*Anas platyrhynchos*	1			
Unidentified Diver	*Gavia sp.*	1			
Black Tern	*Chlidonias niger*	1			

English name	Scientific name	Method of investigations			
		Visual surveys, number	Horizontal radar tracks, number	Vertical radar records, number	Night time acoustic records, number
Lesser Black-backed Gull	*Larus fuscus*	1			
Herring Gull	*Larus argentatus*		12		
Total waterbirds		***15,559***	***310***		***6***
Landbirds					
Common Crane	*Grus grus*	1,483	25		
Unidentified passerine	*Passeriformes*	69	9		1
Unidentified Wader	*Limicolae*	43	2		
White Wagtail	*Motacilla alba*	41			
European Robin	*Erithacus rubecula*	18			6
Eurasian Curlew	*Numenius arquata*	18			
Meadow Pipit	*Anthus pratensis*	11			
Common Starling	*Sturnus vulgaris*	11			
Goldcrest	*Regulus regulus*	10			
Eurasian Skylark	*Alauda arvensis*	10			
Common Chaffinch	*Fringilla coelebs*	8			
Whimbrel	*Numenius phaeopus*	8	1		
Common Swift	*Apus apus*	6			
Barn Swallow	*Hirundo rustica*	6			
Unidentified Thrush	*Turdidae*	4			
Yellow Wagtail	*Motacilla flava*	3			
Common Redstart	*Phoenicurus phoenicurus*	3			
Short-eared Owl	*Asio flammeus*	3			
Song Thrush	*Turdus philomelos*	2			
Sand Martin	*Riparia riparia*	2			
Yellowhammer	*Emberiza citrinella*	2			
Eurasian Pied Flycatcher	*Ficedula hypoleuca*	2			

English name	Scientific name	Method of investigations			
		Visual surveys, number	Horizontal radar tracks, number	Vertical radar records, number	Night time acoustic records, number
Lesser Whitethroat	*Sylvia curruca*	1			
Fieldfare	*Turdus pilaris*	1			
Firecrest	*Regulus ignicapilla*	1			
Ruff	*Philomachus pugnax*	1			
Long-/Short-eared Owl	*Asio otus*	1			
Eurasian Siskin	*Carduelis spinus*	1			
Northern Wheatear	*Oenanthe oenanthe*	1			
Common Wood Pigeon	*Columba palumbus*	1			
Unidentified Falcon	*Falco sp.*	1			
Common Sandpiper	*Actitis hypoleucos*	1			1
Grey Heron	*Ardea cinerea*	1			
Common Blackbird	*Turdus merula*				10
Redwing	*Turdus iliacus*				4
Golden Plover	*Pluvialis apricaria*				1
Total landbirds		***1,774***	***37***		***23***
Unidentified bird	*Aves*	236		600	
GRAND TOTAL		**17,569**	**347**	**600**	**29**

Table 5.34 Numbers of individual birds of different species recorded during the migration monitoring at BŚ III in 2013. The table shows numbers of birds registered during daytime visual observations and numbers of bird calls recorded at night a given in parentheses. Species are sorted by cumulative total number of registrations. Additionally, species conservation status is listed according to IUCN Red List, EU Birds Directive, SPEC status, and whether it is listed among strictly protected species in Poland.

English name	Scientific name	Number of individuals observed during spring migration	Number of individuals observed during autumn migration	Total number of individuals observed during the monitoring	IUCN[1]	EU Birds Directive[2]	SPEC status[3]	Strictly protected in Poland[4]
Waterbirds / marine birds								
Unidentified geese	*Anserini*	75	11,969	12,044				
Unidentified ducks	*Anatinae*	1,363	2,108	3,471				
Common Scoter	*Melanitta nigra*	970 (41)	173	1,143 (41)				
Long-tailed Duck	*Clangula hyemalis*	489 (12)	124	613 (12)	VU			
Velvet Scoter	*Melanitta fusca*	323	134	457	EN		SPEC3	
Common/Velvet Scoter	*Melanitta sp.*	293	139	432				
Eurasian Wigeon	*Anas penelope*	70	324	394				
Great Cormorant	*Phalacrocorax carbo*	123	71	194				
Unidentified swans	*Cygnidae*	13	179	192				
Razorbill	*Alca torda*	96	24	120				
Northern Pintail	*Anas acuta*	92		92			SPEC3	Z-1
Little Gull	*Larus minutus*	47	43	90		Annex I	SPEC3	Z-1
Mallard	*Anas platyrhynchos*	74 (2)	1	75 (2)				
Whooper Swan	*Cygnus cygnus*	52	32	84		Annex I		

English name	Scientific name	Number of individuals observed during spring migration	Number of individuals observed during autumn migration	Total number of individuals observed during the monitoring	IUCN[1]	EU Birds Directive[2]	SPEC status[3]	Strictly protected in Poland[4]
Greater White-fronted Goose	*Anser albifrons*	12	53	65				
Eurasian Teal	*Anas crecca*	8 (24)	31	39 (24)				
Black-Headed Gull	*Larus ridibundus*	34 (1)	16	50 (1)				Z-1
Unidentified divers	*Gavia sp.*	47	1	48				
Bean Goose	*Anser fabalis*		35	35				
Black-throated Diver	*Gavia arctica*	21	3	24		Annex I	SPEC3	
Common/Arctic Tern	*Sterna hirundo / paradisea*	19	2	21				
Unidentified gull	*Laridae*		15 (6)	15 (6)				
Red-throated Loon	*Gavia stellata*	9	11	20		Annex I	SPEC3	
Common Guillemot	*Uria aalge*	7	13	20				
Unidentified tern	*Sterninae*	4	15	19				
Common Shelduck	*Tadorna tadorna*		15	15				Z-1
Common Tern	*Sterna hirundo*	11	3	14		Annex I		Z-1
Mute Swan	*Cygnus olor*	11	2	13				
Eurasian Coot	*Fulica atra*	(11)		(11)				
Goosander	*Mergus merganser*	10		10				Z-1
Arctic Skua	*Stercorarius parasiticus*	10		10				

English name	Scientific name	Number of individuals observed during spring migration	Number of individuals observed during autumn migration	Total number of individuals observed during the monitoring	IUCN[1]	EU Birds Directive[2]	SPEC status[3]	Strictly protected in Poland[4]
Northern Shoveler	*Anas clypeata*	9		9			SPEC3	Z-1
Red-breasted Merganser	*Mergus serrator*	8		8				Z-1
Gadwall	*Anas strepera*		8	8			SPEC3	Z-1
Common Eider	*Somateria mollissima*	4	4	8				
Greylag Goose	*Anser anser*	5		5				
Black Guillemot	*Cepphus grylle*	5		5			SPEC2	
Unidentified auk	*Alcidae*	2	3	5				
Common Gull	*Larus canus*	3	3	6			SPEC2	Z-1
Unidentified Merganser	*Mergus sp.*		3	3				
Common Goldeneye	*Bucephala clangula*	2		2				Z-1
Whiskered Tern	*Chlidonias hybrida*	1		1				Z-1
Black Tern	*Chlidonias niger*		1	1		Annex I	SPEC3	Z-1
Lesser Black-backed Gull	*Larus fuscus*		1	1				Z-1
Tundra Swan	*Cygnus columbianus*	1		1		Annex I	SPEC3w	
Great Crested Grebe	*Podiceps cristatus*	1		1				
Parasitic/Pomarine Skua	*Stercorarius parasiticus / pomarinus*	1		1				
Total waterbirds		***4,325 (91)***	***15,559 (6)***	***19,884 (97)***				

English name	Scientific name	Number of individuals observed during spring migration	Number of individuals observed during autumn migration	Total number of individuals observed during the monitoring	IUCN[1]	EU Birds Directive[2]	SPEC status[3]	Strictly protected in Poland[4]
Landbirds								
Common Blackbird	*Turdus merula*	54 (3,344)	(10)	54 (3,354)				
Common Crane	*Grus grus*	31	1,483	1,514		Annex I	SPEC2	Z-1
Eurasian Skylark	*Alauda arvensis*	101 (1,291)	10	111 (1,291)			SPEC3	
European Robin	*Erithacus rubecula*	12 (646)	18 (6)	30 (652)				
Redwing	*Turdus iliacus*	9 (589)	(4)	9 (593)				
Common Chaffinch	*Fringilla coelebs*	500	8	508				
Common Starling	*Sturnus vulgaris*	429 (10)	11	440 (10)			SPEC3	
Common Wood Pigeon	*Columba palumbus*	390	1	391				
Song Thrush	*Turdus philomelos*	18 (333)	2	20 (333)				
European Golden Plover	*Pluvialis apricaria*	325	(1)	325 (1)		Annex I		
Great Tit	*Parus major*	295		295				
White Wagtail	*Motacilla alba*	175 (1)	41	216 (1)				
Unidentified passerines	*Passeriformes*	115	69 (1)	184 (1)				
Fieldfare	*Turdus pilaris*	4 (105)	1	5 (105)				
Meadow Pipit	*Anthus pratensis*	69	11	80				
Barn Swallow	*Hirundo rustica*	59	6	65			SPEC3	
Eurasian Siskin	*Carduelis spinus*	51	1	52				

English name	Scientific name	Number of individuals observed during spring migration	Number of individuals observed during autumn migration	Total number of individuals observed during the monitoring	IUCN[1]	EU Birds Directive[2]	SPEC status[3]	Strictly protected in Poland[4]
Unidentified Wader	*Limicolae*		43	43				
European Greenfinch	*Carduelis chloris*	15		15				
Brambling	*Fringilla montifringilla*	13		13				
Unidentified thrushes	*Turdidae*	13	4	17				
Eurasian Curlew	*Numenius arquata*		18	18	NT		SPEC2	Z-1
Common Swift	*Apus apus*	9	6	15				
Goldcrest	*Regulus regulus*	1	10	11				
Rook	*Corvus frugilegus*	10		10				
Whimbrel	*Numenius phaeopus*	2	8	10				
Dunnock	*Prunella modularis*	9		9				
Common Reed Bunting	*Emberiza schoeniclus*	7		7				
Wood Lark	*Lullula arborea*	7		7			SPEC2	
Northern Lapwing	*Vanellus vanellus*	7		7			SPEC2	Z-1
Little Ringed Plover	*Charadrius dubius*	(7)		(7)				
Yellow Wagtail	*Motacilla flava*	2	3	5				
Long-tailed Bushtit	*Aegithalos caudatus*	4		4				
Tree Pipit	*Anthus trivialis*	4		4				
Red Knot	*Calidris canutus*	4		4			SPEC3w	

English name	Scientific name	Number of individuals observed during spring migration	Number of individuals observed during autumn migration	Total number of individuals observed during the monitoring	IUCN[1]	EU Birds Directive[2]	SPEC status[3]	Strictly protected in Poland[4]
Common Linnet	*Carduelis cannabina*	4		4			SPEC2	
Twite	*Carduelis flavirostris*	4		4				
Common Pigeon	*Columba livia*	4		4				
Red-breasted Flycatcher	*Ficedula parva*	4		4		Annex I		
Chaffinch/Brambling	*Fringilla sp.*	4		4				
Eurasian Wren	*Troglodytes troglodytes*	4		4				
Grey Heron	*Ardea cinerea*	3	1	4				
Eurasian Oystercatcher	*Haematopus ostralegus*	(4)		(4)				
Long-eared Owl	*Asio otus*	2	1	3				
Common House Martin	*Delichon urbica*	3		3			SPEC3	
Short-eared Owl	*Asio flammeus*		3	3		Annex I	SPEC3	Z-1
Common Redstart	*Phoenicurus phoenicurus*		3	3			SPEC2	
Yellowhammer	*Emberiza citrinella*	1	2	3				
Eurasian Pied Flycatcher	*Ficedula hypoleuca*	1	2	3				
Eurasian Sparrowhawk	*Accipiter nisus*	2		2				
Eurasian Hobby	*Falco subbuteo*	2		2				Z-1
Lapland Bunting	*Calcarius lapponicus*	2		2				

English name	Scientific name	Number of individuals observed during spring migration	Number of individuals observed during autumn migration	Total number of individuals observed during the monitoring	IUCN[1]	EU Birds Directive[2]	SPEC status[3]	Strictly protected in Poland[4]
Blue Tit	*Parus caeruleus*	2		2				
Black Redstart	*Phoenicurus ochruros*	2		2				
Common Chiffchaff	*Phylloscopus collybita*	2		2				
Wood Warbler	*Phylloscopus sibilatrix*	2		2			SPEC2	
Eurasian Woodcock	*Scolopax rusticola*	2		2			SPEC3	
Eurasian Blackcap	*Sylvia atricapilla*	2		2				
Eurasian Tree Sparrow	*Passer montanus*	1 (1)		1 (1)			SPEC3	
Common Sandpiper	*Actitis hypoleucos*		1 (1)	1 (1)			SPEC3	
Lesser Whitethroat	*Sylvia curruca*		1	1				
Unidentified *Acrocephalus* warbler	*Acrocephalus sp.*	1		1				
Common Buzzard	*Buteo buteo*	1		1				
European Goldfinch	*Carduelis carduelis*	1		1				
Western Marsh Harrier	*Circus aeruginosus*	1		1		Annex I		Z-1
Stock Dove	*Columba oenas*	1		1				
Unidentified pigeon	*Columba sp.*	1		1				
Carrion Crow	*Corvus corone*	1		1				
Common Kestrel	*Falco tinnunculus*	1		1			SPEC3	Z-1

English name	Scientific name	Number of individuals observed during spring migration	Number of individuals observed during autumn migration	Total number of individuals observed during the monitoring	IUCN[1]	EU Birds Directive[2]	SPEC status[3]	Strictly protected in Poland[4]
Common Snipe	*Gallinago gallinago*	1		1			SPEC3	Z-1
Common Grasshopper Warbler	*Locustella naevia*	1		1				
Unidentified Pipit	*Motacillidae.*	1		1				
Osprey	*Pandion haliaetus*	1		1		Annex I	SPEC3	Z-1
Unidentified Falcon	*Falco sp.*		1	1				
Sand Martin	*Riparia riparia*	1	2	3			SPEC3	
Common Redshank	*Tringa totanus*	1		1			SPEC2	Z-1
Northern Wheatear	*Oenanthe oenanthe*		1	1			SPEC3	
Firecrest	*Regulus ignicapilla*		1	1				
Ruff	*Philomachus pugnax*		1	1		Annex I	SPEC2	Z-1
Spotted Redshank	*Tringa erythropus*	(1)		(1)			SPEC3	
Total landbirds		***2,811 (6,332)***	***1,774 (23)***					
GRAND TOTAL		**7,136 (6,423)**	**17,569 (29)**	**24,705 (6,452)**				

[1] IUCN Red List categories of protected species: NT (near threatened), VU (vulnerable), EN (endangered), CR (critically endangered) (IUCN 2013).

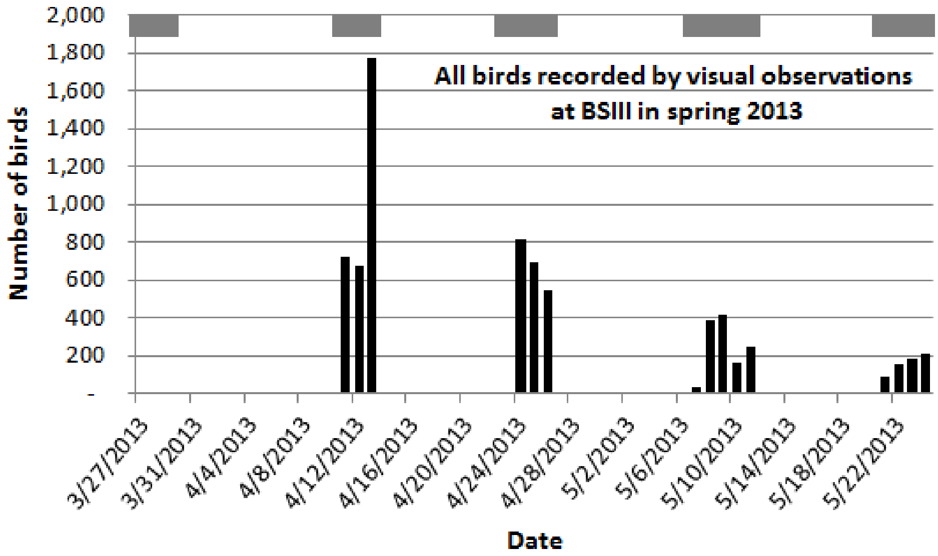
[2] The column notes whether a species is included into Annex I of the EU Birds Directive.

[3] SPEC categories represent Species of European Conservation Concern status: SPEC1 – species of global conservation concern, SPEC2 – species concentrated in Europe and with an unfavourable conservation status in Europe, SPEC3 – species not concentrated in Europe, but with unfavourable conservation status in Europe. W category relates to winter populations (BirdLife International 2004).

[4] Bird species listed in “Annex 1 (Załącznik 1) – Species of wild animals being subject to strict protection, listing of species requiring active protection” of Rozporządzenie Ministra Środowiska z dnia 12 października 2011 roku w sprawie ochrony gatunkowej zwierząt (Dziennik Ustaw 2011 nr 237 poz. 1419).

5.3.1 Temporal distribution of bird migration

In general, bird migration was dispersed through different monitoring periods, as different species have own schedules, some of them early and others late. The highest numbers of diurnal migrants was recorded in early and late April during spring migration and in last days of September – first days of October during autumn migration (Figure 5.75). Peak days of spring migration were dominated by Common Starling, Common Chaffinch and Long-tailed Ducks in early April and Common Scoters and Long-tailed Ducks in late April. Peak period of autumn migration was dominated by geese and crane passage (see chapter 5.2, Appendix A). Mass migration events are usually determined by correspondence of species-specific migration preferences and suitable weather conditions (Alerstam 1974, Nowakowski et al. 2005).



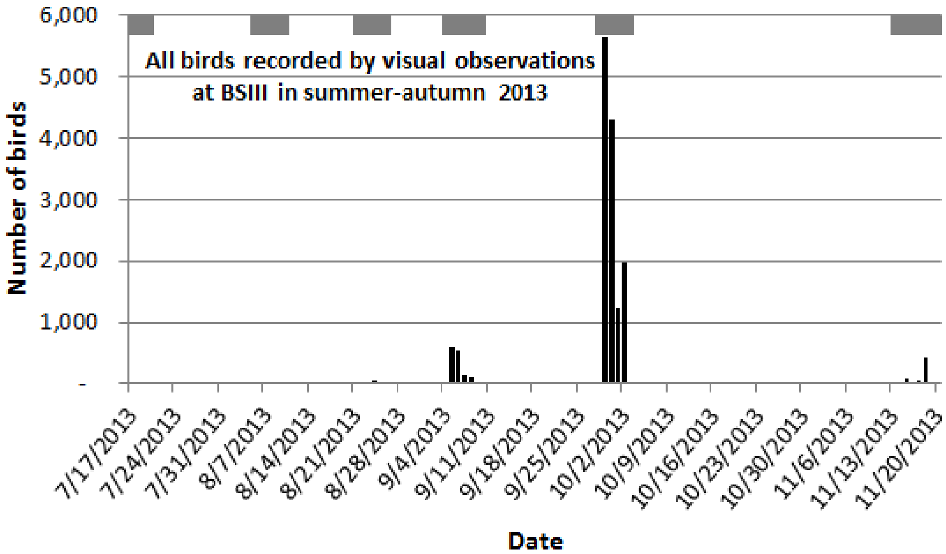
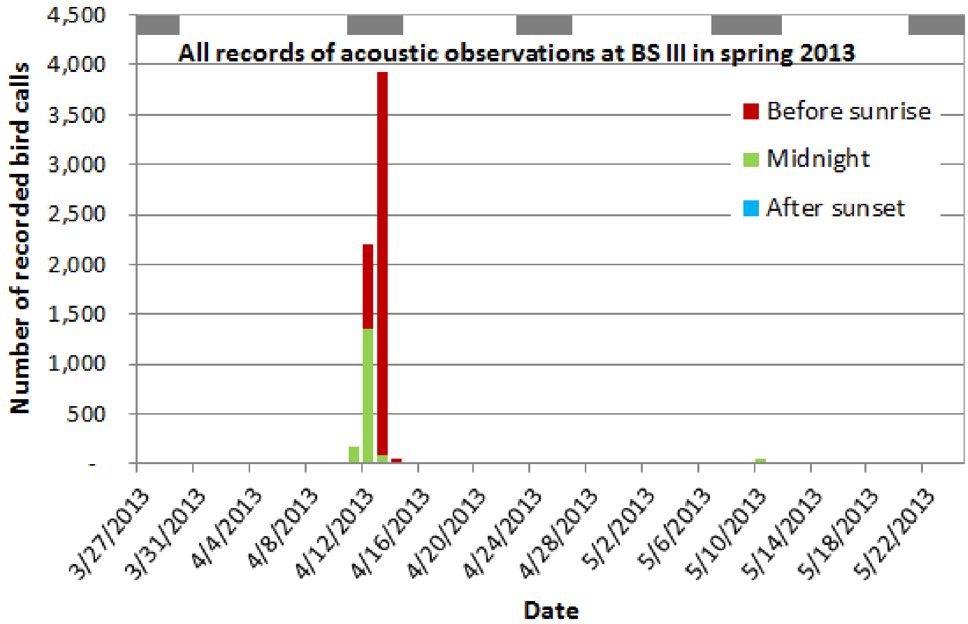


Figure 5.75 Temporal distribution of all birds registered during daytime visual observations at BŚ III area in March – May (upper chart) and July – November (lower chart) 2013. Grey areas on top of the charts indicate periods when investigations were conducted.

Similar to peak period of passerines recorded during daylight hours, nocturnal acoustic observations indicates very high activity of nocturnally migrating passerine birds in early April

(Figure 5.76). Dominant identified migrants were different thrush species, European Robin and Skylark (see chapter 5.2, Appendix A). There were few acoustic records achieved during the autumn migration (Figure 5.76).



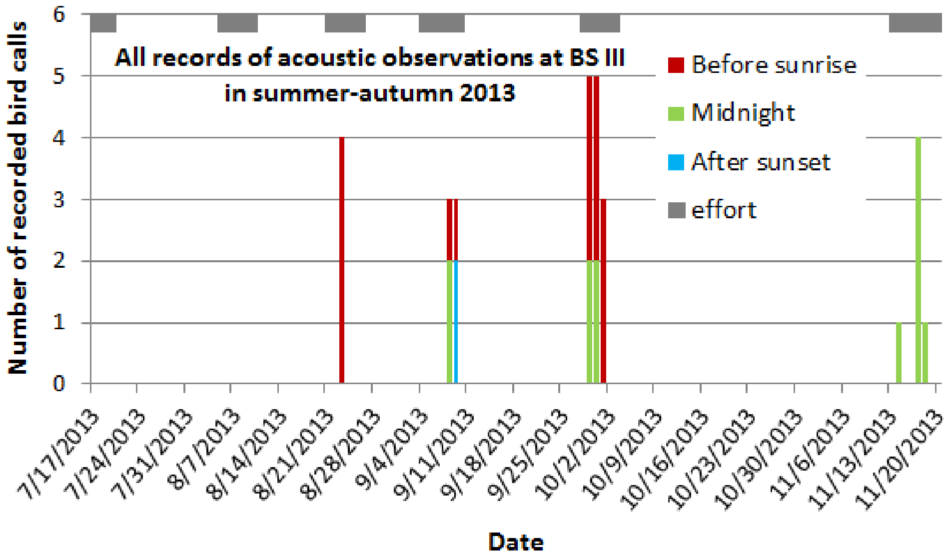
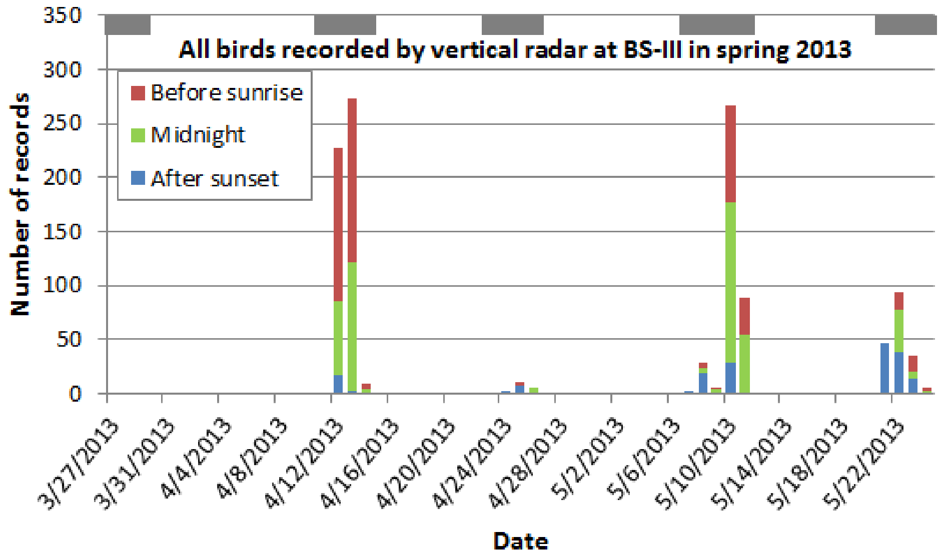


Figure 5.76 Temporal distribution of registered bird calls of all species at BŚ III during night time observations in March – May (upper chart) and July – November (lower chart) 2013. Grey areas on top of the charts indicate periods when acoustic nigh time observations were conducted.

Registration of nocturnal migrants using vertical radar also indicated high migration intensity in early April, but also intensive migration in early May (Figure 5.77). In autumn, similarly to daytime observations, very intensive passage of nocturnal migrants took place in late September – early October (Figure 5.77). However nocturnal migration of birds was recorded during all observation periods except for the November cruise (Figure 5.77).

Both acoustic and vertical radar observations of nocturnal migrants indicated that bird passage was more intensive at midnight and before sunrise compared to first hour after the sunset (Figure 5.76, Figure 5.77).



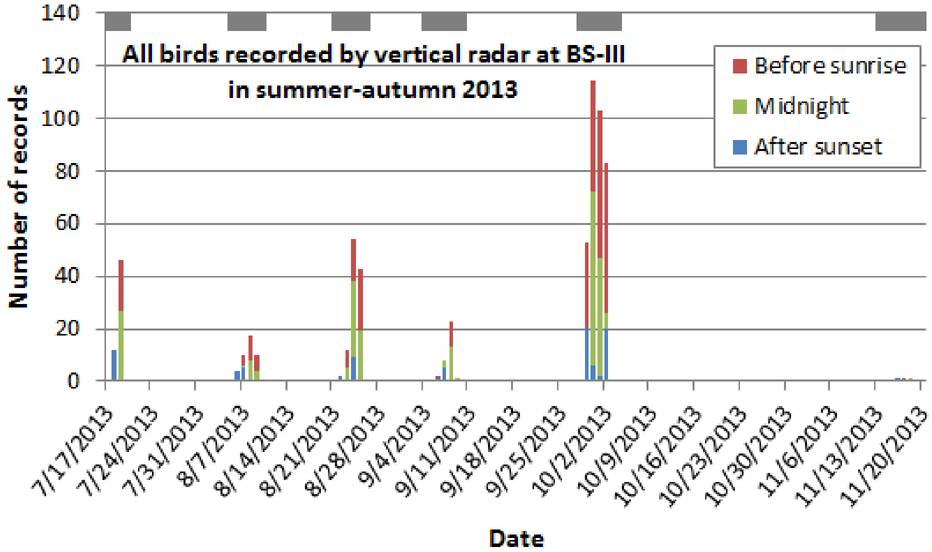


Figure 5.77 Temporal distribution of bird targets registered using vertical radar at BŚ III during night time in March – May (upper chart) and July – November (lower chart) 2013. Grey areas on top of the charts indicate periods when vertical radar investigations were conducted.

5.4 Flight altitudes

Flight altitude of migrating bird was assessed using two methods: visual evaluations during surveys at daylight hours and measurements by the vertical radar at night. When conducting visual observations during daylight hours, the flight altitude was assessed visually for the majority of recorded birds. Assessing height of flying birds visually is somewhat biased to an observer perception and uncertainty gets bigger with increasing distance. On the other hand, vertical radar measurements are not species-specific and characterise overall flux of nocturnally migrating birds, and altitude range below 40 m is uncertain.

5.4.1 Flight altitude of diurnal migrants in spring

After grouping diurnal observations into five altitude bands, the majority of identified seaducks flew low, between 0-15 m and 15-20 m above sea level (Table 5.35). Slightly more of unidentified ducks were registered flying higher, which is one of the reasons they were difficult to identity to species level.

Migrating geese were not numerous on spring migration, and the majority of observed birds (94%) flew below 20 m (Table 5.35).

All of observed auks (Razorbills and guillemots) flew very low, not exceeding 15 m above the water (Table 5.35).

Out of 76 divers with assessed flight altitude, 50% flew below 15 m, 15% between 15-20 m, and the remaining 35% between 20-60m (Table 5.35). Cormorants had rather wide range of flight altitudes: about 40% of them were recorded below 20 m and the remaining 60% between 20-60 m (Table 5.35).

Not many waders have been recorded during the spring migration and the majority of them were observed flying between 60-200 m (Table 5.35). Of passerine migrants 65% were observed flying below 15 m, 27% between 15-20 m and 8% between 20-60 m (Table 5.35). It should be admitted, however, that small passerine birds flying higher than 100 m could have been easily missed by the observers.

Large proportion (65%) of Common Wood Pigeons flew below 15 m, 10% between 15-20 m and the remaining 25% between 20-60 m (Table 5.35).

Two out of three recorded crane flocks flew at 200 m altitude and one at 250 m. Raptors generally flew low: out of eight individuals observed, five flew below 15 m, two at 20 m and one at 25 m altitude.

Table 5.35 Numbers of birds of different species recorded flying at different altitude bands during visual observation at BŚ III in spring 2013.

English name	Scientific name	Total number of birds	0–15 m	15–20 m	20–60 m	60–200 m	>200 m
Waterbirds / marine birds							
Unidentified ducks	*Anatinae*	1,358	836	235	164	73	50
Common Scoter	*Melanitta nigra*	962	743	166	53	0	0
Long-tailed Duck	*Clangula hyemalis*	479	445	34	0	0	0
Velvet Scoter	*Melanitta fusca*	298	238	33	27	0	0
Great Cormorant	*Phalacrocorax carbo*	123	50	1	68	4	0
Razorbill	*Alca torda*	96	96	0	0	0	0
Geese	*Anserini*	81	36	30	3	12	0
Divers	*Gaviidae*	76	38	11	27	0	0
Swans	*Cygnidae*	62	38	0	24	0	0
Little Gull	*Larus minutus*	47	35	5	6	1	0

English name	Scientific name	Total number of birds	0–15 m	15–20 m	20–60 m	60–200 m	>200 m
Eurasian Wigeon	*Anas penelope*	45	33	12	0	0	0
Black-headed Gull	*Larus ridibundus*	34	24	2	0	8	0
Mallard	*Anas platyrhynchos*	32	24	6	2	0	0
Northern Pintail	*Anas acuta*	22	0	5	0	17	0
Land birds							
Common Chaffinch	*Fringilla coelebs*	500	463	35	1	1	0
Common Starling	*Sturnus vulgaris*	429	117	296	16	0	0
Great Tit	*Parus major*	294	107	83	104	0	0
Common Wood Pigeon	*Columba palumbus*	390	259	35	96	0	0
European Golden Plover	*Pluvialis apricaria*	255	12	0	1	312	0
White Wagtail	*Motacilla alba*	173	156	13	4	0	0
Eurasian Skylark	*Alauda arvensis*	100	76	11	16	1	0
Meadow Pipit	*Anthus pratensis*	64	33	30	1	0	0
Barn Swallow	*Hirundo rustica*	59	56	2	1	0	0
Eurasian Siskin	*Carduelis spinus*	49	6	43	0	0	0
Common Crane	*Grus grus*	31	0	0	0	0	31
Common Blackbird	*Turdus merula*	27	25	2	0	0	0
Song Thrush	*Turdus philomelos*	17	15	2	0	0	0
European Robin	*Erithacus rubecula*	12	12	0	0	0	0

5.4.2 Flight altitude of diurnal migrants in autumn

After grouping observations into five altitude bands the majority of seaducks were recoded flying at 0-15 m and 15-20 m above sea level (Table 5.36). A higher percentage of unidentified ducks flew above 20 m, and the majority were recorded at the possible rotor height between 20-200 m (Table 5.36). It is likely that dabbling ducks made up a substantial proportion of unidentified ducks and an example of European Wigeon, the most numerous observed dabbling duck species, indicates that dabbling ducks fly somewhat higher than seaducks: 45% of Wigeon were recorded flying higher than 20 m (Table 5.36).

All auks flew at lower altitude bands, the majority bellow 15 m and a small proportion between 15-20 m (Table 5.36). Similarly, the majority of divers were recorded below 15 m and some between 15-20 m, but Great Cormorants had wider range of flight altitudes (Table 5.36).

Nearly 70% of all swans were recorded flying low, under 15 m, and the rest were equally distributed (~10% each) in the upper altitude bands of 15-20 m, 20-60 m and 60-200 m (Table 5.36). Little Gulls predominantly flew below 15 m with a small proportion between 15-20 m (Table 5.36).

Observed migrating geese flew relatively high, mostly at the potential wind turbine rotor height (Table 5.36). Cranes flew higher than geese; about 53% were assessed as flying above 200 m, 39% between 60-200 m, and 4% each at 15-20 m and 20-60 m (Table 5.36).

Only small numbers of waders and passerines were recorded during the autumn migration. More than half of all waders, 75% flew between 60-200 m and the rest lower than 15 m. The majority of passerines were registered at lower than 15 m altitude (Table 5.36).

Table 5.36 Numbers of birds of different species recorded flying at different altitude bands during visual observation at BSIII in summer-autumn 2013.

English name	Scientific name	Total number of birds	0–15 m	15–20 m	20–60 m	60–200 m	>200 m
Waterbirds / marine birds							
Geese	*Anserini*	12,057	90	141	1,806	8,855	1,165
Unidentified ducks	*Anatinae*	2,008	373	103	546	956	30
Eurasian Wigeon	*Anas penelope*	324	54	118	152	0	0
Swans	*Cygnidae*	213	143	21	26	23	0
Common Scoter	*Melanitta nigra*	173	155	15	3	0	0
Velvet Scoter	*Melanitta fusca*	134	93	41	0	0	0
Long-tailed Duck	*Clangula hyemalis*	124	120	0	4	0	0
Great Cormorant	*Phalacrocorax carbo*	71	16	19	26	10	0
Little Gull	*Larus minutus*	41	34	6	1	0	0
Eurasian Teal	*Anas crecca*	31	30	1	0	0	0
Razorbill	*Alca torda*	24	24	0	0	0	0
Divers	*Gaviidae*	15	13	2	0	0	0
Land birds							
Common Crane	*Grus grus*	1,483	0	60	58	585	780
White Wagtail	*Motacilla alba*	39	39	0	0	0	0

5.4.3 Flight altitude of diurnal migrants – overall assessment

Considering all migrating birds observed together it appears that the majority of migrants flew at 0-15 m altitude in spring and at 60-200 m altitude during the autumn migration (Figure 5.78). This, however, does not mean that spring and autumn migration occurs at different heights. The difference is primarily driven by different species composition and their predominant flight altitudes: seaduck species dominated the migrating bird composition in spring and geese were the most abundant in autumn (Table 5.33, Table 5.36).

Flight altitudes are species-specific and are unlikely to differ between spring and autumn migrations. However, there could be large variation within the same species depending on different factors. For example, resident birds usually fly lower compared to the same species on long-distance migration (IfAÖ 2004, Krijgsveld et al. 2005), birds fly higher at night than during the day (Alerstam 1990, Jacoby 1983, Žalakevičius 1987, Kahlert et al. 2012), also bird fly higher in tailwind conditions and lower in headwinds (Skov et al. 2012, 2012b).

Species that are taxonomically related and have similar ecology often fly at similar heights above the sea level. We therefore grouped all observations of migrating similar species that we collected in Polish offshore waters in order to have more generic overview of flight altitudes by different taxonomic groups based on larger sample sizes (Table 5.37). Considering the commonly used assumption that wind turbine rotor altitude starts 20 m above sea level, we can summarize that about one third of all divers and dabbling ducks were observed flying at potential rotor height; only 10% of seaducks, 0% of diving ducks, etc. (Table 5.37). Less than a third of all birds of the considered taxonomic groups were flying at the potential rotor height, except for geese, waders and cranes. The percentages for geese, waders and cranes flying above 20 m were higher and constituted 87%, 71% and 96% respectively (Table 5.37). It should also be noted that substantial proportions of migrating geese and cranes fly higher than upper limit of potential rotor height.

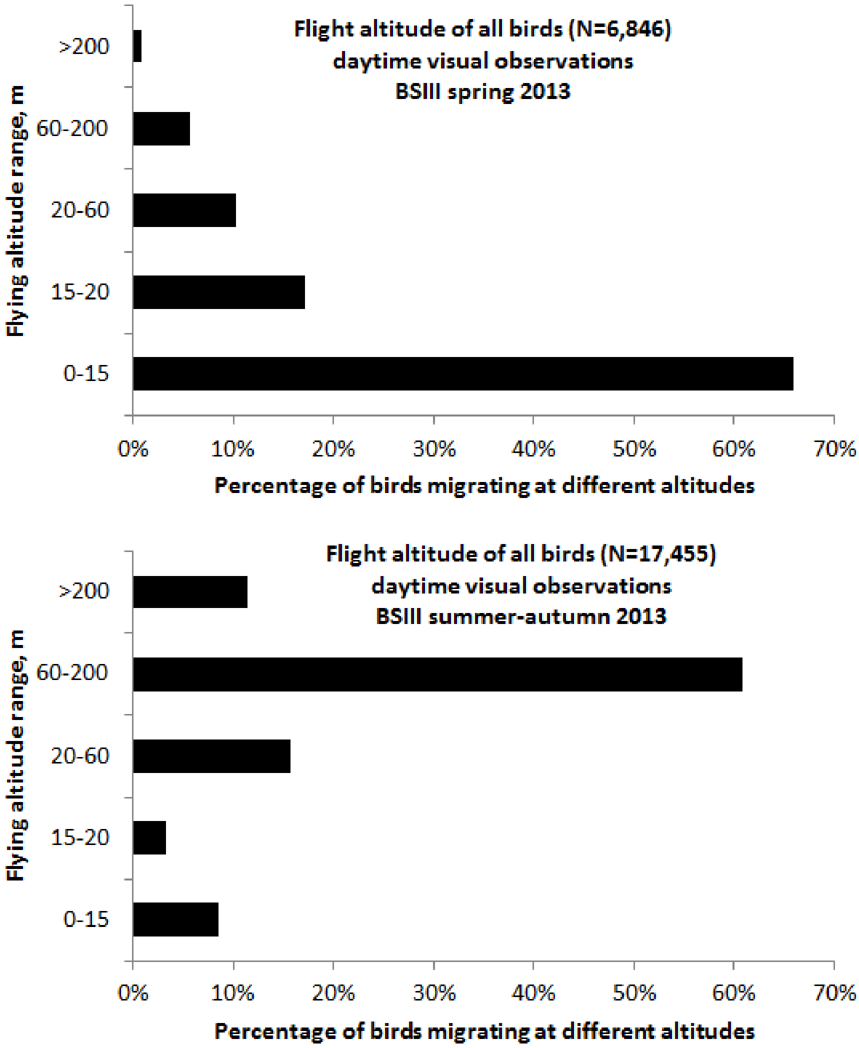


Figure 5.78 Flight altitude distribution of all birds recorded at BŚ III during daytime visual observations in March – May (upper chart) and July – November (lower chart) 2013.

Table 5.37 Flight altitudes of the main bird taxonomic groups recorded in Polish offshore waters during spring and autumn 2013. Data are summarised as % of birds flying above 20 m height, which is often considered as a boundary of the rotor-swept area when specific turbine parameters are unknown.

Taxonomic group	% above 20 m in Polish offshore waters (number of birds)	Dominating species
Divers (*Gavia sp.*)	34% (N=313)	Similar numbers of Red-throated and Black-throated Divers
Seaducks (*Mergini*)	10% (N=11,259)	7 species in total, dominated by Common Scoter, Long-tailed and Velvet Scoter
Dabbling ducks (*Anas sp.*)	33% (N=1,147)	At least 6 species, dominated by Eurasian Wigeon and Mallard

Taxonomic group	% above 20 m in Polish offshore waters (number of birds)	Dominating species
Diving ducks (*Aythya sp.)*	0% (N=194)	Greater Scaup (dominating), Tufted Duck
Geese (*Anserini*)	87% (N=14,985)	At least 5 species, most numerous Greater White-fronted Goose
Swans (*Cygnus sp.*)	23% (N=542)	3 species, most numerous Whooper Swan, followed by Mute Swan and Tundra Swan
Gulls (*Laridae*)	13% (N=501)	At least 6 species, the sample dominated by small gulls, Little Gull and Black-headed Gull
Terns (*Sternidae*)	26% (N=109)	At least 4 species with Common Tern being dominant
Skuas (*Stercorariidae*)	5% (N=42)	Two species with Arctic Skua dominating
Waders (*Scolopacidae*, *Charadriidae*)	71% (N=1,031)	At least 17 species, Golden Plover accounting for more than half of the sample
Cranes	96% (N=1,609)	One species, the Common Crane
Small passerines	8% (N=4,676)	At least 46 species; Common Chaffinch, Common Starling and Great Tit being most numerous
Thrushes (*Turdus sp*.)	1% (N=205)	Similar representation of 4 species: Redwing, Blackbird, Song Thrush, and Fieldfare
Pigeons (*Columbidae*)	25% (N=823)	At least 2 species, dominated by Common Wood Pigeon
Raptors and owls (*Falconiformes*)	15% (N=40)	At least 8 species of raptors and 2 owl species (Long- and Short-eared Owls)

5.4.4 Flight altitude of nocturnal migrants

Flight altitude of nocturnal migrants was measured using the vertical radar, which was operated continuously during every night of field observations on BŚ III area in spring and summer-autumn 2013. Collected radar images were processed for three periods every night: 1 hour after sunset, 1 hour at midnight and 1 hour before sunrise. As mentioned in the method description, species identification is not possible for radar measurements and assessment of migration intensity below 40 meters is not reliably represented due to technical characteristics of the radar. Simultaneously conducted acoustic registrations of bird calls at night provide information about migration intensity at low altitude that is not covered by the vertical radar.

A total of 1,102 radar reflections have been identified as passing birds in spring and considering all registrations together, 86% of all registered birds flew above 200 m (Figure 5.79), an altitude which is usually considered as an upper limit of the blade swept area of a typical offshore wind farm (although there are already higher turbines in development).

A total of 600 radar reflections have been identified as passing birds in autumn (Figure 5.79). Considering all registrations together, 88% of all registered birds flew above 200 m (Figure

5.79), an altitude which could be considered as an upper limit of the blade swept area of a typical offshore wind farm.

Results of altitude distribution of nocturnal migrants are in agreement with the common knowledge suggesting that nocturnal migration over the sea is represented by mostly passerine birds flying at high altitudes (Alerstam 1990, IfAÖ 2004, Krijgsveld et al. 2011, FEBI 2013).

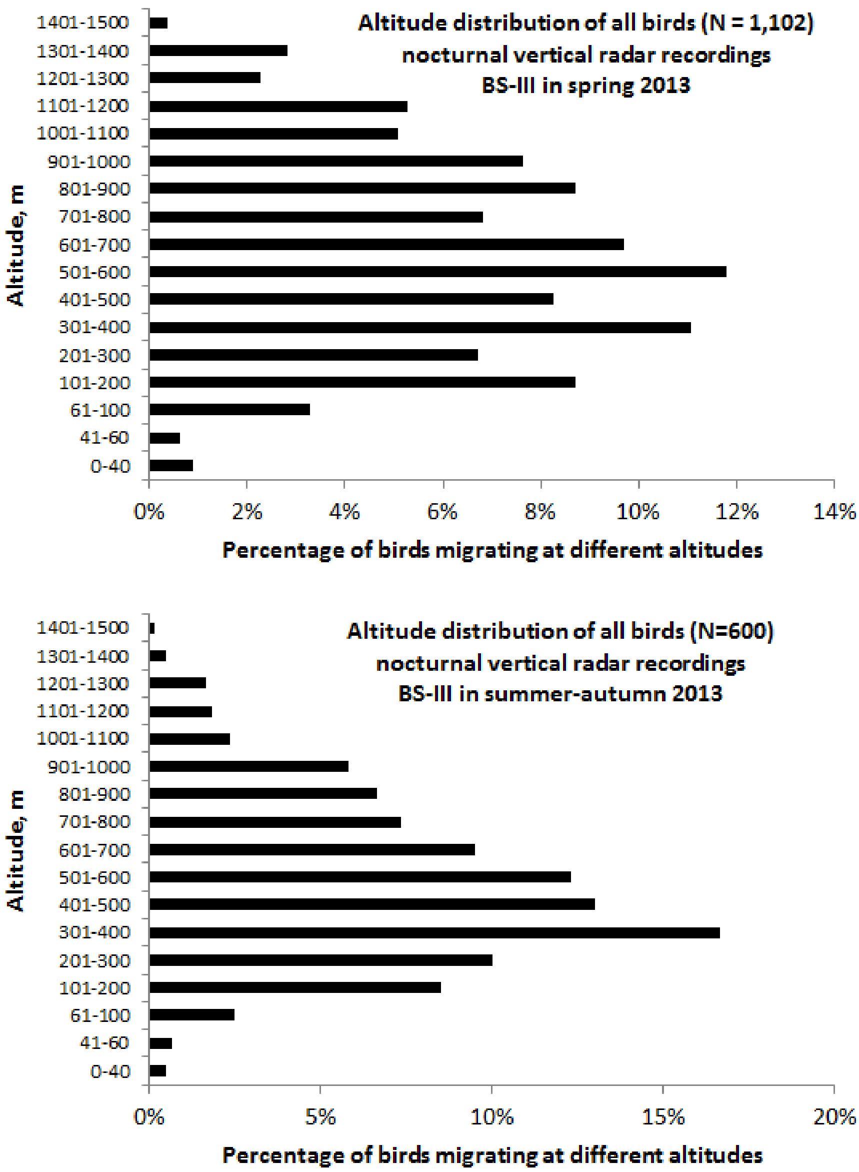


Figure 5.79 Flight altitude distribution of all birds recorded at BŚ III during night time recordings by vertical radar in March – May (upper chart) and July – November (lower chart) 2013.

Nocturnal spring migration

Considering spring survey cruises separately, some variation in altitude of nocturnal migrants could be noted although the general pattern remains the same – majority of birds fly high, at an altitude of a few hundred meters (Figure 5.80, Figure 5.81, Figure 5.82, Figure 5.83). The slight differences could be attributed to migration of different species and/or different weather conditions. E.g., recorded high intensity nocturnal migration during the first April cruise (Figure 5.80) coincided with the period when very intensive nocturnal migration of thrushes and other song-birds was recorded using acoustic observations (Figure 5.76). It could therefore be assumed that at many of the targets detected by the vertical radar were flocks of thrushes and/or other flocking passerines. Also, rather intensive passage was registered during the cruise on May 7-11 (Figure 5.82). Acoustic records of nocturnal migrants were very few during that period represented mainly by Common Scoters and Long-tailed Ducks (see species characteristics in chapter 5.2). Daytime visual observations also indicated rather intensive migration of these duck species (see chapter 5.2). Therefore, it can be expected that at least some of the nocturnal targets logged using vertical radar were also represented by seaducks migrating at night in early May.

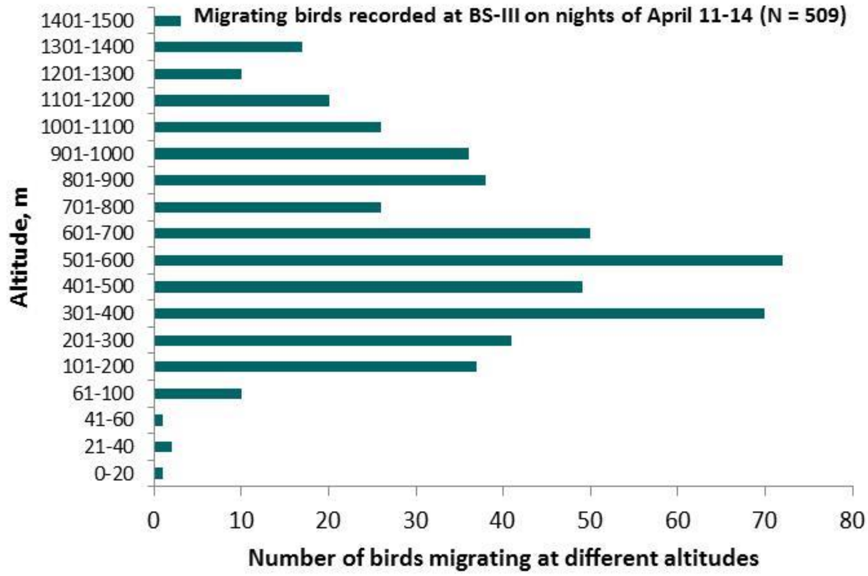


Figure 5.80 Altitude distribution of bird targets registered using vertical radar at the BŚ III area during night time on April 11-14, 2013.

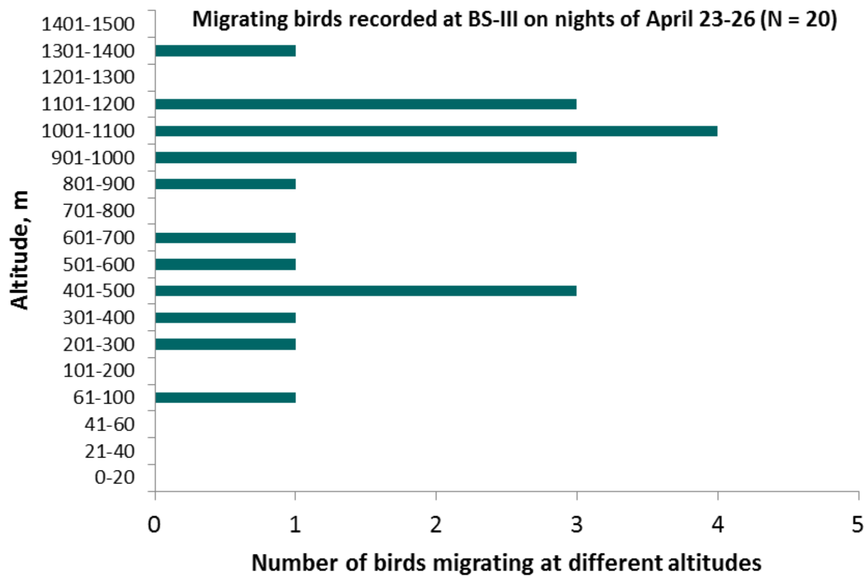


Figure 5.81 Altitude distribution of bird targets registered using vertical radar at the BŚ III area during night time on April 23-26, 2013.

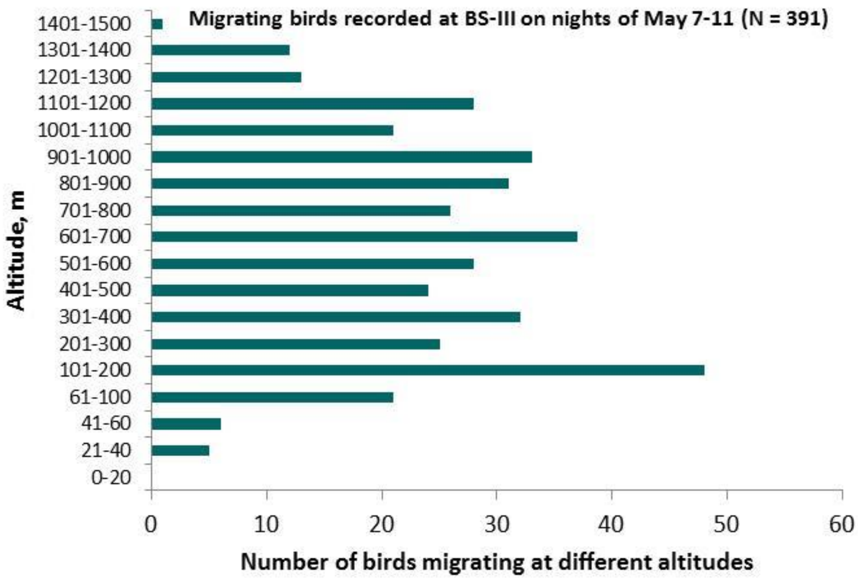


Figure 5.82 Altitude distribution of bird targets registered using vertical radar at BŚ III area during night time on May 7-11, 2013.

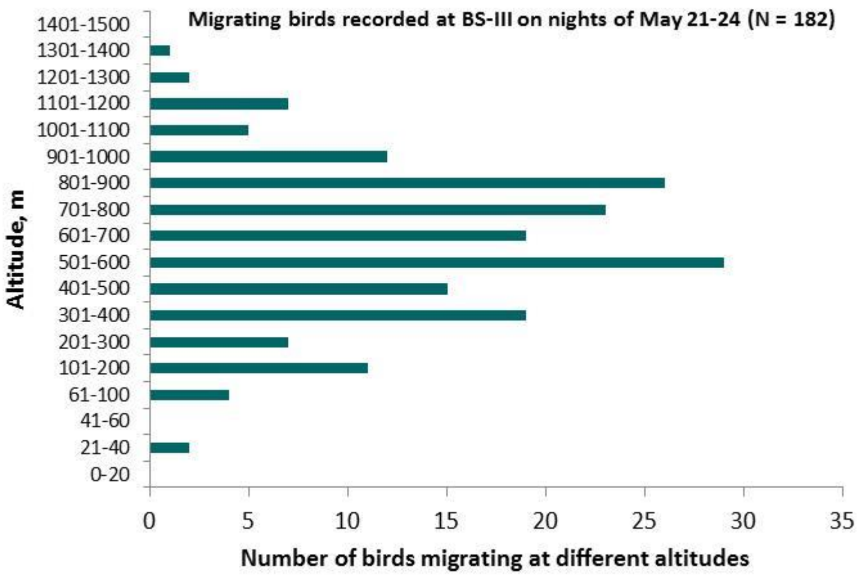


Figure 5.83 Altitude distribution of bird targets registered using vertical radar at BŚ III area during night time on May 21-24, 2013.

Nocturnal late summer – autumn migration

Considering autumn survey cruises separately, some variation in altitude of nocturnal migrants could be noted although the general pattern remains the same – majority of birds fly high, at an altitude of a few hundred meters (Figure 5.84, Figure 5.85, Figure 5.86, Figure 5.87, Figure 5.88). The differences between the cruises could be attributed to migration of different species and/or different weather conditions.

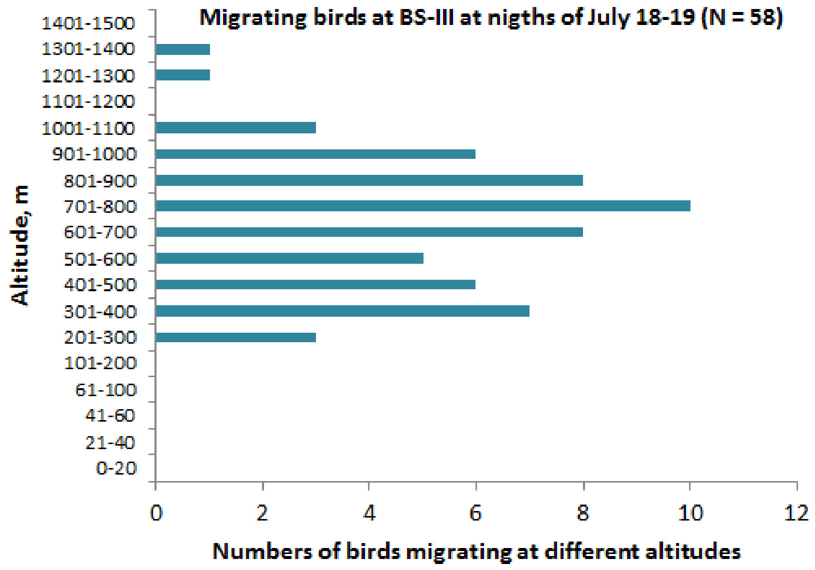


Figure 5.84 Altitude distribution of bird targets registered using vertical radar at BŚ III area during night time on July 18-19, 2013.

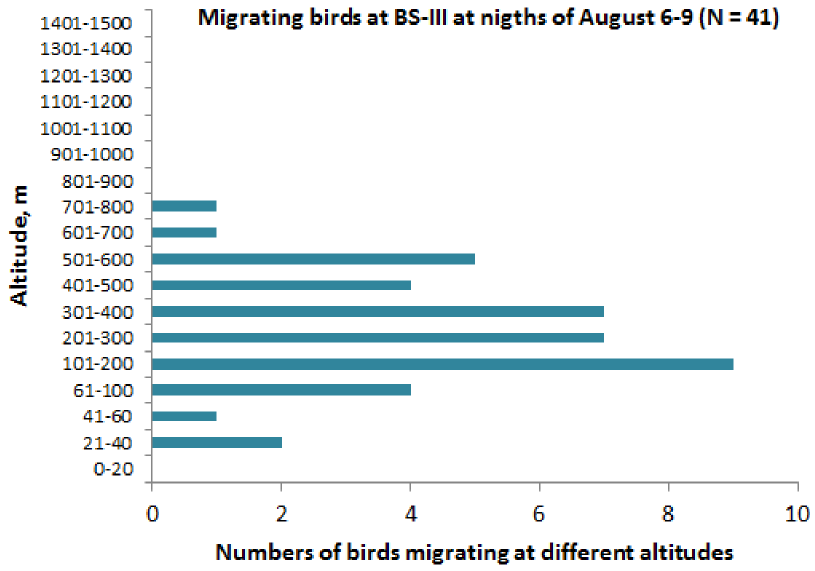


Figure 5.85 Altitude distribution of bird targets registered using vertical radar at BŚ III area during night time on August 6-9, 2013.

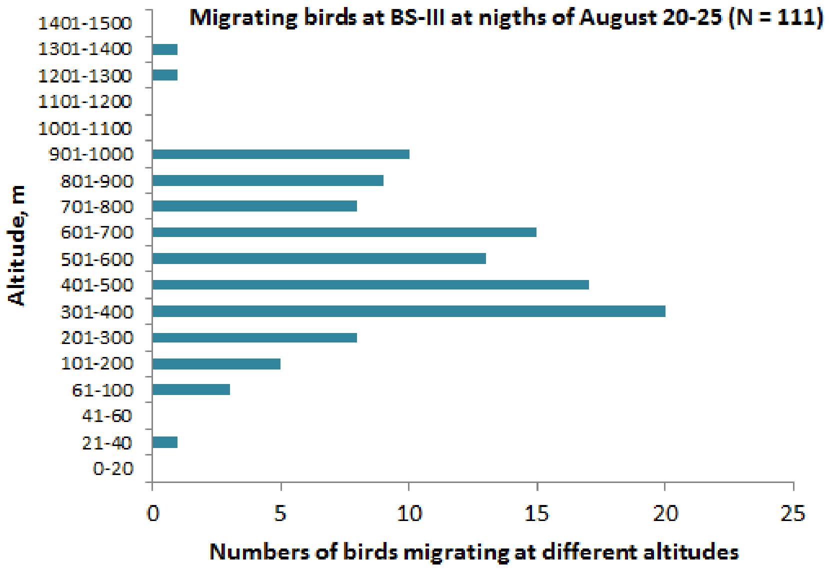


Figure 5.86 Altitude distribution of bird targets registered using vertical radar at BŚ III during night time on August 20-25, 2013.

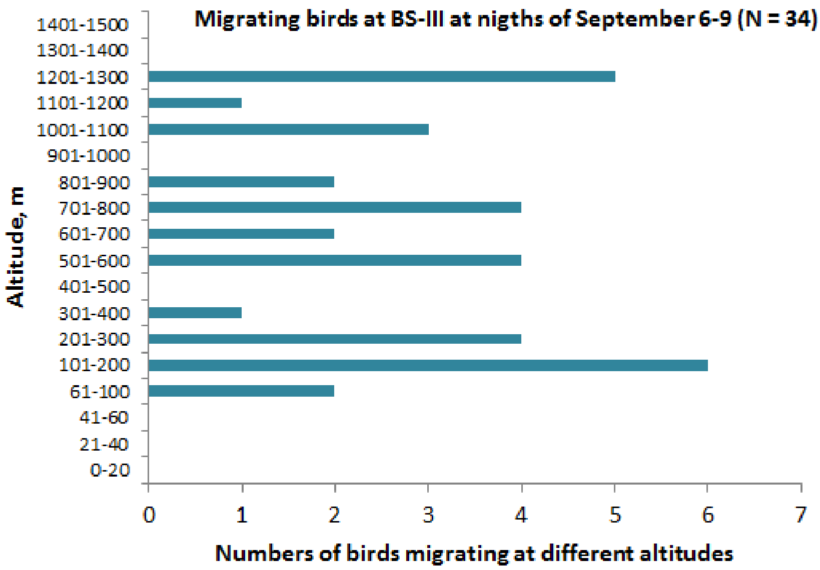


Figure 5.87 Altitude distribution of bird targets registered using vertical radar at BŚ III during night time on September 6-9, 2013.

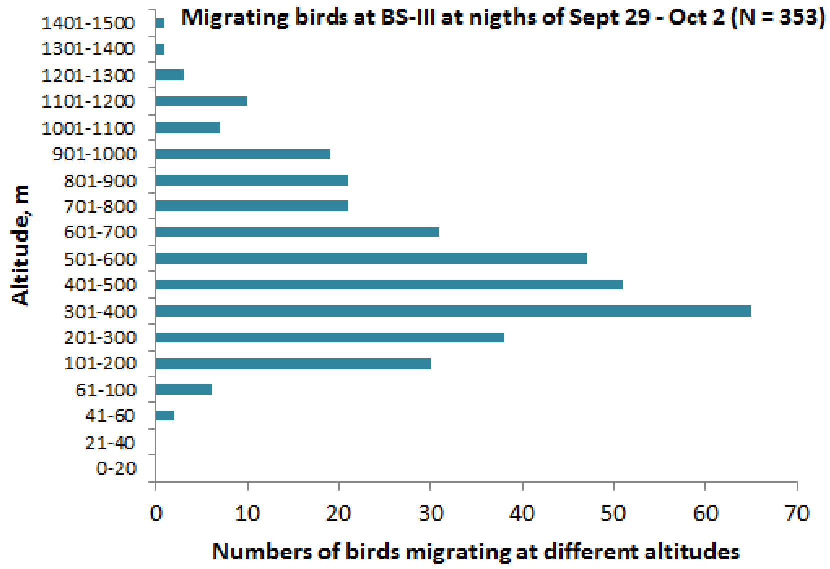


Figure 5.88 Altitude distribution of bird targets registered using vertical radar at BŚ III during night time on September 29 – October 2, 2013.

5.5 Flight directions

Flight directions of migrating bird were assessed using two methods: visual evaluations and measured by the horizontal radar during daylight hours. Tracking with horizontal radar provides more accurate information on flight directions of migrating birds whereas directions assessed visually by the observers are more prone to errors as observers follow birds for shorter time period and there are no landmarks helping to assess flight directions in the open sea. Therefore horizontal radar data should be considered as the primary information source on this question and visually assessed migration directions should be viewed as supporting data.

Seasonal migrants typically have clearly defined flight directions, whereas locally moving resident birds do not.

Recorded flight directions during spring migration

A total of 264 birds tracks representing at least 26 species were logged at BŚ III in spring 2013 (Table 5.32, Appendix B). Species composition of logged tracks in general terms was similar to the overall composition of visually recorded migrating large-bodied bird species, i.e. small passerines and waders cannot be tracked by the radar system used. Small birds constitute too small objects for reflecting the radar beam for sufficient differentiation at the search resolution used (radar search radius was set to 6 km).

The dominant recorded direction was NE for all bird species during spring migration at BŚ III (see species characteristics in chapter 5.2).

The majority of recorded Long-tailed Duck tracks were directed NE, indicating migratory movements of the species (Figure 5.89). Responsive movements of Long-tailed Ducks avoiding the survey ship could be observed to a distance of at least 2 km. Most birds passed to the northwest of the survey ship. Temporally, most of the Long-tailed Duck tracks were recorded in May (Appendix B). NE direction of migrating Long-tailed ducks suggests that birds were likely flying from major wintering areas in Pomeranian Bay and Słupsk Bank and heading to spring staging sites in north-eastern Baltic: Gulf of Riga and Estonian archipelago.

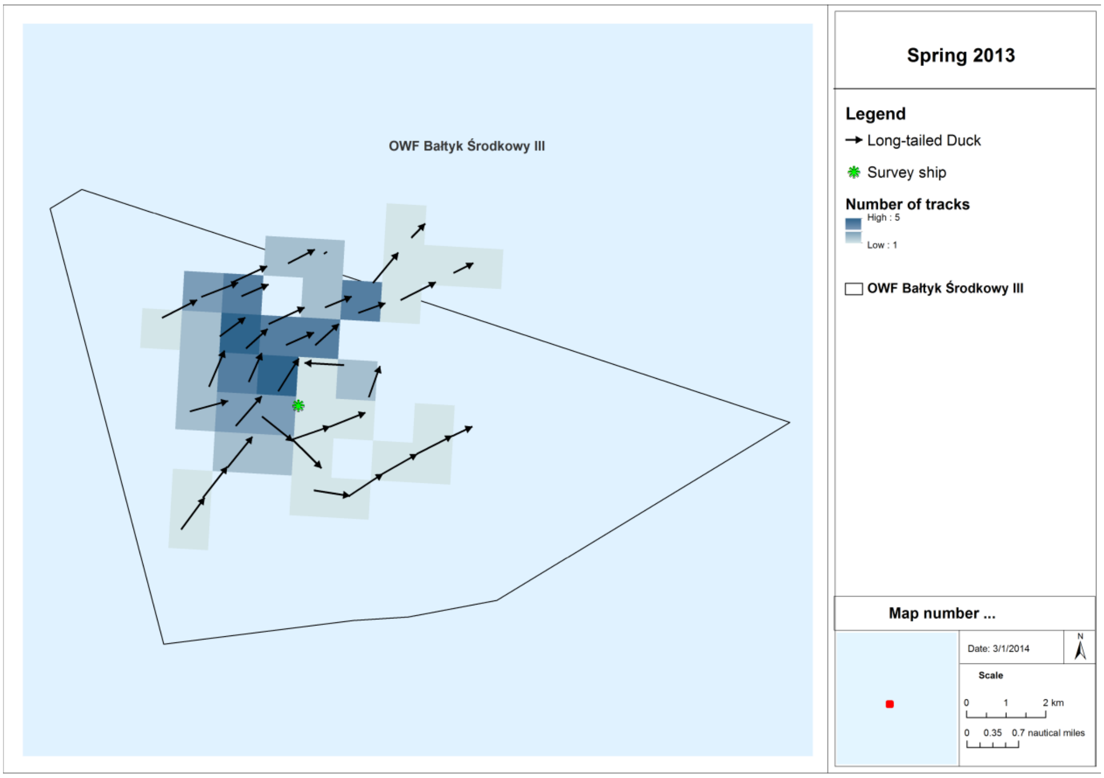


Figure 5.89 Mean flight directions of Long-tailed Ducks recorded using horizontal surveillance radar at BŚ III in spring 2013 with a backdrop showing the number of tracks recorded. The grid resolution is 1 km.

Most scoters, similarly to Long-tailed Ducks, maintained NE flying direction indicating migratory movements of these species (Figure 5.90, Figure 5.91). Responsive movements of Common Scoter avoiding the survey ship could be observed to a distance of at least 2 km (Figure 5.90), whereas no obvious avoidance reactions were observed for Velvet Scoter (Figure 5.91). Temporally, Common Scoters were tracked in all periods with the highest abundance in mid-May (Appendix B). NE direction of migrating scoters suggests that birds were likely flying from major wintering areas further east: Velvet Scoters from the Pomeranian Bay and Common Scoters could have originated not only from the Pomeranian Bay but also further east including Danish Belts, Kattegat and even North Sea. Migrating scoters were likely heading to spring staging sites in north-eastern Baltic: Gulf of Riga and Estonian archipelago where these birds typically stage until mid to late May.

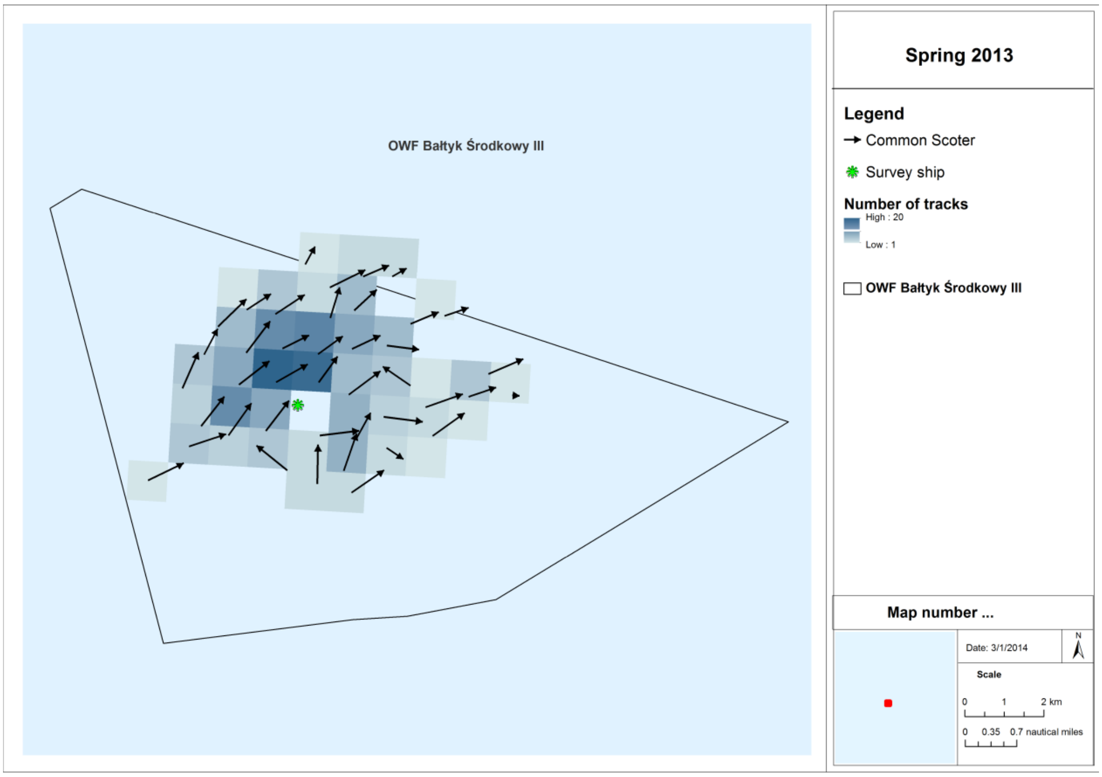


Figure 5.90 Mean flight directions of Common Scoters recorded using horizontal surveillance radar at BŚ III in spring 2013 with a backdrop showing the number of tracks recorded. The grid resolution is 1 km.

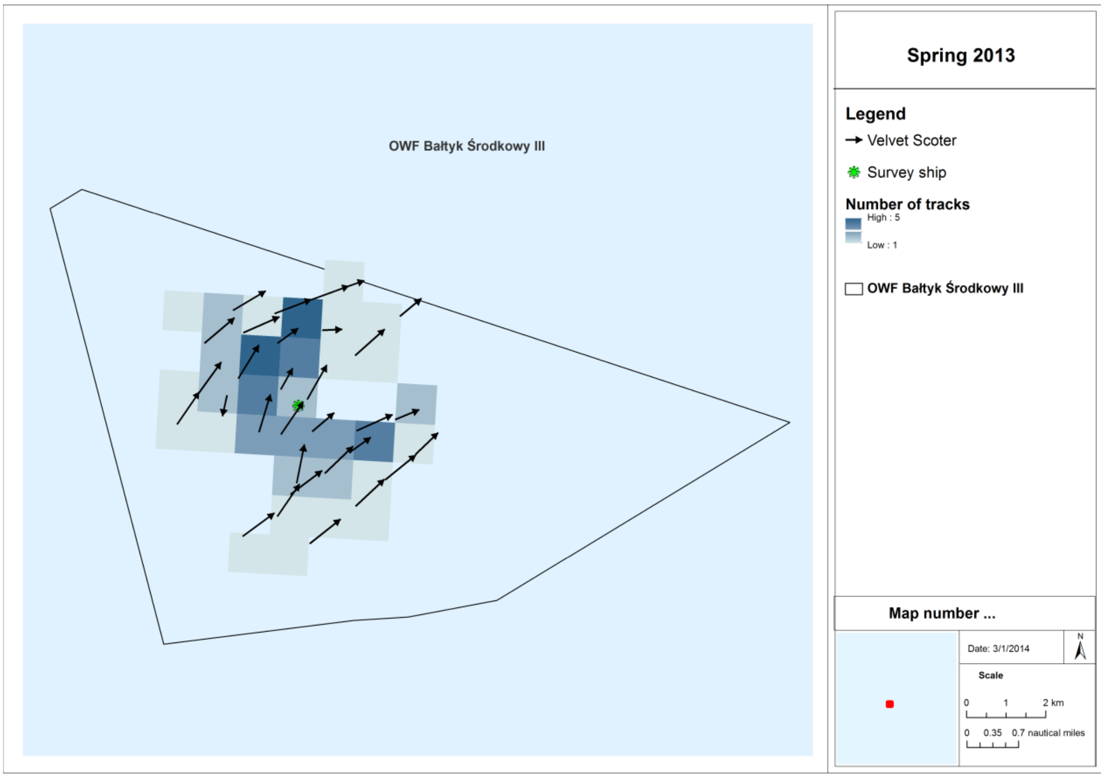


Figure 5.91 Mean flight directions of Velvet Scoters recorded using horizontal surveillance radar at BŚ III in spring 2013 with a backdrop showing the number of tracks recorded. The grid resolution is 1 km.

Unidentified ducks, which constituted 30% of all recorded tracks at BŚ III, also had predominantly a NE flight direction (Figure 5.92). Avoidance of the anchored observation ship can be seen to a distance of at least 1 km (Figure 5.92). Unidentified ducks were recorded in all periods, with the highest number of tracks in late April (Appendix B). Majority of unidentified ducks were most likely seaducks of species described above, but they were in many cases too far to be reliably identified.

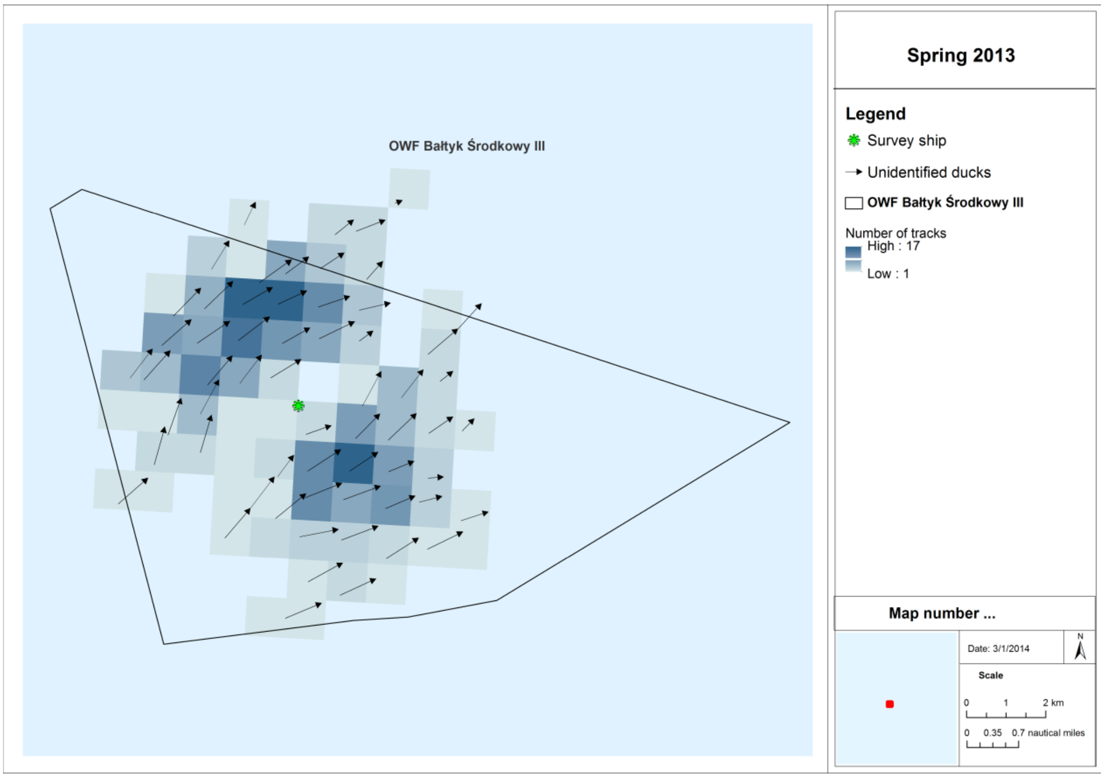


Figure 5.92 Mean flight directions of unidentified ducks recorded using horizontal surveillance radar at BŚ III in spring 2013 with a backdrop showing the number of tracks recorded. The grid resolution is 1 km.

Divers displayed a mean migration direction towards NE and E, and also showed evasive behaviour of up to 2 km towards the survey ship (Figure 5.93). Temporally, divers were recorded in all periods of observations (Appendix B). Origin of migrating divers is hard to predict as these birds winter dispersed along the entire coast of the Baltic Sea and the North Sea and similarly to seaducks, divers aggregate in the north-eastern Baltic in late spring before continuing to their breeding grounds in the Arctic.

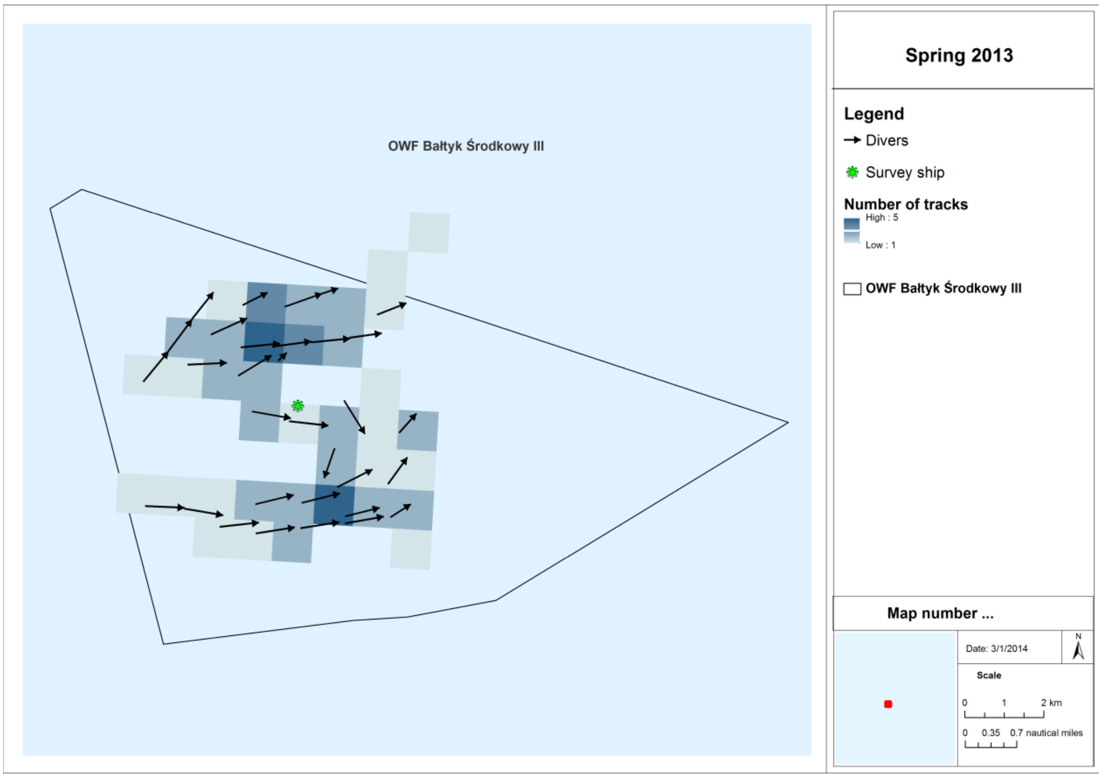


Figure 5.93 Mean flight directions of divers recorded using horizontal surveillance radar at BŚ III in spring 2013 with a backdrop showing the number of tracks recorded. The grid resolution is 1 km.

Recorded geese tracks indicate NE migration direction (Figure 5.94). Geese tracks were recorded in late April and mid-May (Appendix B). Only two tracks of Common Cranes have been logged, one of them was heading north and the other one east (see species characteristics in chapter 5.2). North direction of some geese and cranes may represent birds migrating to Sweden, whereas birds flying NE most likely cross Pomeranian Bay after departing from Rügen Island and eastern coast of Mecklenburg-Vorpommern and continue towards eastern Baltic coast and further.

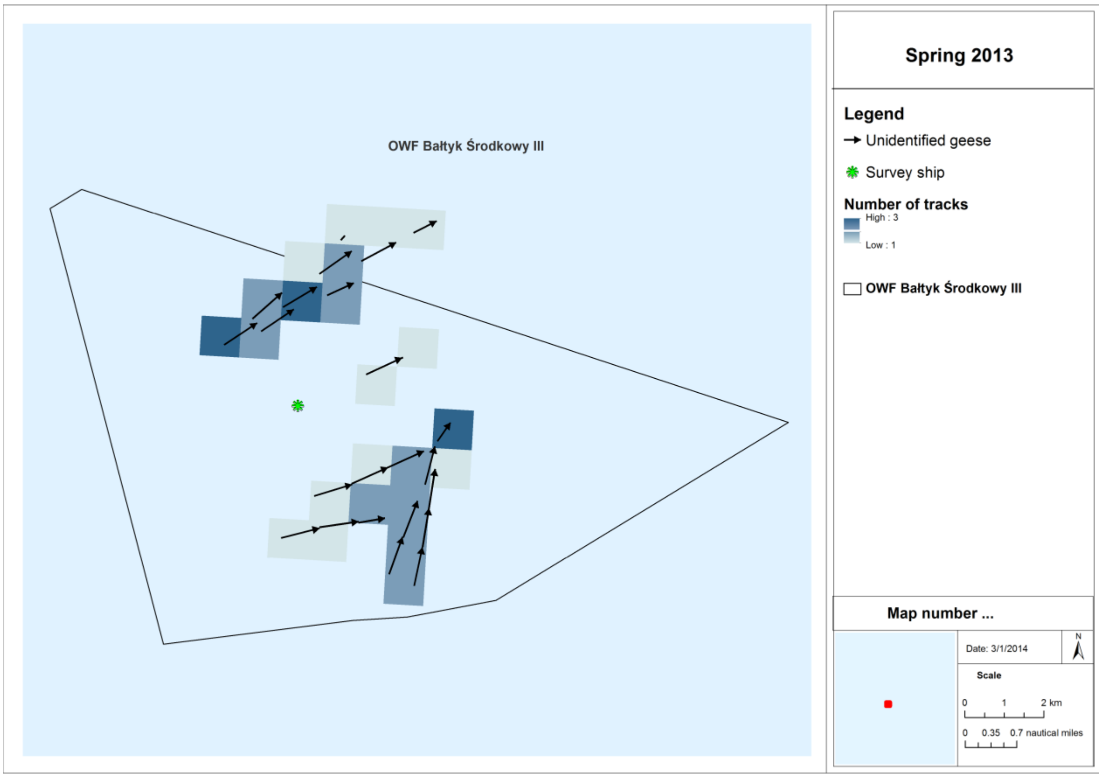


Figure 5.94 Mean flight directions of geese recorded using horizontal surveillance radar at BŚ III in spring 2013 with a backdrop showing the number of tracks recorded. The grid resolution is 1 km.

Little Gull was the most numerous identified tracked gull species, although only six tracks were recorded in spring. Most of the tracked gulls flew to the east (see species characteristics in chapter 5.2). Five out of six tracked Little Gulls were recorded on May 9. Little Gulls migrate from wintering areas along Atlantic coasts of Western Europe and Mediterranean Sea to breeding areas that are mostly located in NE Europe and Russia.

Recorded flying directions of Common Wood Pigeons were surprisingly opposite to predominant migration directions of other species as majority of logged pigeon flocks were heading SW (see species characteristics in chapter 5.2). This could represent reverse migration or birds that were lost at sea.

No raptor tracks were logged using horizontal radar in spring.

Daytime visual observations clearly support migration directions logged using horizontal radar and indicate the majority of spring migrants fly NE-E (Figure 5.95, also see species characterisations in chapter 5.2).

Migration direction of small passerine birds, which were underrepresented in horizontal radar dataset, showed that these birds also maintained E-NE migration directions, however with more easterly tendency (Figure 5.96). Considering recorded direction of some passerines, it is possible that they use Bornholm Island as a stepping stone on their migration over the Baltic and head for the shortest way to the land on the eastern direction.

Few Common Chaffinch were recorded flying NW in spring, which is the shortest way to the Scandinavian Peninsula for birds, which possible deported from the coast of Poland (Figure 5.96).

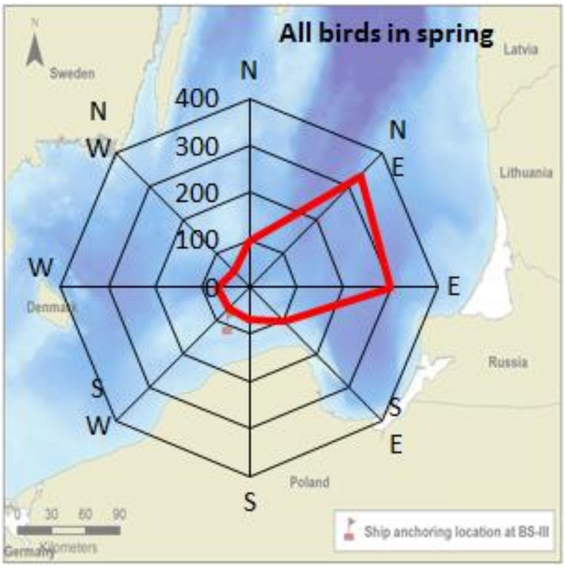


Figure 5.95 Flight directions of all birds recorded during visual daytime surveys at BŚ III in spring 2013.

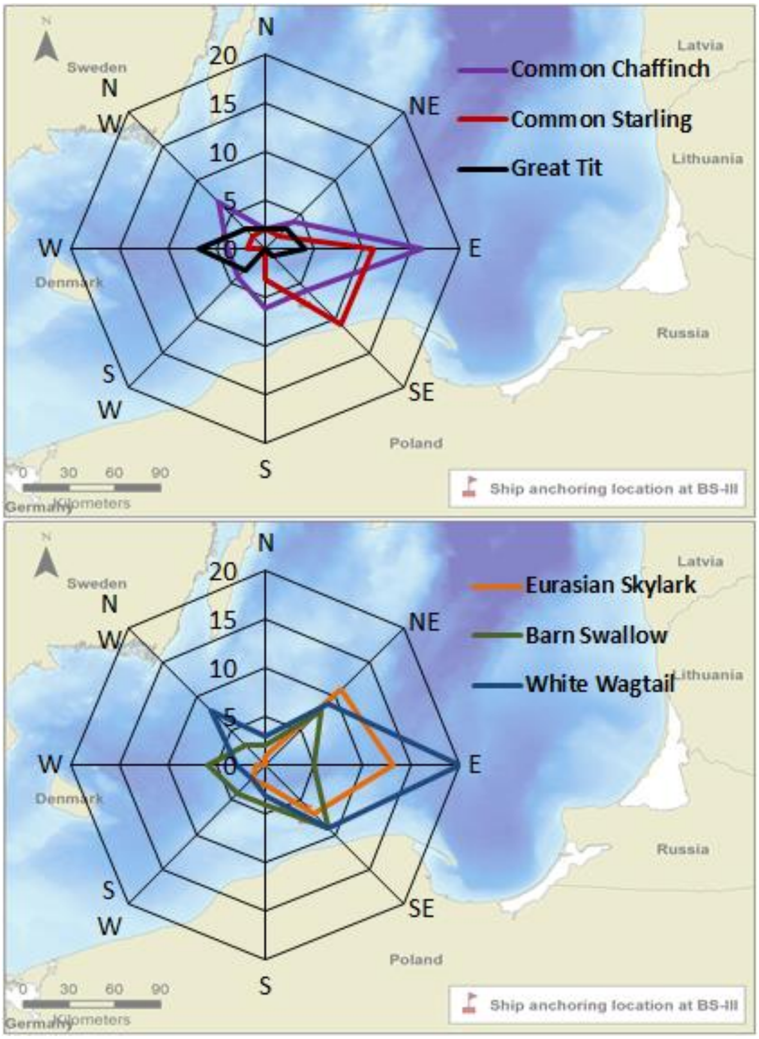


Figure 5.96 Flight directions of six most common passerine species recorded during visual daytime surveys at BŚ III in spring 2013.

Recorded flight directions during autumn migration

A total of 347 birds tracks representing at least 15 species were logged using horizontal radar at BŚ III in summer – autumn 2013 (Table 5.33).

The dominant recorded direction in autumn was SW for all bird species, which is exact opposite to the observations in spring (see species characteristics in chapter 5.2).

Numerous tracks of recorded geese had stable SW direction (Figure 5.97). The same was true for all tracked ducks and cranes (Figure 5.98, Figure 5.99, Figure 5.100), whereas swan tracks had a W direction (Figure 5.101). Such direction pattern clearly indicates that all these recorded birds were on their autumn migration. Like during spring migration, most waterbirds and Cranes displayed evasive flight patterns within 1-2 km distance from the survey ship.

In contrast, flight directions among gull and cormorant tracks varied to some extent, suggesting that movements included some residents in the area (Figure 5.102, Figure 5.103).

No raptor tracks were recorded using horizontal radar in the summer – autumn period.

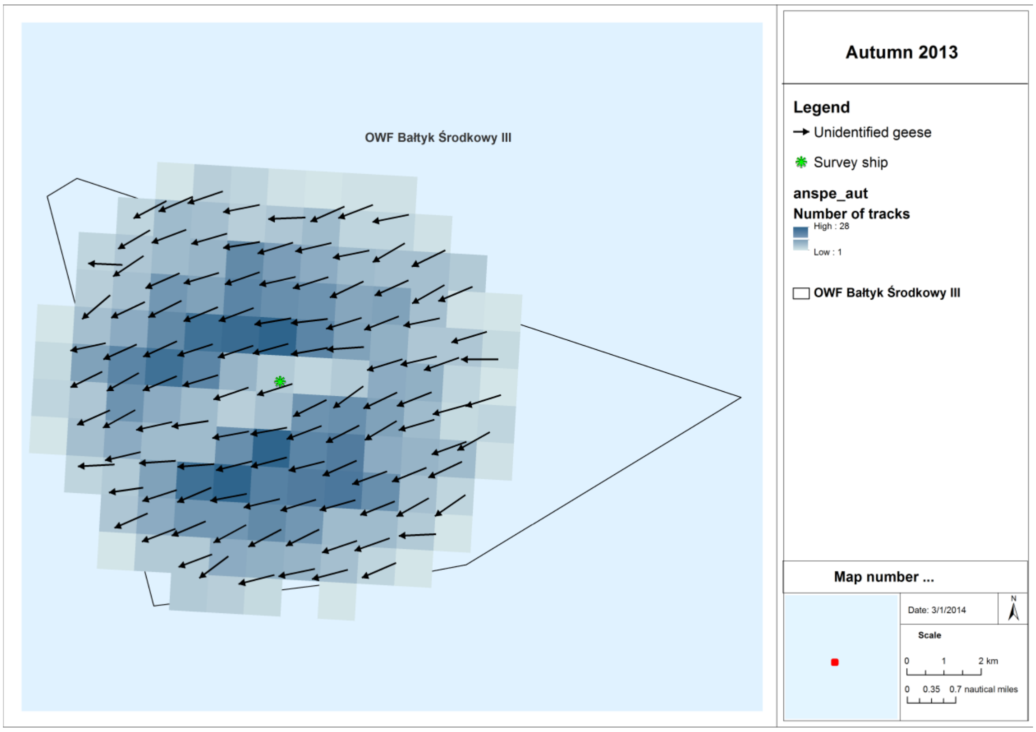


Figure 5.97 Mean flight directions of geese recorded using horizontal surveillance radar at BŚ III in autumn 2013 with a backdrop showing the number of tracks recorded. The grid resolution is 1 km.

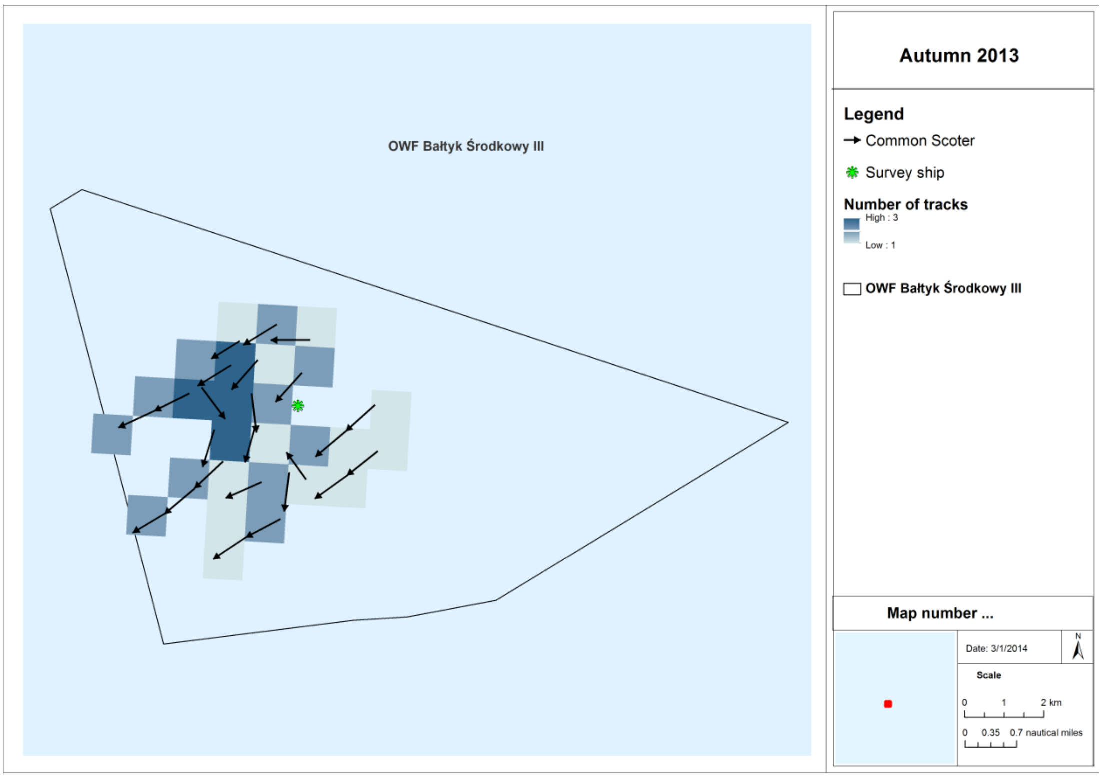


Figure 5.98 Mean flight directions of Common Scoter recorded using horizontal surveillance radar at BŚ III in autumn 2013 with a backdrop showing the number of tracks recorded. The grid resolution is 1 km.

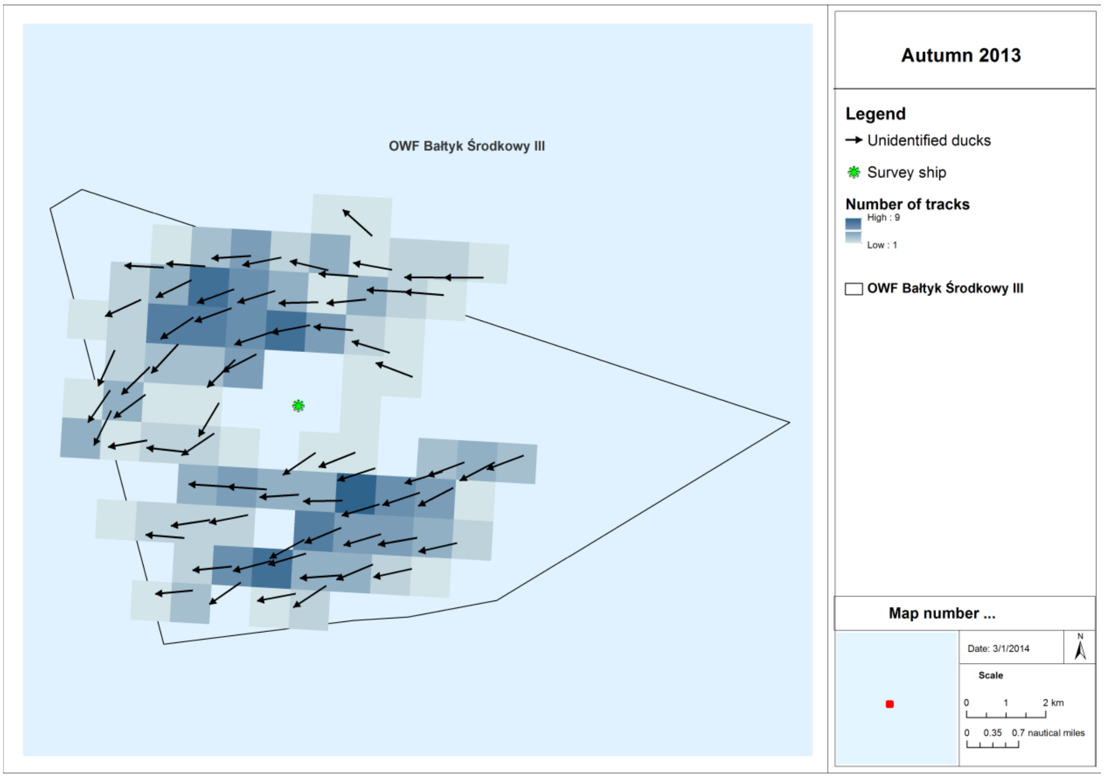


Figure 5.99 Mean flight directions of unidentified ducks recorded using horizontal surveillance radar at BŚ III in autumn 2013 with a backdrop showing the number of tracks recorded. The grid resolution is 1 km.

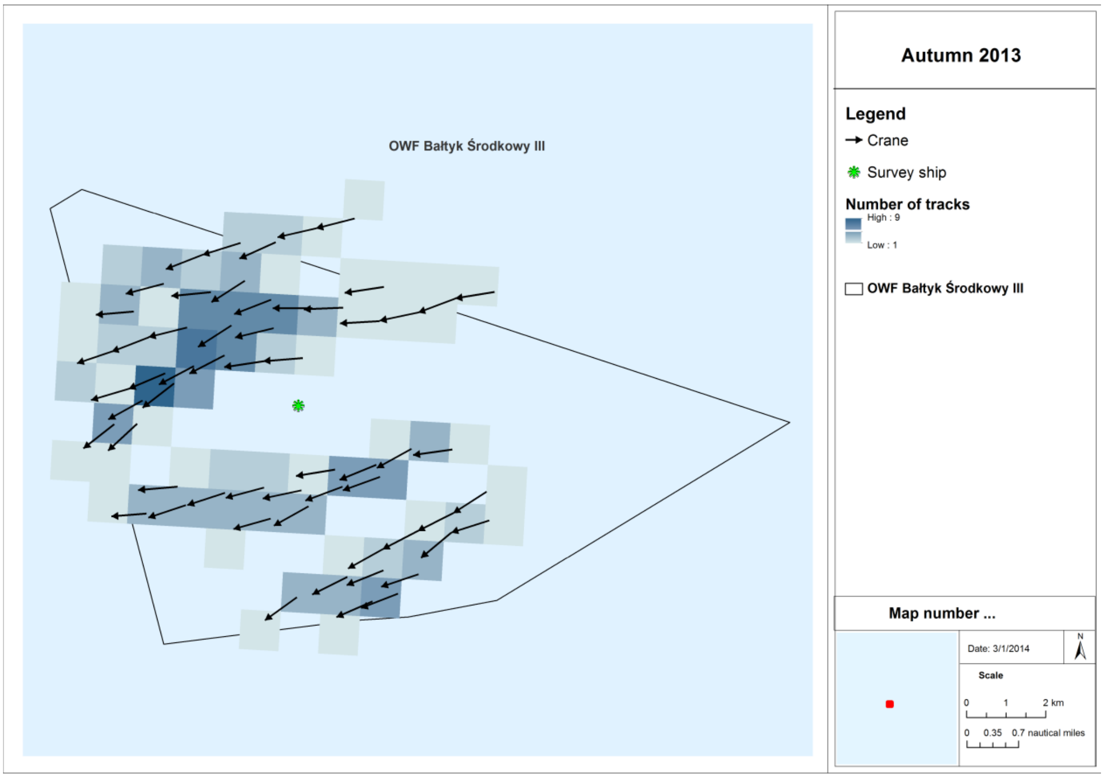


Figure 5.100 Mean flight directions of Cranes recorded using horizontal surveillance radar at BŚ III in autumn 2013 with a backdrop showing the number of tracks recorded. The grid resolution is 1 km.

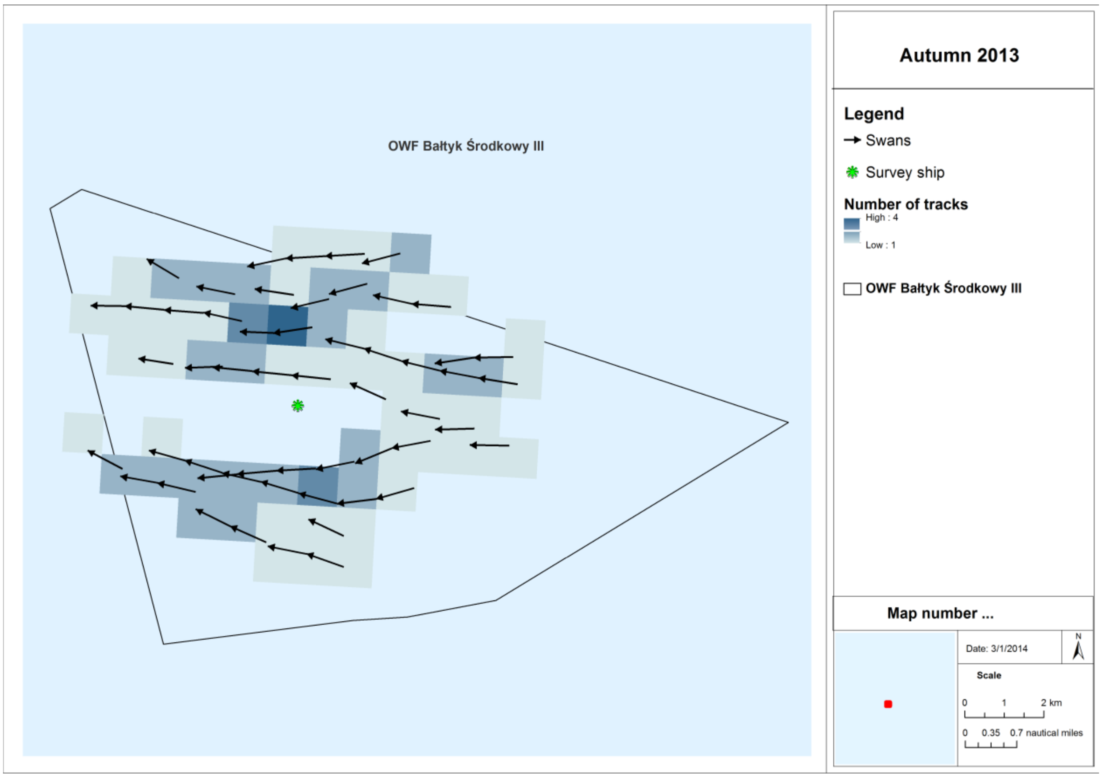


Figure 5.101 Mean flight directions of swans recorded using horizontal surveillance radar at BŚ III in autumn 2013 with a backdrop showing the number of tracks recorded. The grid resolution is 1 km.

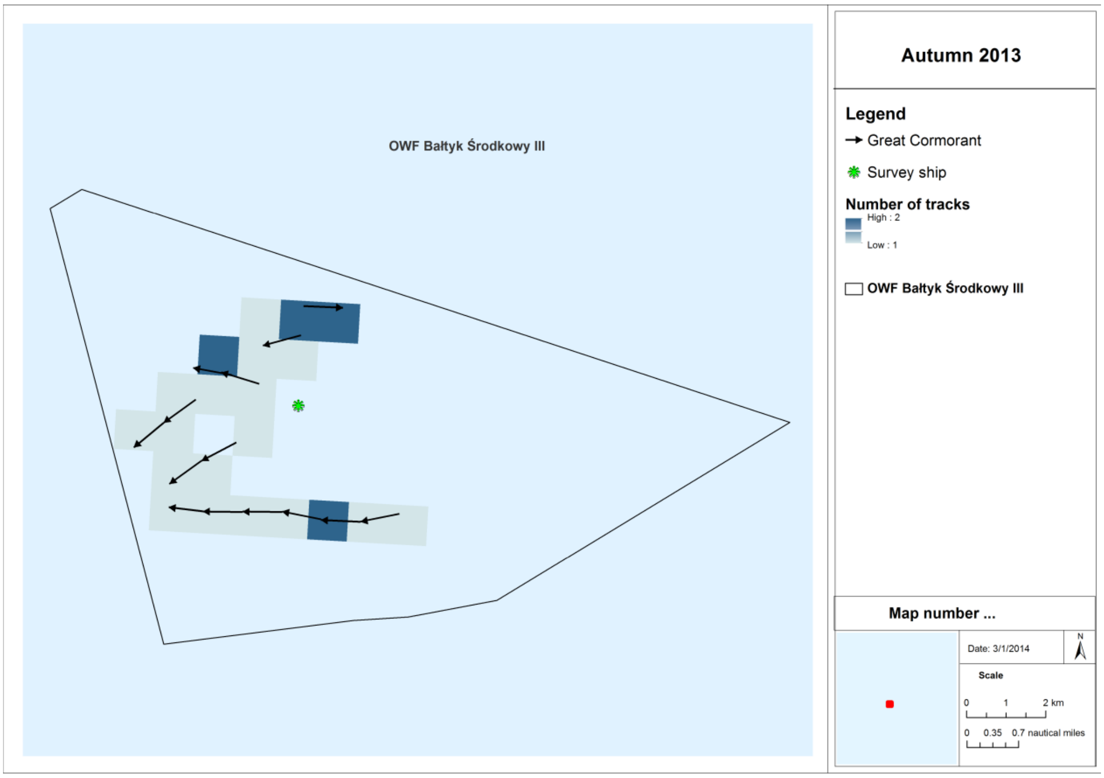


Figure 5.102 Mean flight directions of Great Cormorant recorded using horizontal surveillance radar at BŚ III in autumn 2013 with a backdrop showing the number of tracks recorded. The grid resolution is 1 km.

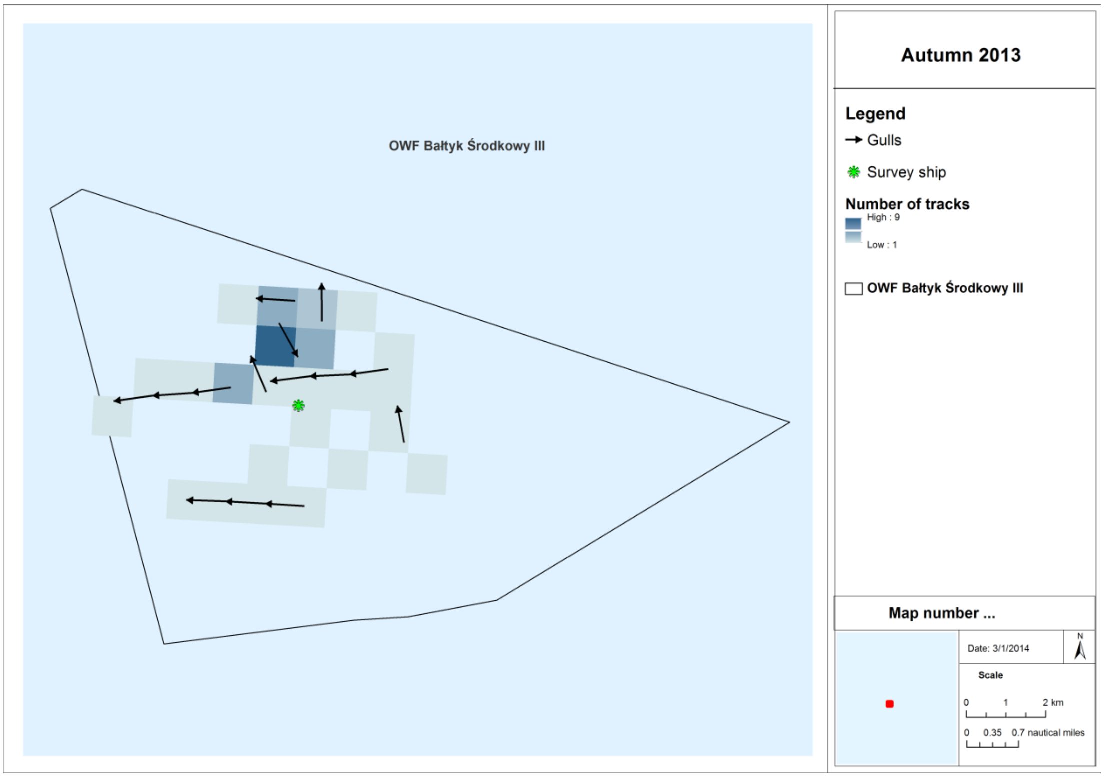


Figure 5.103 Mean flight directions of gulls recorded using horizontal surveillance radar at BŚ III in autumn 2013 with a backdrop showing the number of tracks recorded. The grid resolution is 1 km.

Visually recorded flight directions of passing birds clearly indicated that the majority of them were migrants heading W, SW and S (Figure 5.104). The same was generally true for most of the species/species groups when considering them separately (see species characterisations in chapter 5.2). Only few species such as auks and cormorants showed a more dispersed pattern, which could be interpreted as recordings of both, migrating and locally staging birds (Figure 5.105).

Migration direction of small passerine birds, which were underrepresented in horizontal radar dataset, showed that these birds also maintained consistent SW migration direction (Figure 5.106).

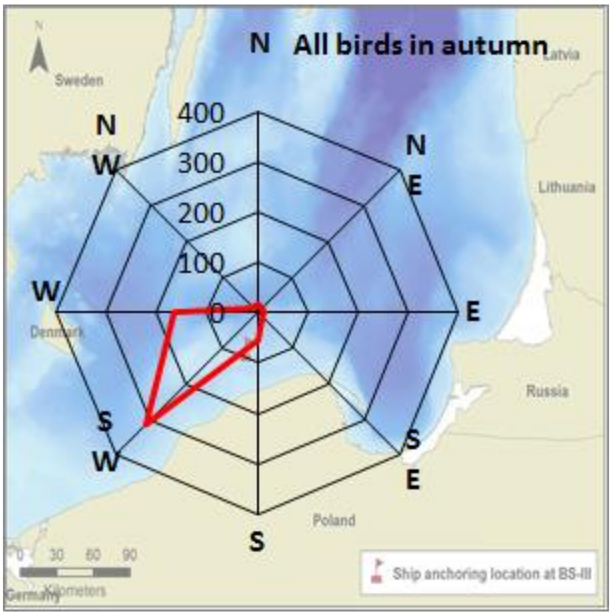


Figure 5.104 Visually recorded flight directions of all bird species together at BŚ III during daylight hours in July – November 2013.

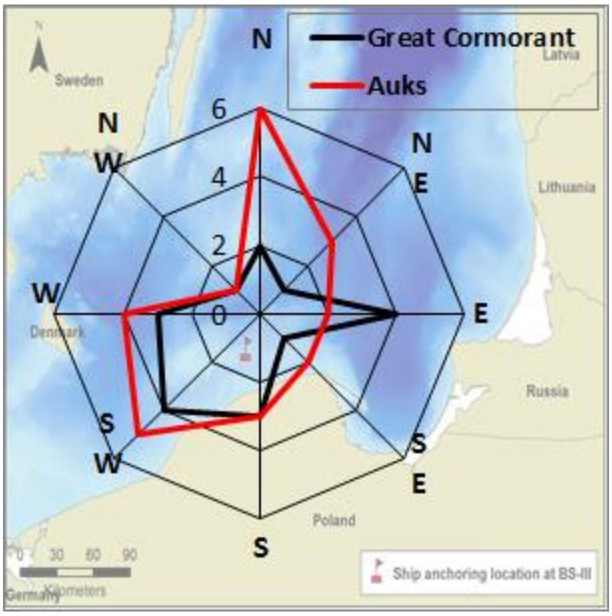


Figure 5.105 Visually recorded flight directions of all auk species and Great Cormorants at BŚ III area during daylight hours in July – November 2013.

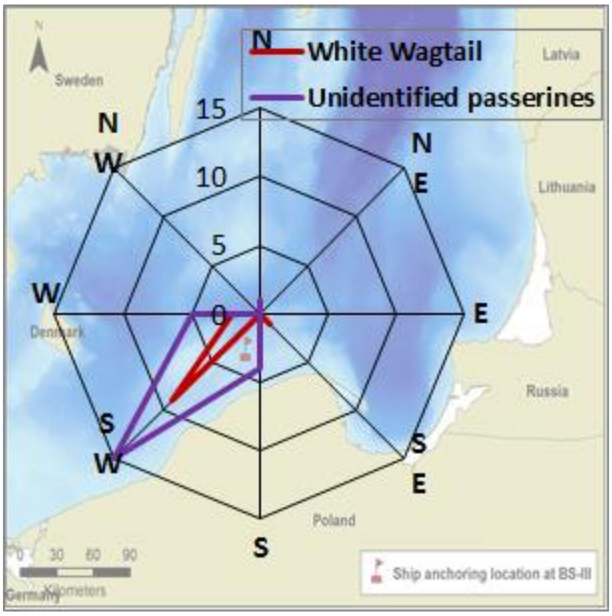


Figure 5.106 Visually recorded flight directions White Wagtails and unidentified passerine birds at BŚ III area during daylight hours in July – November 2013.

In summary, recording flight directions helped determining whether observers recorded resident or migrating birds and allowed identification of main migration directions. Flight direction indicated that resident birds were not numerous and consisted some of Long-tailed Ducks in early spring, auks, cormorants and possibly divers. The majority of migrating birds indicated clear migratory trajectories, which were primarily directed E-NE in spring and SW in autumn.

By extending the flight trajectories, we could speculate that the majority of migrating birds pass the BŚ III area as part of their route over the Pomeranian Bay and bypassing the Gulf of Gdansk, which represents a substantial shortcut compared to if they would be following the coast line of the Baltic Sea (Figure 5.107). Some cranes had northerly direction in spring; therefore it is possible that they were on their way to Sweden after departing from the coast of Poland (Figure 5.107).

Flight directions suggest that autumn migrants likely arrive from the eastern coast of the Baltic Sea and head to wintering areas in southern and western Baltic (waterbirds) and south-western Europe and Africa (landbirds) (Figure 5.108).

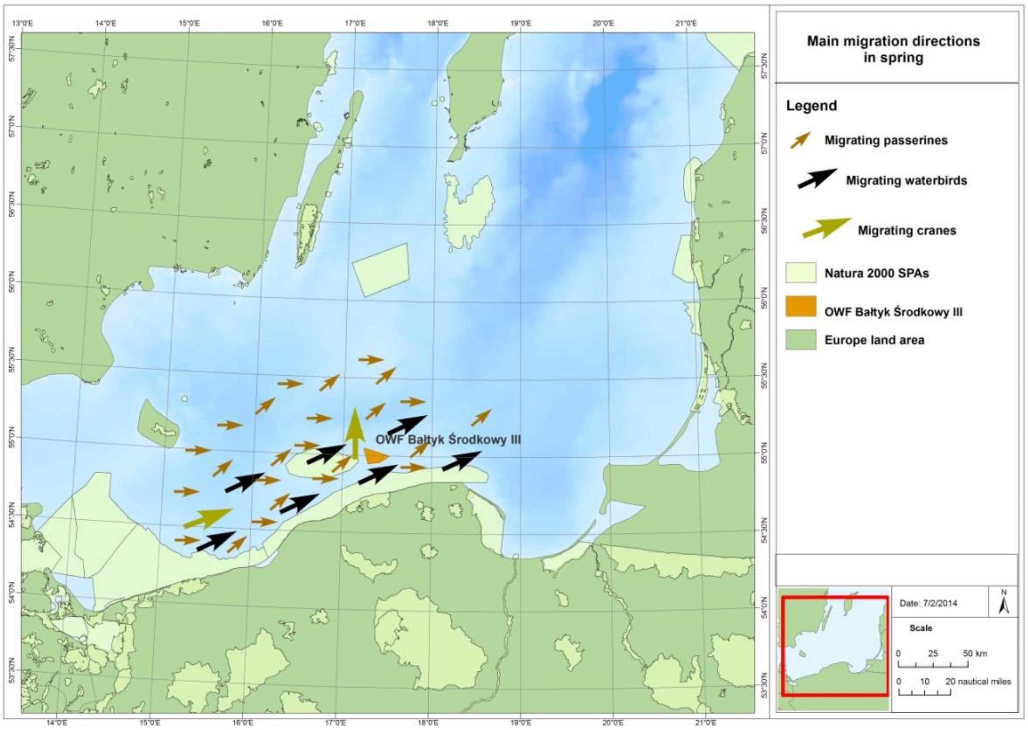


Figure 5.107 Likely migration routes of waterbirds, landbirds and cranes over BŚ III area in spring, based on recorded flight directions.

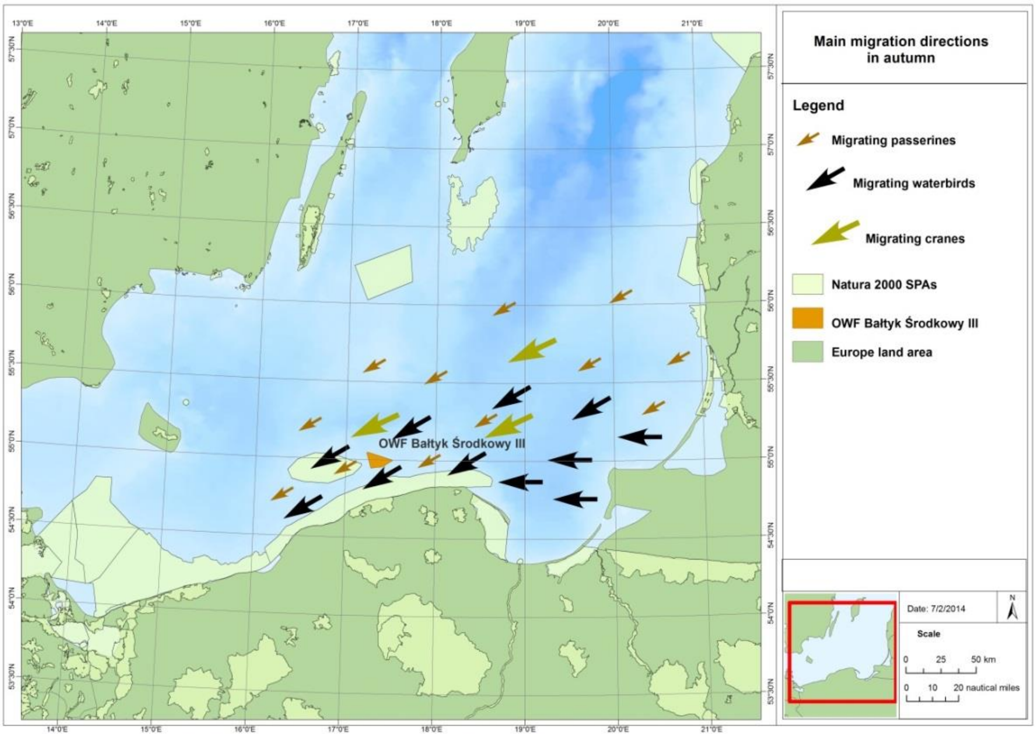


Figure 5.108 Likely migration routes of waterbirds, landbirds and cranes over BŚ III area in autumn, based on recorded flight directions.

5.6 Sensitivity of identified species to the impacts of offshore wind farms

Migrating birds can face several types of impacts (habitat displacement, collision risk, barrier effect, habitat change) from offshore wind farms and different species have varying sensitivities to these impacts depending on their biology and behaviour. There are several schemes, which used different approaches to assess sensitivity of bird species to wind farms with generic conclusions being similar (e.g. Garthe & Hüppop 2004, Langston 2010, Chylarecki et al. 2011, Furness et al. 2013). EU guidance on wind energy development (European Union, 2011) provides a comprehensive list of assessed bird species for all main potential impacts and this scoring system was adapted in our study, but modifying it where relevant (Table 5.38). The following generic modifications were assumed: (1) habitat displacement and habitat change were not considered for landbird species and waterbird species which do not use offshore marine habitats; (2) if sensitivity scoring for a particular species observed at BŚ III was not provided in the EU guidance document (European Union, 2011), we adapted sensitivity scoring from another biologically and ecologically similar species.

Table 5.38 Sensitivity of diver species to wind farms: XXX = Evidence on substantial risk of impact, XX = Evidence or indications of risk or impact, X = Potential risk or impact, x = small or non-significant risk or impact. (The table adapted from European Union 2011)

Species	Latin	Habitat displacement	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Waterbirds						
Red-throated Diver	*Gavia stellata*	XXX	X			
Black-throated Diver	*Gavia arctica*	X	X			
Great Crested Grebe	*Podiceps cristatus**	X	X			
Tundra Swan	*Cygnus columbianus*					
Whooper Swan	*Cygnus cygnus*		X			
Mute Swan	*Cygnus olor*					
Greater White-fronted Goose	*Anser albifrons*		X			
Greylag Goose	*Anser anser**		X			
Bean Goose	*Anser fabalis*					
Northern Pintail	*Anas acuta**			x		
Northern Shoveler	*Anas clypeata**			x		
Eurasian Teal	*Anas crecca**			x		
Eurasian Wigeon	*Anas penelope*			x		
Mallard	*Anas platyrhynchos**			x		
Gadwall	*Anas strepera**			x		
Common Goldeneye	*Bucephala clangula*		x	x		

Species	Latin	Habitat displace ment	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Long-tailed Duck	*Clangula hyemalis*	XX	X	X	X	
Velvet Scoter	*Melanitta fusca**	XX	X	X	X	
Common Scoter	*Melanitta nigra*	XX	X	X	X	
Common Eider	*Somateria mollissima*	X	x			
Goosander	*Mergus merganser**					
Red-breasted Merganser	*Mergus serrator*					x
Common Shelduck	*Tadorna tadorna**			x		
Eurasian Coot	*Fulica atra*					
Arctic Skua	*Stercorarius parasiticus*	X	X			
Common Gull	*Larus canus**		x	x		x
Little Gull	*Larus minutus*					x
Black-Headed Gull	*Larus ridibundus**					x
Common Tern	*Sterna hirundo*		XX	x		
Whiskered Tern	*Chlidonias hybrida*					
Common Guillemot	*Uria aalge*	XX	X		X	
Razorbill	*Alca torda*	XX	X		X	
Black Guillemot	*Cepphus grylle**	XX	X		X	
Great Cormorant	*Phalacrocorax carbo*	X	x	x		
Landbirds						
Long-tailed Bushtit	*Aegithalos caudatus**					
Eurasian Skylark	*Alauda arvensis*					
Meadow Pipit	*Anthus pratensis*					
Tree Pipit	*Anthus trivialis**					
Common Swift	*Apus apus*		x			
Lapland Bunting	*Calcarius lapponicus**		x	x		
Common Linnet	*Carduelis cannabina*					
European Goldfinch	*Carduelis carduelis*					
European Greenfinch	*Carduelis chloris*					

Species	Latin	Habitat displace ment	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Twite	*Carduelis flavirostris*					
Eurasian Siskin	*Carduelis spinus*					
Common House Martin	*Delichon urbica**					
Yellowhammer	*Emberiza citrinella**					
Common Reed Bunting	*Emberiza schoeniclus**					
European Robin	*Erithacus rubecula**		X			
Eurasian Pied Flycatcher	*Ficedula hypoleuca**					
Red-breasted Flycatcher	*Ficedula parva**					
Common Chaffinch	*Fringilla coelebs**					
Brambling	*Fringilla montifringilla**					
Barn Swallow	*Hirundo rustica**					
Common Grasshopper Warbler	*Locustella naevia**					
Wood Lark	*Lullula arborea**		X			
White Wagtail	*Motacilla alba**					
Yellow Wagtail	*Motacilla flava**					
Northern Wheatear	*Oenanthe oenanthe*					
Blue Tit	*Parus caeruleus**					
Great Tit	*Parus major**					
Eurasian Tree Sparrow	*Passer montanus**					
Black Redstart	*Phoenicurus ochruros***		x	x		
Common Redstart	*Phoenicurus phoenicurus***		x	x		
Common Chiffchaff	*Phylloscopus collybita***		x	x		
Wood Warbler	*Phylloscopus sibilatrix***		x	x		
Dunnock	*Prunella modularis***		x	x		
Firecrest	*Regulus ignicapilla**					
Goldcrest	*Regulus regulus**					
Sand Martin	*Riparia riparia**					

Species	Latin	Habitat displace ment	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Common Starling	*Sturnus vulgaris*			x		
Eurasian Blackcap	*Sylvia atricapilla***		x			
Lesser Whitethroat	*Sylvia curruca***		x			
Eurasian Wren	*Troglodytes troglodytes***		x			
Redwing	*Turdus iliacus**		x			
Common Blackbird	*Turdus merula**		x			
Song Thrush	*Turdus philomelos**		x			
Fieldfare	*Turdus pilaris**		x			
Common Pigeon	*Columba livia**		x	x		
Stock Dove	*Columba oenas**		x	x		
Common Wood Pigeon	*Columba palumbus**		x	x		
Carrion Crow	*Corvus corone**					
Rook	*Corvus frugilegus**					
Grey Heron	*Ardea cinerea**			x		
Common Crane	*Grus grus*		X	x		
Common Sandpiper	*Actitis hypoleucos**		x	x		
Red Knot	*Calidris canutus**		x	x		
Little Ringed Plover	*Charadrius dubius**		x	x		
Common Snipe	*Gallinago gallinago*		X			
Eurasian Oystercatcher	*Haematopus ostralegus**		x			
Eurasian Curlew	*Numenius arquata*			X		
Whimbrel	*Numenius phaeopus**			X		
Ruff	*Philomachus pugnax**		X	X		
European Golden Plover	*Pluvialis apricaria*		X	X		
Eurasian Woodcock	*Scolopax rusticola**		X			
Spotted Redshank	*Tringa erythropus**		x			
Common Redshank	*Tringa totanus**		x			
Northern Lapwing	*Vanellus vanellus*		X	x		

Species	Latin	Habitat displace ment	Bird strike / collision	Barrier effect	Change in habitat structure	Potential positive impact
Short-eared Owl	*Asio flammeus**		x			
Long-eared Owl	*Asio otus*		x			
Eurasian Sparrowhawk	*Accipiter nisus*		x	x		
Common Buzzard	*Buteo buteo*		XX	x		
Western Marsh Harrier	*Circus aeruginosus*		x	x		
Eurasian Hobby	*Falco subbuteo*			x		
Common Kestrel	*Falco tinnunculus*		XX	X		
Osprey	*Pandion haliaetus**		X	X		

* the species was not listed in the original table by the European Union (2011), therefore sensitivity scoring was adapted from ecologically similar species

5.7 Conservation status of the identified species

Out of at least 109 bird species registered during the migratory bird monitoring at BŚ III in 2013, 49 species are listed in at least one of the following lists indicating unfavourable species conservation status (Table 5.34). Three species are considered as globally threatened according to IUCN: Long-tailed Duck is vulnerable (VU), Velvet Scoter is endangered (EN) and Eurasian Curlew is near threatened (NT, IUCN 2013). 14 species are listed in the Annex I of the EU Birds Directive. Following BirdLife International's SPEC criteria, 11 species have SPEC 2, 22 species have SPEC 3, and 2 species have SPEC 3w categories (BirdLife International 2004). Finally, 25 of the encountered bird species are listed in the Annex 1 of the Regulation of the Minister of the Environment (Journal of Laws 2011) naming species that are subject to strict protection and require active conservation in Poland (Table 5.34).

5.8 Comparison of the results with other relevant investigations

Spring migration

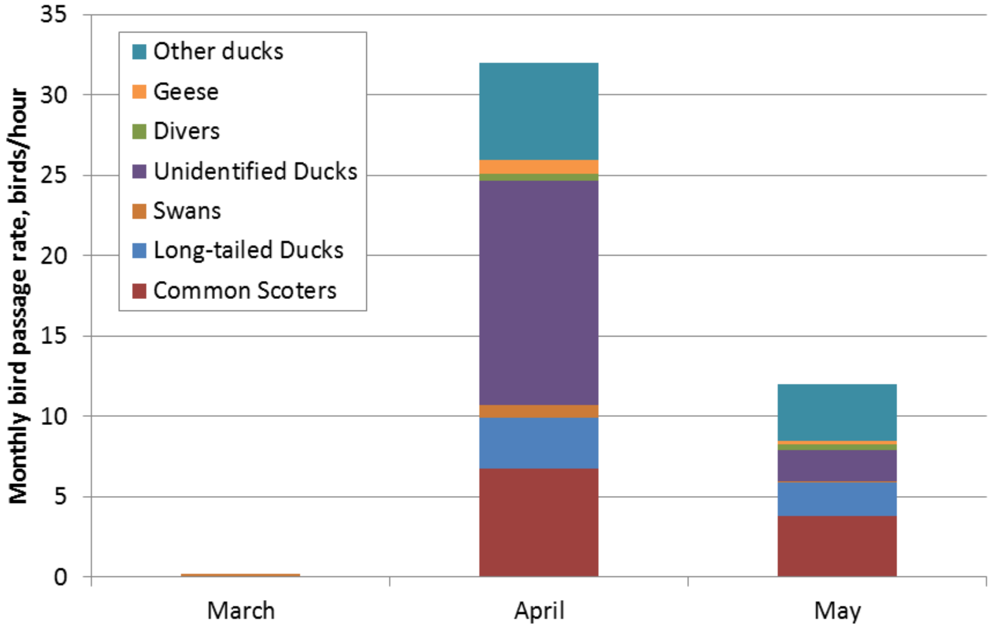
Considering monthly bird passage, the observed rates at BŚ III were lower compared to the passage rates observed at Krieger's Flak in different years. Less than 1 water-bird/hour was recorded at BŚ III in March, whereas at Krieger's Flak it was about 6 birds/hour in March 2003 and over 200 birds/hour in March 2004; in April about 32 waterbirds/hour were passing BŚ III compared to about 100 birds/hour at Krieger's Flak in April 2002 and 12 birds/hours in April 2003; in May about 12 waterbirds/hour were recorded at BŚ III compared to 17 birds/hour at Krieger's Flak in May 2002 and 18 in May 2003 (Table 5.39, IfAÖ 2004).

Visually recorded migration of landbirds at BŚ III ranged from 0.2 bird/hour in March to about 27 birds/hour in April and 1.3 in May (Figure 5.109). Landbird migration rates were lower at Krieger's Flak in 2002 and 2003 ranging from less than 1 to 6 birds/hour in different months (IfAÖ 2004). Common Cranes were observed migrating at BŚ III only in April, with an average passage rate of 0.4 birds/hour. In comparison, very low crane passage rates (0-0.3 birds/hour) were also observed at Krieger's Flak in springs 2002 and 2003, but 14 birds/hour were recorded in March 2004 (IfAÖ 2004).

Daily spring migration intensities of all bird species pooled together at BŚ III were several times lower compared to the offshore observation stations in the Fehmarn Belt (southern Baltic) where bird passage rates regularly reached 200 birds/hour and occasionally exceeded 400 birds/hour (FEBI 2013).

Table 5.39 Passage rates of migrating waterbirds and cranes recorded at BŚ III area during daylight hours in March – May 2013 and numbers reported for similar offshore area Krieger's Flak (IfAÖ 2004).

Species	BŚ III Max daily, birds/hour	BŚ III Avg monthly, birds/hour	Krieger's Flak, Avg monthly, birds/hour
Long-tailed Duck (*Clangula hyemalis*)	16	0 – 3.2	---
Common Scoter (*Melnitta nigra*)	29	0 – 6.8	1.5 – 3
Common Eider (*Somateria mollissima*)	---	---	0 – 198
Unidentified ducks	52	0 – 14	---
Geese (all species)	3.1	0 – 0.9	3 – 40
Common Crane (*Grus grus*)	1.4	0 – 0.4	0.1 – 14



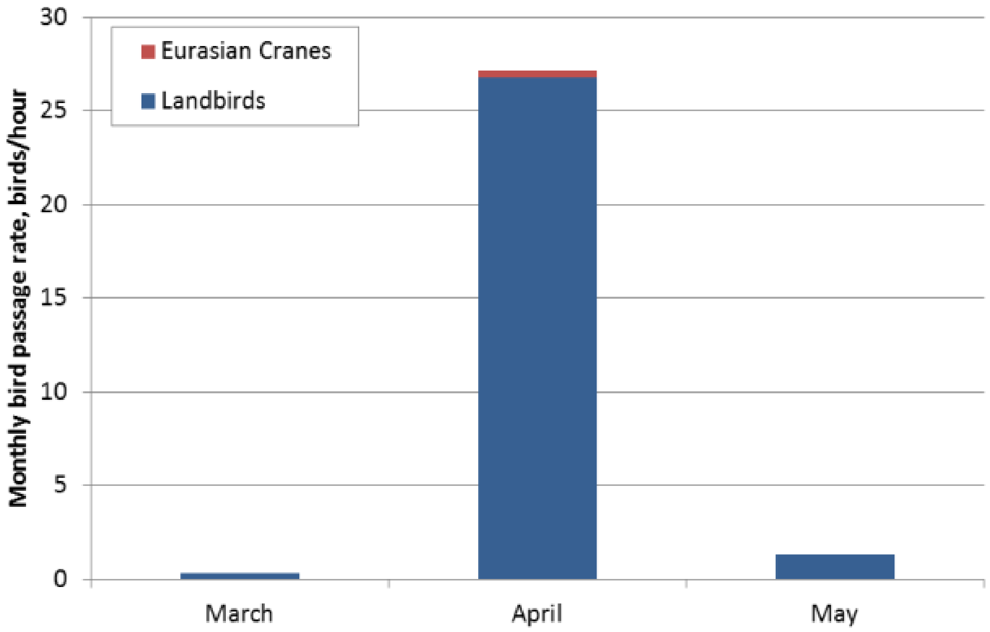


Figure 5.109 Monthly migration intensity expressed as bird passage rates per observation hour of waterbirds (upper chart), and all landbirds and cranes (lower chart) recorded at BŚ III area during daylight hours in March – May 2013.

Autumn migration

Considering monthly bird passage, the observed rates for ducks at BŚ III were mostly lower compared to the passage rates observed at Krieger's Flak in different years. From 1 to 30 ducks/hour were recorded at BŚ III in different months, whereas at Krieger's Flak it ranged from 2 to 40 ducks/hour in different months of autumn seasons 2002 and 2003 with a peak of 330 ducks/hour in October 2003 (IfAÖ 2004). The observed migration of geese and cranes at BŚ III, however was substantially higher than the autumn passage rates reported for Krieger's Flak: the highest monthly intensity of geese passage at Krieger's Flak was about 64 birds/hour compared to 139 bird/hour at BŚ III. Similarly, the highest monthly autumn passage rate of cranes was 4.2 birds/hour at Krieger's Flak compared to 33 birds/hour at BŚ III (Table 5.40).

Visually recorded migration of landbirds at BŚ III ranged from 0.23 birds/hour in August to about 9 birds/hour in October (Figure 5.110). Similar range of landbird migration rates was observed at Krieger's Flak in 2002 and 2003 with a peak of 8 birds/hour in September 2002 (IfAÖ 2004).

Daily autumn migration intensities of all bird species pooled together at BŚ III were comparable to the offshore observation stations in the Fehmarn Belt primarily due to high numbers of geese and cranes recorded at BŚ III, however, there were no days with such high bird passage rates as in Fehmarn Belt that occasionally exceeded 1,000 birds/hour (FEBI 2013).

Table 5.40 Passage rates of migrating birds recorded at BŚ III area during daylight hours in July – November 2013 and figures reported for relevant offshore area Krieger's Flak (IfAÖ 2004).

Species	BŚ III Max daily, birds/hour	BŚ III Avg monthly, birds/hour	Krieger's Flak, Avg monthly, birds/hour
Long-tailed Duck (*Clangula hyemalis*)	6	0 – 2.9	---
Common Scoter (*Melanitta nigra*)	5	0.2 – 2.5	0 – 16
Common Eider (*Somateria mollissima*)	---	---	0 – 330
Unidentified ducks	73	0 – 26.4	----
Geese (all species)	433	0 – 139.2	0 – 64
Common Crane (*Grus grus*)	66	0 – 33.0	0 – 4.2

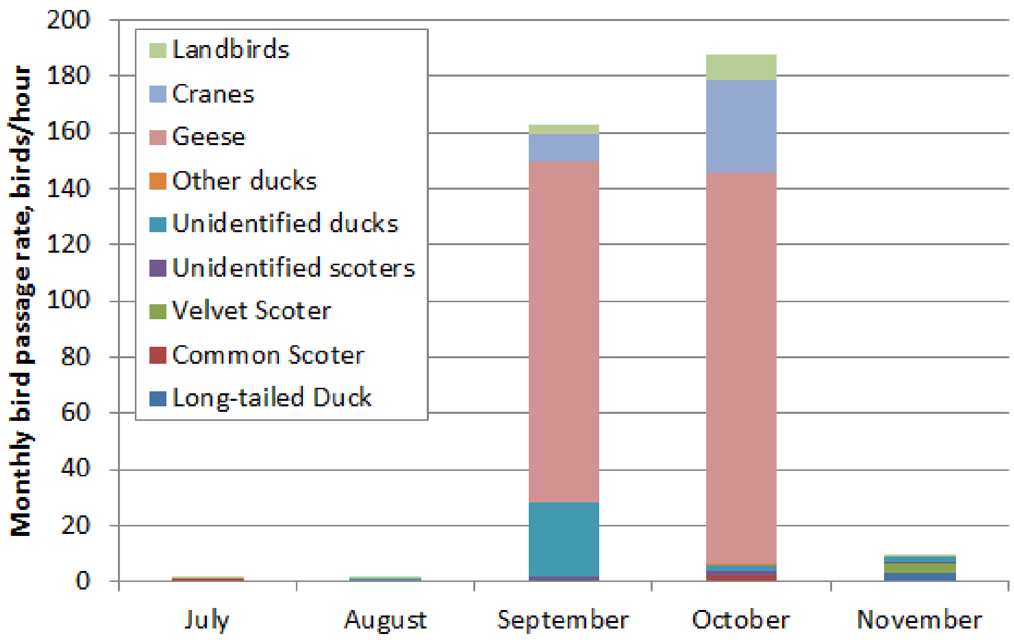


Figure 5.110 Monthly migration intensity expressed as bird passage rates per observation hour of ducks, geese, cranes and landbirds recorded at BŚ III area during daylight hours in July – November 2013.

Flight altitudes

Flight altitudes may differ between resident birds on their local flights and long distance migration: local flights are typically lower compared to higher altitude during migrations (Krijgsveld et al. 2005). Further, flight altitude of migrating birds depend on wind direction and birds usually fly higher in tail winds and lower in head winds (Krijgsveld et al. 2005, Skov et al. 2012, FEBI 2013, Skov et al. 2014). For a better overview of flight altitudes of migrating birds in Polish offshore waters and comparison with other studies we pooled observations collected during both spring and summer seasons (Table 5.41). This allowed increasing the sample size and more reliably calculating the percentage of birds flying higher than 20 m, the metric often used when reporting flight altitudes relative to the unknown wind turbine parameters.

Generally speaking, observations in Polish offshore waters showed bird flight altitudes being similar as recorded in other studies, the more notable exception being Great Cormorant, which was flying higher compared to other places (Table 5.41).

Table 5.41 Flight altitudes of the most abundant marine bird species (N>100 birds) recorded in Polish offshore waters during spring and autumn 2013 and comparison to the results of other relevant offshore studies. Data are summarised as % of birds flying above 20 m height, which is often considered as a boundary of the rotor-swept area when specific turbine parameters are unknown.

Species	% above 20 m in Polish offshore waters (number of birds)	% of birds flying above 20 m reported in literature
Eurasian Wigeon (*Anas penelope*)	36% (N=830)	
Mallard (*Anas platyrhynchos*)	9% (N=182)	
Greater Scaup (*Aythya marila*)	0% (N=178)	3% (Furness et al. 2013)
Long-tailed Duck (*Clangula hyemalis*)	13% (N=4.211)	0% (Day et al. 2003, Paton et al. 2010) 3% (Furness et al. 2013)
Common Scoter (*Melanitta nigra*)	7% (N=4,785)	0.1% (Johnston et al. 2014) 1% (Cook et al. 2012) 3% (Furness et al. 2013) 6.1% (Skov et al. 2012b) 24% (Garthe et al. 2012) 1% above 22.5 m (SmartWind 2013)
Velvet Scoter (*Melanitta fusca*)	7% (N=1,006)	0% (Paton et al. 2010, Cook et al. 2012) 3% (Furness et al. 2013)
Great White-fronted Goose (*Anser albifronts*)	43% (N=1,083)	
Whooper Swan (*Cygnus cygnus*)	35% (N=154)	
Little Gull (*Larus minutus*)	11% (N=251)	4.8% (Johnston et al. 2014) 18% (Garthe et al. 2012) 1.1% above 22.5 m (SmartWind 2013)

Species	% above 20 m in Polish offshore waters (number of birds)	% of birds flying above 20 m reported in literature
Black-headed Gull (*Larus ridibundus*)	12% (N=206)	2.9% (Johnston et al. 2014) 7.9% (Cook et al. 2012) 18% (Furness et al. 2013) 25-30% (Krijgsveld et al. 2005, 2011) 0.3% above 22.5 m (SmartWind 2013)
Great Cormorant (*Phalacrocorax carbo*)	42% (N=540)	0.1% (Johnston et al. 2014) 4% (Furness et al. 2013) 7.5% (Leopold et al. 2004) 28% (Krijgsveld et al. 2011)
Razorbill (*Alca torda*)	0% (N=426)	0% (Paton et al. 2010) 0.4% (Cook et al. 2012) 0.8% (Johnston et al. 2014) 1% (Furness et al. 2013) 0% above 22.5 m (SmartWind 2013)
Common Crane (*Grus grus*)	96% (N=1,640)	100% (Pettersson 2005)
Golden Plover (*Pluvialis apricaria*)	94% (N=670)	0% above 22.5 m (SmartWind 2013)
Eurasian Skylark (*Alauda arvensis*)	17% (N=249)	0% above 22.5 m (SmartWind 2013)
Meadow Pipit (*Anthus pratensis*)	2% (N=158)	4.2% above 22.5 m (SmartWind 2013)
Eurasian Siskin (*Carduelis spinus*)	3% (N=118)	
Common Chaffinch (*Fringilla coelebs*)	0% (N=1,155)	
Barn Swallow (*Hirundo rustica*)	1% (N=172)	
White Wagtail (*Motacilla alba*)	2% (N=457)	
Great Tit (*Parus major*)	32% (N=653)	
Common Starling (*Sturnus vulgaris*)	5% (N=957)	~25% (Krijgsveld et al. 2005) 3.6% above 22.5 m (SmartWind 2013)
Common Wood Pigeon (*Columba palumbus*)	25% (N=800)	

6 Summary of results and conclusions

Investigations of migratory bird monitoring at BŚ III area in spring and summer-autumn 2013 allowed to characterise seasonal migrations of birds over the study area.

Species composition and abundance

High diversity of passing bird species has been recorded and included 97 identified species (32 waterbirds and 65 landbirds) during spring and 56 identified species (25 waterbirds and 31 landbirds) during autumn migration. Species composition included nearly all marine bird species living in the Baltic Sea and all major taxonomic groups of land birds. Rather high diversity of registered species is not surprising as from over 300 species regularly living in the region, the majority are migrants. It should be noted that both with respect to the landbird and waterbird migration the species composition at BŚ III should be expected to be comparable to all other sites located in the same coastal zone along the Baltic mainland coast.

Out of at least 109 bird species registered during the migratory bird monitoring, 49 species are listed in at least one of the following lists indicating unfavourable species conservation status: IUCN Red List, Annex I of EU Bird Directive, SPEC category of Species of European Conservation Concern, and Annex I of the Regulation of the Minister of the Environment of Poland (Journal of Laws 2011).

In terms of frequency and estimated abundance, seaducks dominate diurnally migrating bird composition at BŚ III, especially Long-tailed Duck, Common Scoter and Velvet Scoter. These species are numerous on wintering sites located further south and west from the BŚ III and therefore they pass the BŚ III area on their seasonal migrations. Considering flyway populations, the highest percentage of 3.7% was estimated for the Golden Plover and 3.4% for the Common Scoter passing the BŚ III area during the daylight hours. The total percentage of Common Scoters is likely higher, possibly up to 10% as this species also migrates at night. Migrating seaducks are not funnelled over the BŚ III but migrate in a broad front over the sea. Geese species were the most abundant migrants in autumn, with the total estimated exceeding 100,000 birds crossing the BŚ III area. This constitutes about 4% of geese populations considered together. The majority of geese breed in northern Siberia and migrate primarily to Western Europe for wintering, and some of these migrants pass the BŚ III area.

Other duck species, dabbling ducks and diving ducks, were not numerous and only occasional small flocks were recorded during spring and autumn migrations at BŚ III. For many of these ducks marine waters do not represent their prime habitat and therefore it could be expected that major part of their populations follow the coastline while migrating, a phenomenon frequently observed from the coast.

Two diver species, Red-throated Diver and Black-throated Diver were registered in rather low numbers and estimates suggest that up to several hundred birds pass the area per migration season, which constitute only a small percentage of the flyway population. Divers migrate both along the coasts and over open sea areas, in this way dispersing broadly

All three auk species that live in the Baltic Sea (Razorbilll, Black Guillemot and Common Guillemot) were recorded and Razorbill was the most abundant of them during the migration monitoring. Estimates based on the observation data indicated that over 6,000 Razorbills could be passing the BŚ III area, but this figure almost certainly overrepresented migrating birds and is influenced by the local movements of resident birds, which is supported by the recorded flight directions.

Gulls were not very numerous during the migration periods at BŚ III. However Little Gull, which due to unfavourable conservation status in Europe is listed in the Annex I of EU Birds Directive and other conservation status defining documents, was consistently observed during both spring and autumn migrations and estimates suggest that up to 1,500 birds of this species, or 2% of the flyway population) could be passing the BŚ III area during migrations. Little gulls breed mostly to the east and north from the Baltic Sea and migrate for wintering to coastal waters in Western Europe (BirdLife International 2004). Substantial proportion of the breeding population migrates over the Baltic Sea, possibly widely dispersed from coastal to offshore areas and some bird inevitable pass the BŚ III area.

Great Cormorants were regularly observed at BŚ III although not in high numbers. Estimates suggest that up to 1,000 birds could be passing the area per migration season. While some of the observed individuals could have been migrants, many of observed cormorants did not show clear movement patterns, which suggest that they were resident birds which ventured far out to the open sea.

Observation revealed rather high passage of Common Cranes in autumn. It is likely that this species was crossing the southern Baltic likely leaving the land somewhere between Latvia and Poland and heading towards Rügen Island in Germany, a well-known staging area supporting many thousands of cranes in spring and autumn. It is not known what proportion of migrating birds could be crossing southern Baltic Sea on their seasonal migrations.

Waders, except for the Golden Plover, were not abundant at BŚ III area during migration periods. But several large flocks of Golden Plovers were recorded in spring 2013. It seems that only waders migrating in broad front over the sea cross BŚ III area and high numbers of these migrants are unlikely as they fly dispersed over much larger region.

Only few raptors were recorded at BŚ III: 8 birds of different species in spring and 1 unidentified falcon in autumn. Being soaring birds which use raising thermal air currents for flight, raptors are unlikely to choose to cross large expanses of the open sea which lacks sufficient thermal currents. Therefore, only occasional individuals are expected to cross the BŚ III area and regular migration is not anticipated.

Although a lot of diurnally migrating passerines avoid flying over the open sea, some species were observed in relatively high numbers, though tiny proportions considering their very large populations. The most common species were: Common Chaffinch, Common Starling, Eurasian Skylark, White Wagtail, and Great Tit. The majority of passerines migrate at night and fly in a broad front at high altitudes.

Migration timing

Migrating birds all have species-specific timing of seasonal migration, which is adjusted to weather conditions. Generally migration periods correspond to the conducted observation and the busiest months are typically April and September-early October. Time wise bird migration is more concentrated in spring and spread out in autumn. “Migration windows” of some species are broad, but narrow of others. And even if “migration window” is broad, typically peak migration is concentrated during a few days when flying conditions are optimal (e.g. Nowakowski et al. 2005). Birds generally avoid flying in strong winds, especially headwinds, during precipitations and when visibility is poor.

Flight directions

Recording flight directions helped determining whether observers recorded resident or migrating birds and allowed identification of main migration directions. Flight direction indicated that resident birds were not numerous and consisted of some Long-tailed Ducks in early spring, auks, cormorants and possibly some divers. The majority of migrating birds indicated clear migratory trajectories, which were primarily directed E-NE in spring and SW in autumn.

By extending the flight trajectories, we could speculate that the majority of migrating birds pass the BŚ III area as part of their route over the Pomeranian Bay and bypassing the Gulf of Gdansk, which represents a substantial shortcut compared to if they would be following the coast line of the Baltic Sea. Some cranes and passerines had northerly direction in spring; therefore it is possible that these birds were on their way to Sweden after departing from the coast of Poland (Figure 5.107).

Flight directions suggest that autumn migrants likely arrive from the eastern coast of the Baltic Sea and head to wintering areas in southern and western Baltic (waterbirds) and south-western Europe and Africa (landbirds).

Flight altitudes

The majority of registered waterbirds flew low during the daytime, below the potential rotor altitude (>20 m). Of marine species, only divers and Great Cormorants had relatively high proportions of individuals (~30%) flying above 20 meters. Similarly, many of daytime migrating land birds flew low. However, a substantial proportions of migrating geese, cranes and waders were flying at rotor altitude or above (>200 m).

Specific altitudes of daytime migrating birds that were recorded in Polish offshore waters will be used in collision risk estimates for relevant species in the environmental impact assessment.

Greater majority of nocturnal migrants fly above 200 m with peak numbers at an altitude range between 400-600 m, which indicates substantially higher altitudes compared to diurnal migration. Other studies report similar findings, concluding that night time migration usually occurs at altitudes above typical height of offshore wind turbines (IfAÖ 2004; Krijgsveld et al. 2005, FEBI 2013).

Overall conclusion

In conclusion, the BŚ III area does not lie on the major migratory route through which birds are funnelling during seasonal migrations. The area, however, is crossed by birds of different species which migrate in a broad front over the sea.

Considering registered species abundance, conservation status and sensitivity to offshore wind farms, several migrating bird species have been assessed as most relevant for consideration in the environmental impact assessment of the BŚ III wind farm, namely: Long-tailed Duck, Velvet Scoter, Common Scoter, geese species, swan species, Common Crane, Little Gull, Golden Plover and Razorbill.

7 Gaps in the current knowledge

Bird migration in offshore areas of the Baltic Sea has not been studied until the recent decade when plans of constructing offshore wind farms emerged. Still few studies have been conducted thus far and some of them are confidential. Some of the information about bird migration at sea could be obtained from land-based radar studies of bird migration (e.g., research in southern Sweden by Lund University (Alerstam 1990), Estonia (Jacoby 1983, Kahlert et al. 2012) and Lithuania (Žalakevičius 1987).

In addition to technical limitations of studying bird migration in the offshore environment, it has to be admitted that existing knowledge about migration patterns and flight characteristics of many species is limited. Whereas 'time windows' of seasonal migrations of many species are well known, specific days when high migration peaks would occur are still hard to predict for many migrants.

Information about migration routes over the open sea and overland are also rather poorly known for the majority of the species. Therefore, it is often difficult, if not impossible, to know where migrants are coming from and heading to. This is especially true if we aim to identify specific areas (e.g., Natura 2000 sites) that passing by birds are using during the annual cycle. It is only recently when such information became possible to study by using modern telemetry techniques. Knowledge gaps about bird migration routes and annual cycles are begging to be filled, but at very slow rate. Considering, species diversity, high variability of bird behaviours and often very large populations, it is unlikely that in the nearest future it will be possible to characterise birds migrating through a specific site to very precise numbers and details about their origin and destination.

Nocturnal migration is another aspect of bird migration that is known in only general terms, and specific knowledge is very limited. Species identification and quantification are very difficult, often impossible at night. Even modern radar technologies do not allow identification of birds, small song birds that do not fly in flocks are often missed, also birds flying above or below the radar range cannot be detected, etc.

Knowledge about flight altitudes of migrating bird is also a topic that only recently started to receive attention. This trend has been mostly driven aiming to understand possible impacts of wind energy harvesting offshore. However a lot of existing knowledge relies on visual observations but not on measurements, therefore available data are often associated with observer perception bias and distance (height) detection. Reliable measurements can only be obtained using laser range finders (usable only from a stable platform), telemetry, and vertical radar coupled with visual identifications.

8 References

/1/ Alerstam, T (1975) Crane *Grus grus* migration over sea and land. Ibis 117: 489-495.

/2/ Alerstam, T (1975b) Redwing (*Turdus iliacus*) migration towards southeast over southern Sweden. Die Vogelwarte 28: 2-17.

/3/ Alerstam, T (1978) Analysis and a theory of visible bird migration. Oikos 30: 273-349.

/4/ Alerstam, T (1990) Bird migration. Cambridge University Press.

/5/ APEM Ltd (2012) East Anglia ONE Offshore Windfarm. Environmental Statement, Volume 2 Chapter 12 Ornithology, Marine and Coastal Appendices, 261 p.

/6/ Band, W., (2012). Using a collision risk model to assess bird collision risks for offshore windfarms, s.l.: The Crown Estate.

/7/ BirdLife International (2004). Birds in Europe: population estimates, trends and conservation status. BirdLife Conservation series No. 12. BirdLife International, Cambridge, UK.

/8/ BirdLife International (2014) Species factsheets. Downloaded from http://www.birdlife.org on 30/06/2014.

/9/ BSH (Bundesamt fur Seeschiffahrt und Hydrographie) (2007) Investigation of the impacts of offshore wind turbines on the marine environment (StUK 3). Standard. Hamburd and Rostock.

/10/ Buckland, ST, Anderson, DR, Burnham, KP, Laake, JL (1993) Distance sampling: estimating abundance of biological populations. Chapman & Hall. London.

/11/ Buckland, ST, Anderson, DR, Burnham, KP and Laake, JL, Borchers, DL, Thomas, L (2001) Introduction to distance sampling - Estimating abundance of biological populations. Oxford University Press, Oxford.

/12/ Burnham, KP, Anderson, DR (2002) Model Selection and Multimodel Inference: A Practical Information-Theoretic Approach, 2nd ed. Springer-Verlag. ISBN 0-387-95364-7.

/13/ Buse, P. (2013) Methodological procedure for pre-investment wind farm ornithological monitoring based on collision risk estimation. The Ring 35, 3-30.

/14/ Chylarecki, P, Kajzer, K, Polakowski, M, Wysocki, D, Tryjanowski, P, Wuczynski, A (2011) Wytyczne dotyczace oceny oddzialywania elektrowni wiatrowych na ptaki. Generalna Dyrekcja Ochrony Srodowiska, Warszawa.

/15/ Cook, ASCP, Johnston, A, Wright, LJ, Burton, NHK (2012) A Review of Flight Heights and Avoidance Rates of Birds in Relation to Offshore Wind Farms. Crown Estate Strategic Ornithological Support Services. Project SOSS-02. http://www.bto.org/science/wetland-and-marine/soss/projects.

/16/ Cramp, S (ed.) (1985) Handbook of the birds of Europe, the Middle East and North Africa. Vol. 4. Oxford University Press, Oxford.

/17/ Cramp S, Simmons KEL (1977) The Birds of the Western Palearctic. Vol. I. Oxford University Press, Oxford.

/18/ Cramp S, Simmons KEL (1983) The Birds of the Western Palearctic. Vol. III. Oxford University Press, Oxford.

/19/ Day, RH, Rose, JR, Ritchie, RJ, Shook, JE, Cooper, BA (2003) Collision potential of eiders and other birds near a proposed wind farm at St. Lawrence Island, October-November 2002. ABR, Inc. Environmental Research & Services, Fairbanks, Alaska, USA.

/20/ Desholm, M, Gill, R, Bøvith, T, Fox, AD (2014) Combining spatial modelling and radar to identify and protect avian migratory hot-spots. Current Zoology 60: *in press*.

/21/ Durinck J, Skov, H, Jensen FP, Pihl, S (1994) Important marine areas for wintering birds in the Baltic Sea. Ornis Consult, Copenhagen.

/22/ European Union (2011) EU Guidance on wind energy development in accordance with the EU nature legislation. Ecosystems LtD.

/23/ FEBI (2013). Fehmarnbelt Fixed Link EIA. Bird Investigations in Fehmarnbelt – Baseline. Volume III. Bird Migration. Report No. E3TR0011 commissioned by Femern A/S. 333 pages (available at: http://vvmdocumentation.femern.com/)

/24/ Forewind (2013) Dogger Bank Creyke Beck. Ornithology Addendum ± relating to the cumulative and in-combination assessment. F-OFC-HRA-007 Issue 3, 71 p.

/25/ Fox, AD (2003) Diet and habitat use of scoters *Melanitta* in the Western Palearctic – a brief overview. Wildfowl 54:163-182.

/26/ Fox, AD, Ebinge, BS, Mitchell, C, Heinicke, T, Aarvak, T, Colhound, K, Clausen P, Dereliev, S, Farago, S, Koffibjerg, K, Kruckenberg, H, Loonen, MJJE, Madsen, J, Mooij, J, Musil, P, Nilsson, L, Pihl, S, van der Jeugd, H (2010) Current estimates of goose population sizes in western Europe, A gap analysis and an assessment of trends. Ornis Svecica 20: 115-127.

/27/ Furness, RW, Wade, HM, Masden, EA (2013) Assessing vulnerability of marine bird population to offshore wind farms. Journal of Environmental Management 119: 56-66.

/28/ Garthe, S, Huppop, O (2004) Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. Journal of Applied Ecology 41: 724-734.

/29/ Garthe, S, Mendel, B, Kotzerka, J, Schwemmer, H, Sonntag, N (2012) Possible impacts of wind farms on seabirds: the case study Alpha Ventus. FTZ, University of Kiel. http://rave2012.iwes.fraunhofer.de/img/pdfs/Session2/2.6_Garthe.pdf

/30/ Griffin, L, Rees, E, Hughes, B (2011) Migration routes of Whooper Swans and geese in relation to wind farm footprints: Final report. WWT, Slimbridge. 87 pages.

/31/ Guse, N, Garthe, S, Schirmeister, B (2009) Diet of red-throated divers *Gavia stellata* reflects the seasonal availability of Atlantic herring *Clupea harengus* in the southwestern Baltic Sea. Journal of Sea Research 62: 268-275.

/32/ IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org

/33/ IfAÖ (2004) Projektansvarig: Sweden Offshore Wind AB Undersökningsperiod: April 2002 till mars 2004. Report commissioned by Sweden Offhshore Wind AB. Institut für Angewandte Ökologie GmbH, Germany.

/34/ Jacoby, VE (1983) Radar and visual observations of the spring passage of sea-ducks on the west coast of Estonia. – Communications of the Baltic Commission for the Study of Bird Migration 16: 24–39.

/35/ Johnson, A, Cook, ASCP, Wright, LJ, Humphreys, EM, Burton, NHK (2014) Modelling flight heights of marine birds to more accurately assess collision risk with offshore wind turbines. Journal of Applied Ecology 51: 31-41.

/36/ Journal of Laws (2011) The Regulation of the Minister of Environment concerning the species protection of 12 October 2011. No. 237, item. 1419 [Rozporządzenie Ministra Środowiska z dnia 12 października 2011 roku w sprawie ochrony gatunkowej zwierząt (Dziennik Ustaw 2011 nr 237 poz. 1419]

/37/ Kahlert, J, Leito, A, Laubek, B, Luigujoe, L, Kuresoo, A, Aaen, K, Luud, A (2012) Factors affecting the flight altitude of migrating waterbirds in Western Estonia. Ornis Fennica 89: 241-253.

/38/ Krijgsveld, KL, Lensink, R, Schekkerman, H, Wiersma, P, Poot, MJM, Meesters, EHWG, Dirksen, S (2005) Baseline studies North Sea wind farms: fluxes, flight paths and altitudes of flying birds 2003-2004, Bureau Waardenburg Report 05-041, The Netherlands.

/39/ Krijgsveld, KL, Fljn, RC, Japink, M, van Horssen, PW, Heunks, C, Collier, MP, Poot, MJM, Beuker, D, Birksen, S (2011) Effect studies offshore wind farm Egmond aan Zee. Bureau Waardenburg Report 10-219, The Netherlands.

/40/ Kuczyński, L, Chylarecki, P (2012) Atlas pospolitych ptaków lęgowych Polski. Rozmieszczenie, wybiórczość siedliskowa, trendy. Główny Inspektorat Ochrony Środowiska, Warszawa.

/41/ Langston, RHW (2010) Offshore wind farms and birds: Round 3 zones, extensions to Round 1 & Round 2 sites & Scottish Territorial Waters. RSPB, The Lodge, Sandy, UK.

/42/ Ławicki Ł, Staszewski A (2011) Gęsi. pages 66–79 *In* Sikora A, Chylarecki P, Meissner W, Neubauer G. (eds). Monitoring ptaków wodno-błotnych w okresie wędrówek. Poradnik metodyczny. GDOŚ, Warszawa.

/43/ Ławicki, Ł, Wylegala, P, Smyk, B (2013) Monitoring geese in Poland: the start of a new project. Goose Bulleting, 16: 4-5.

/44/ Leito, A, Ojaste, I, Sellis, U (2011) The migration routes of Eurasian Cranes breeding in Estonia. Hirundo 24: 41-53.

/45/ Leopold, MF, Camphuysen, CJ, van Lieshout, SMJ., ter Braak, CJF, Dijkman, EM (2004) Baseline studies North Sea wind farms: Lot 5 marine birds in and around the future site Nearshore Windfarm (NSW). Alterra-rapport 1047. Alterra, Wageningen, The Netherlands.

/46/ Loss, SR, Will, T, Marra, PP (2013) Estimates of bird collision mortality at wind facilities in the contiguous United States. Biological Conservation 168: 201-209.

/47/ Madsen, J, Cracknell, G, Fox, T, editors (1999) Goose populations of the Western Palearctic. Wetlands International Publication No. 48. National Environmental Research Institute, Denmark.

/48/ Meissner, W (2014) Ornithological monitoring of the area of the planned offshore wind farm „Bałtyk Środkowy III". Final report and the results of the monitoring. Conducted by: POMARINUS Andrzej Kośmicki. Commissioned by: Natural Power Association Sp. z o. o. Gdańsk.

/49/ MFW Bałtyk Środkowy III Sp. z o.o. (2013) Morska farma wiatrowa Bałtyk Środkowy III – opis metodyki wariantowania, Version dated 4.12.2013

/50/ Neubauer G, (2011) Mewy, *In* Sikora, A, Chylarecki, P, Meissner, W, Neubauer G. (eds.) Monitoring ptaków wodno-błotnych w okresie wędrówek. Poradnik metodyczny. GDOŚ, Warszawa. pp: 133-141.

/51/ Nowakowski, JK, Remisiewicz, M, Keller, M, Busse, P, Rowinski, P (2005) Synchronisation of the autumn mass migration of passerines: a case of Robins *Erithacus rubecula*. Acta Ornithologica 40: 103-115.

/52/ Orth, H (2011) Recommendation of methods for future EIA surveys of birds. Report commissioned by DONG Energy. Seacon, Copenhagen.

/53/ Paton, P, Wininarski, K, Trocki, C, McWilliams, S (2010) Spatial distribution, abundance, and flight ecology of birds in nearshore and offshore waters of Rhode Island. Interim Technical Report for the Rhode Island Ocean Special Area Management Plan 2010. Department of Natural Resources Science, University of Rhode Island, USA.

/54/ Pettersson, J (2005) The impact of offshore wind farms on bird life in Southern Kalmar Sound, Sweden. A final report based on studies 1999-2003. At the request of the Swedish Energy Agency. Lund University, Sweden.

/55/ Petersen, IK, Nielsen, RD (2011) Abundance and distribution of selected waterbird species in Danish Marine Areas. NERI Report commissioned by Vattenfall A/S. Aarhus University, Denmark.

/56/ Petersen, IK, Nielsen, RD, Mackenzie, ML (2014) Post-construction evaluation of bird abundances and distributions in the Horns Rev 2 offshore wind farm area, 2011 and 2012. Report commissioned by DONG Energy. Aarhus University, DCE – Danish Centre for Environment and Energy. 51 pp.

/57/ Piper, W, Kulik, G, Durinck, J, Skov, H, Leonhard, SB (2008) Horns Rev II offshore wind farm monitoring of migrating waterbirds. Baseline studies. Report commissioned by DONG Energy A/S. Prepared by Orbicon A/S, DHI, BIOLA, Marine Observers.

/58/ Polakowski, M, Jankowiak, L, Kasprzykowski, Z, Bela, G, Kosmicki, A, Janczyszyn, A, Niemczyk, A, Kilon, D (2014) Autumn migratory movements of raptors along the southern Baltic coast. Ornis Fennica, 91: 39-47.

/59/ Prange, H. (1987) Staging and migration of cranes in the German Democratic Republic. Aquila 93-94, 75-90.

/60/ Prange, H. (2010) Migration and resting of the Common Crane *Grus grus* and changes in four decades. Vogelwelt 131: 155 – 167.

/61/ Royal HaskoningDHV (2014) High Level Technical Design Options Study. Version 1 – initial concept, Polenergia Offshore Wind Developments for projects Middle Baltic II and Middle Baltic III. Version dated 04 February 2014.

/62/ Rydell, J., Engström, H., Hendenström, A., Larsen J.K., Pettersson, J., Green, M. (2012) The effect of wind power on birds and bats. A synthesis. Swedish Environmental Protection Agency, Report 6511, 151 p.

/63/ Skov, H., Heinänen, S., Žydelis, R., Bellebaum, J., Bzoma, S., Dagys, M., Durinck, J., Garthe, S., Grishanov, G., Hario, M., Kieckbusch, J.J., Kube, J., Kuresoo, A., Larsson, K., Luigujoe, L., Meissner, W., Nehls, H.W., Nilsson, L., Petersen, I.K., Roos, M.M., Pihl, S., Sonntag, N., Stock, A., Stipniece, A., Wahl, J., (2011). Waterbird populations and pressures in the Baltic Sea. TemaNord 2011:550, Nordic Council of Ministers, Copenhagen, Denmark. 229 p.

/64/ Skov, H, Desholm, M, Heinänen, S, Christensen, TK, Durinck, J, Johansen, TW (2012) Anholt Supplementary Baseline Surveys of Migratory Birds. Report commissioned by DONG Energy. DHI/Århus University.

/65/ Skov, H, Leonhard, SB, Heinänen, S, Zydelis, R, Jensen, NE, Durinck, J, Johansen, TW, Jensen, BP, Hansen, BL, Piper, W, Grøn, PN (2012b) Horns Rev 2 Monitoring 2010-2012. Migrating Birds. Orbicon, DHI, Marine Observers and Biola. Report commissioned by DONG Energy.

/66/ Skov, H., Desholm, M., Heinänen, S., Johansen, T.W. (2014) Birds and bats at Kriegers Flak. Baseline investigations and impact assessment for establishment of an offshore wind farm. DHI and Aarhus Universitet, Denmark. Prepared for EnergiNet.Dk.

/67/ SmartWind 2013 Hornsea Offshore Wind Farm – Project One. Environmental Statement Volume 5 – Offshore Annexes. Chapter 5.5.1 Ornithology Technical Report, July 2013. Smart Wind Limited, London.

/68/ Stempniewicz, L (1995) Feeding ecology of the Long-tailed Duck *Clangula hyemalis* wintering in the Gulf of Gdansk (southern Baltic Sea). Ornis Svecica 5: 133-142.

/69/ Stryjecki, M, Mielniczuk, K, Biegaj, J (2011) Guide to the location determination and environmental impact forecasting procedures for offshore wind farms in Polish maritime areas. Foundation for Sustainable Energy, Warsaw.

/70/ Sweden offshore wind ab (2007). Wind Farm - Krieger's Flak. Environmental impact assessment.

/71/ Tomiałojć L, Stawarczyk T (2003) The avifauna of Poland. Distribution, numbers and trends [Awifauna Polski. Rozmieszczenie, liczebność i zmiany], PTPP "pro Natura", Wrocław (in Polish)

/72/ Thomas, L, Buckland, ST, Rexstad, EA, Laake, JL, Strindberg, S, Hedley, SL, Bishop, JRB, Marques, TA, Burnham, KP (2010) Distance Software: design and analysis of distance sampling surveys for estimating population size. Journal of Applied Ecology, 47, 5-14.

/73/ Vanermen, N, Stienen, EWM, Courtens, W, Onkelinx, T, Van de walle, M, Verstraete, H (2013) Bird monitoring at offshore wind farms in the Belgian part of the North Sea - Assessing seabird displacement effects. Rapporten van het Instituut voor Natuur- en Bosonderzoek 2013 (INBO.R.2013.755887). Instituut voor Natuur- en Bosonderzoek, Brussel.

/74/ Wetlands International (2014). Waterbird Population Estimates. Retrieved from wpe.wetlands.org.

/75/ Wuczyński, A, Smyk, B, Kolodziejczyk, P, Lenkiewicz, W, Orlowski, G, Pola, A (2012) Long-term changes in numbers of geese stopping over and wintering in south-western Poland. Central European Journal of Biology 7: 495-506.

/76/ Žalakevicius M (ed) 1987. Modelling and forecasting. Study, modelling and forecasting of seasonal bird migration. A monograph, Vilnius, Lithuania (in Russian).

/77/ Žydelis, R (2002) Habitat selection of waterbirds wintering in Lithuanian coastal zone of the Baltic Sea. PhD thesis, University of Vilnius, Lithuania.

/78/ Žydelis, R, Ruškytė, D, (2005= Winter foraging of Long-tailed Ducks (*Clangula hyemalis*) exploiting different benthic communities in the Baltic Sea. Wilson Bulletin, 117: 133-141.

FIGURES

TABLES