Energinet.dk

April 2015

VESTERHAV SYD OFFSHORE WIND FARM

EIA – background report – **FINAL**

Resting birds

Project	Vesterhav Syd Offshore Wind Farm EIA - background report Energinet.dk

Frontpage photo: Common Scoter (Stefan Pfützke, www.green-lens.de)

Project nr. 215170
Document nr. 1215459438
Version: final
Prepared by hw
Controlled by am, iel, rwa, rf
Approved by dt, hhk, trhs

NIRAS A/S

Åboulevarden 80
Postboks 615
8000 Aarhus C

CVR-nr. 37295728
Tilsluttet FRI
www.niras.dk

T: +45 8732 3232
F: +45 8732 3200
E: niras@niras.dk

CONTENTS

1 Summary 7

2 Introduction 9
2.1 Objectives 9

3 Project description 10
3.1 Wind farm location 10
3.2 Physical characteristics 13
3.3 Turbines and park layout 13
3.4 Foundation 16
3.5 Decommissioning 16

4 Background 18
4.1 Study area 18
4.2 Aerial surveys 18
4.3 Data analyses 23
4.4 Legal basis / legislation 32
4.5 Worst case –scenario assumptions 33
4.6 0-alternative 34

5 Existing conditions 35
5.1 Introduction 35
5.2 Overview on bird numbers 36
5.3 Divers 40
5.3.1 Abundance in the Vesterhav Syd area 40
5.3.2 Distribution in the Vesterhav Syd area 43
5.3.3 Abundance and distribution according to other studies 48
5.4 Northern Gannet 50
5.4.1 Abundance in the Vesterhav Syd area 50
5.4.2 Distribution in the Vesterhav Syd area 51
5.4.3 Abundance and distribution according to other studies 54
5.5 Common Scoter 55
5.5.1 Abundance in the Vesterhav Syd area 55
5.5.2 Distribution in the Vesterhav Syd area 56
5.5.3 Abundance and distribution according to other studies 61
5.6 Velvet Scoter 62
5.6.1 Abundance in the Vesterhav Syd area 62
5.6.2 Distribution in the Vesterhav Syd area 63
5.6.3 Abundance and distribution according to other studies 66
5.7 Little Gull 67
5.7.1 Abundance in the Vesterhav Syd area 67
5.7.2 Distribution in the Vesterhav Syd area 68
5.7.3 Abundance and distribution according to other studies 71
5.8 Common Gull 72

CONTENTS

5.8.1 Abundance in the Vesterhav Syd area 72
5.8.2 Distribution in the Vesterhav Syd area....73
5.8.3 Abundance and distribution according to other studies 76
5.9 Lesser Black-backed Gull 77
5.9.1 Abundance in the Vesterhav Syd area 77
5.9.2 Distribution in the Vesterhav Syd area....78
5.9.3 Abundance and distribution according to other studies 81
5.10 Herring Gull....82
5.10.1 Abundance in the Vesterhav Syd area 82
5.10.2 Distribution in the Vesterhav Syd area....83
5.10.3 Abundance and distribution according to other studies 86
5.11 Great Black-backed Gull....87
5.11.1 Abundance in the Vesterhav Syd area 87
5.11.2 Distribution in the Vesterhav Syd area....88
5.11.3 Abundance and distribution according to other studies 91
5.12 Black-legged Kittiwake 92
5.12.1 Abundance in the Vesterhav Syd area 92
5.12.2 Distribution in the Vesterhav Syd area....93
5.12.3 Abundance and distribution according to other studies 96
5.13 Common Guillemot / Razorbill 97
5.13.1 Abundance in the Vesterhav Syd area 97
5.13.2 Distribution in the Vesterhav Syd area....98
5.13.3 Abundance and distribution according to other studies 102

6 Methodology of impact assessment 105
6.1 Introduction 105
6.2 Impact criteria 106
6.2.1 Degree of disturbance....107
6.2.2 Importance....110
6.2.3 Likelihood of occurrence 112
6.2.4 Persistance....114
6.2.5 Assessment method in collisions....114
6.3 Project pressures and impacts on resting birds....116
6.3.1 Impacts during installation/decommissioning 116
6.3.2 Impacts during operation....117
6.4 Sensitivity analysis 118
6.4.1 Habitat loss / change....119
6.4.2 Disturbance 119
6.4.3 Collision....122
6.4.4 Conclusions from sensitivity analyses for impact assessment 123

7 Impact assessment during installation 124
7.1 Habitat loss / change....124
7.1.1 Degree of disturbance....124
7.1.2 Importance....127

CONTENTS

7.1.3 Likelihood of occurrence 128
7.1.4 Persistence 128
7.2 Displacement 129
7.2.1 Degree of disturbance 130
7.2.2 Importance 130
7.2.3 Likelihood of occurrence 131
7.2.4 Persistence 131
7.3 Collisions 132
7.4 Total impacts 133

8 Impact assessment during operation 135
8.1 Habitat loss / change 135
8.1.1 Degree of disturbance 135
8.1.2 Importance 136
8.1.3 Likelihood of occurrence 137
8.1.4 Persistence 137
8.2 Displacement 138
8.2.1 Degree of disturbance 138
8.2.2 Importance 142
8.2.3 Likelihood of occurrence 143
8.2.4 Persistence 146
8.3 Collision 148
8.3.1 Predicted collision risk 148
8.3.2 Impact assessment of collisions during operation 154
8.4 Total impact 162

9 Impact assessment during decommissioning 164
9.1 Habitat loss / change 164
9.1.1 Degree of disturbance 164
9.1.2 Importance 165
9.1.3 Likelihood of occurrence 166
9.1.4 Persistence 166
9.2 Displacement 167
9.3 Collisions 168
9.4 Total impact 169

10 Cumulative impact assessment 171
10.1 Projects considered for cumulative impacts 171
10.2 Cumulative impact assessment 173
10.2.1 Divers 173
10.2.2 Common Scoter 175
10.2.3 Velvet Scoter 176
10.2.4 Common Gull 177
10.2.5 Lesser Black-backed Gull 178
10.2.6 Herring Gull 179

CONTENTS

10.2.7 Auks 181

11 Cross-border effects 183

12 Mitigation measures.... 183

13 Potential insufficient knowledge 183

14 Conclusion of the total impact 184

15 References 186

16 Appendix 191

16.1 Worked example of collision rate model for the Herring Gull 191

16.2 Parameters for collision modelling in resting birds....193

16.3 Distance functions for resting birds....194

16.4 Distribution maps with bird counts and bathymetry 208

16.5 Collision modeling of resting birds with different turbine size....216

16.6 Bird numbers within buffer zones around Development area....218

16.7 Tables for determination of the magnitude of impact (assessement methodology) 222

1 SUMMARY

Vesterhav Syd offshore wind farm is proposed be located in the North Sea about 4 km from the shore north of Ringkøbing Fjord in Jutland, Denmark. The site is approximately 60 km², with an estimated generation capacity of up to 200 MW. The number and power of turbines is not yet defined and options considered range between 3 MW and 10 MW.

The aim of this report is to present the results of the baseline investigations and to assess the impacts on resting birds during the periods of installation, operation and decommissioning. The area is not known to be an important area for resting seabirds.

To inform the investigation of resting birds, six aerial surveys were performed between November 2013 and April 2014 according to international standards. Eighteen transect lines covered an area of approximately 1,032 km². In total, 6,377 birds were identified, the most numerous being the Common Scoter *Melanitta nigra* (2,341 individuals) followed by divers (979 individuals, 148 identified as Red-throated Divers *Gavia stellata*, corresponding to 18% of all divers). Among gull species, the Common Gull *Larus canus* was the most abundant (1,142 individuals). Analyses of selectivity showed that Common Scoter were present in the development area in higher numbers than expected compared to the total investigation area covered by surveys. From the raw data collected, densities and population estimates were calculated using distance sampling methods to account for decreasing detectability of birds with distance during the surveys. Densities of divers peaked in spring with 0.93 individuals/km² on 11th March 2014 with an estimated population of 959 individuals within the study area. The densities of wintering divers was similar to those found in areas further south (area of Horns Rev wind farm projects), but peak numbers in spring were lower. Divers showed concentrations mainly in the north eastern part of the study area. During some surveys also the development area was used in high densities. Most Scoters were located near the coast in the south eastern part of the study area but also in the north eastern part of the development area. The highest estimate for the Common Scoter was 1,996 individuals on 11th February 2014. Velvet Scoter were found regularly with highest estimate of 118 individuals on 11th March 2014. The maximum estimate of auk population (combined Common Guillemot *Uria aalge*, Razorbill *Alca torda*) was 771 individuals on 11th February 2014 with a concentration in offshore areas west of the development area.

The criteria for impact assessment were derived from calculated bird numbers in relation to reference populations as well as the number of birds within species specific buffer zones around the wind turbines. These birds are supposed to be affected by displacement. The zones were defined according to the sensitivity of the species to wind turbines. The highest impact was assessed as “Moderate” for displacement and habitat loss for Common Scoters and divers during the period of operation. This is mainly due to the high sensitivity of these species and the

number of expected birds being affected. This number was 186 in divers and 674 in Common Scoter for the survey day with highest number within the impact zone as a worst case assumption. These numbers represent 0.071% and 0.123% of the biogeographical population in divers and Common Scoter, repectively, and are rated to be of Medium degree of disturbance. Both proportions are located at a low level within the defined threshold of a Medium degree of disturbance (0.05 to 0.5 % of the biogeographical population).
During the period of operation, displacement and habitat loss are supposed to cause ”Minor” impacts in Velvet Scoter and auks. Installation and decommissioning are predicted to cause ”Minor” impacts on divers due to displacement and habitat loss. Collision is assessed to cause ”Minor” impacts in Common Gulls, Herring Gulls and Lesser Black-backed Gulls during the period of operation. For all other resting species the impact of all pressures is regarded as “Negligible”.

The cumulative effects of disturbance in divers, Common Scoter, Velvet Scoter and auks has been considered for the wind farm projects Vesterhav Syd, Vesterhav Nord, Nissum Bredning and Horns Rev 3. In divers and Common Scoter the ”Moderate” impact is still valid, and in Velvet Scoter and auks the magnitude of impact is still of ”Minor” magnitude. For collisions also wind farms Horns Rev 1 and Horns Rev 2 are considered. The magnitude of impact of collisions in Common Gull, Lesser Black-backed Gull and Herring Gull is assessed to be ”Minor” also on a cumulative basis.

2 INTRODUCTION

On March 22nd 2012 a broad political majority of the Danish Parliament agreed on the energy policy for the period 2012-2020. Establishment of nearshore wind farms, generating up to 450 MW of energy, will ensure part fulfillment of the agreement and conversion to a green energy supply in Denmark by 2020. On November 28th 2012 the Danish government identified six sites around Denmark, which are to be subject to pre-investigations prior to their development, including turbines, submarine cables and cable landfall. The selected sites are: Bornholm; Smålandsfarvandet; Sejerø Bugt; Sæby; Vesterhav Syd; and Vesterhav Nord. The Danish Energy Agency (DEA) is responsible for the procurement of the 450 MW wind power for the six nearshore wind farm areas. The six projects are divided into two packages. Package 1, including Bornholm, Vesterhav Syd and Vesterhav Nord, is to be considered as a whole and studies on resting and migrating birds/bats are performed in parallel by the same consultants (NIRAS, IBL Umweltplanung GmbH, Bureau Waardenburg bv). Therefore, data is available to be used for joint analyses. NIRAS Consortium is responsible for the Environmental Statements of the three wind farm sites. This ornithological report will be Annexed to the main Environmental Statement report for Vesterhav Syd Offshore Wind Farm. Energinet.dk is responsible for the EIA process related to the projects.

This report presents the details of the Environmental Impact Assessment for the potential impacts on ornithological interests within the area of influence of the offshore elements of the proposed wind farm "Vesterhav Syd". In this report the potential impacts of the project on resting birds are identified according to the relevant development phase of the Project (installation, operation and decommissioning). The significance of these potential impacts is assessed and potential mitigation options are provided.

The final layout of the wind farm is not yet defined, but the turbines will be distributed within a pre-investigation area that is referred to as “development area” in this report.

2.1 Objectives

The specific objectives of this assessment were to:

- Describe and evaluate the importance of the proposed Vesterhav Syd wind farm site for resting birds;
- Determine the potential impacts of the installation, operation and decommissioning on the offshore elements of the proposed Vesterhav Syd wind farm on sensitive birds and prey species and to predict the significance of those impacts; and
- Identify the potential for cumulative effects with other developments.

3 PROJECT DESCRIPTION

3.1 Wind farm location

Vesterhav Syd is located in the North Sea approximately 4 km from the coast north west of Ringkøbing Fjord (Figure 1).

Figure 1: Overview of location of wind farm area Vesterhav Syd sea cable corridors and onshore cable corridors

The development area for the wind wind farm is of approximately 60 km². In the centre of the area a site for raw material extraction has been designated with existing permission valid until 2014. The water depth of the wind farm area rang-

es from 15 to 25 meters with the deepest water depths in the western periphery of the area. The coordinates of the corner points are given in Table 1.

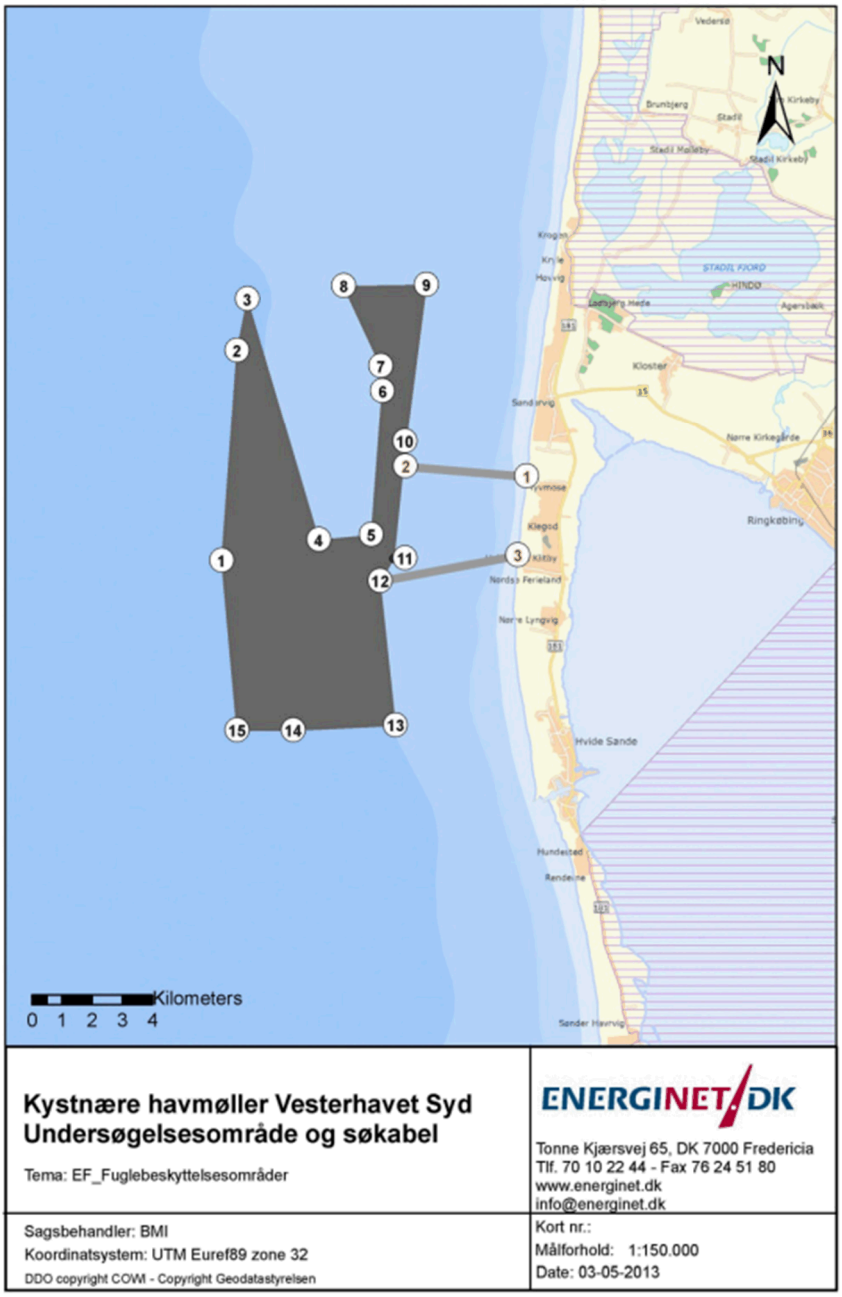


Figure 2: Location of Vesterhav Syd wind farm development area with indication of corner points

Remark: red figures indicate the location of points related to the cable corridor

Table 1 Coordinates of corner points of the development area. The ID numbers refer to the numbers in Figure 2

Development area for offshore wind farm		
ETRS 1989 UTM Zone 32N		
ID	East	North
1	434101.9582	6214229.361
2	434610.4553	6221178.822
3	434949.4534	6222873.812
4	437322.4399	6214907.357
5	439063.7754	6215080.538
6	439436.3504	6219910.265
7	439377.0946	6220667.046
8	438155.5095	6223312.346
9	440889.4040	6223351.430
10	440175.0276	6217890.419
11	439809.9019	6214302.662
12	439356.4284	6213551.365
13	439864.9255	6208805.392
14	436474.9447	6208635.893
15	434610.4553	6208635.893
Export cable corridors		
ETRS 1989 UTM Zone 32N		
ID	East	North
1	444217.6258	6217000.646
2	440199.4950	6217337.941
3	443918.6222	6214408.611
4 (11)	439809.9019	6214302.662

3.2 Physical characteristics

Water depths within the development area are characterised by relatively shallow water in the north eastern part with minimum values of around 15 m and an area of deeper water in the south western part of about 25 m (Figure 3).

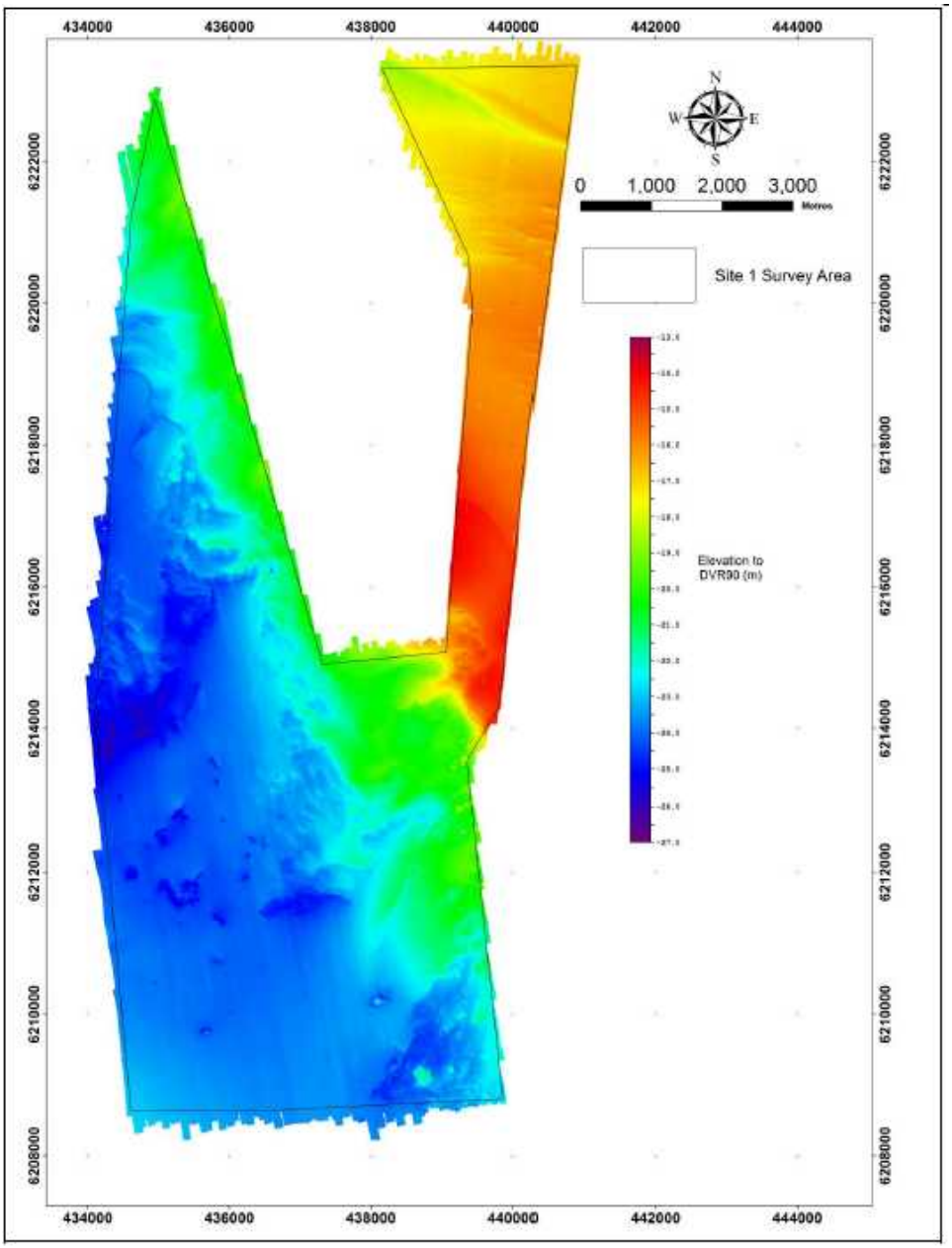


Figure 3: Bathymetry of the Vesterhav Syd area (based on geophysical survey)

3.3 Turbines and park layout

The type and size of turbines have yet to be determined. The capacity of the single turbines to be installed will be between 3 and 10 MW. The number of turbines range between 66 turbines of 3 MW (198 MW) and 20 turbines of 10 MW

(200 MW). The measurements of the turbines (and further possible turbine capacities to consider) vary between 3 and 10 MW models as outlined in Table 2.

Table 2: Measurements of wind turbines

Turbine Capacity (MW)	Rotor Diameter (m)	Total Height (m)	Hub Height above MSL (m)	Swept area (m^2)
3.0 MW	112 m	137 m	81 m	9,852 m^2
3.6 MW	120 m	140 m*	80 m*	11,500 m^2
4.0 MW	130 m	150 m*	85 m*	13,300 m^2
6.0 MW	154 m	174 m*	97 m*	18,600 m^2
8.0 MW	164 m	184 m*	102 m*	21,124 m^2
10 MW	190 m	220 m	125 m	28,400 m^2

*Based on 20m air gab between MSL and wing tip.

Possible layouts of the offshore wind farm for Vesterhav Syd have been developed by DTU Wind Energy (DTU 2014) and are shown for the 3 MW and 10 MW arrangement in Figure 4.

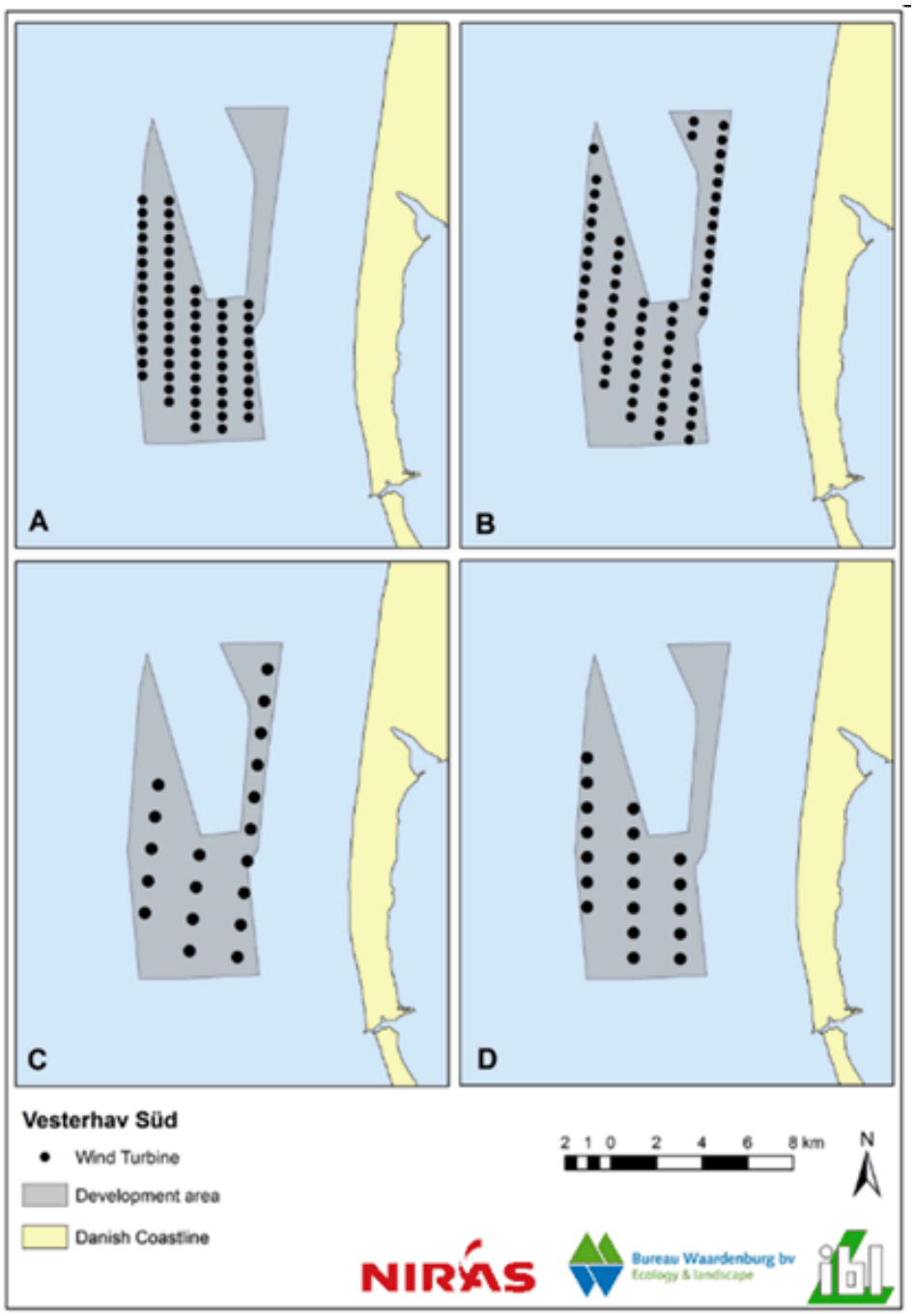


Figure 4: Suggested layouts for the 3 MW turbines (A and B, top) and 10 MW turbines (C and D, bottom).

The cables from the wind farm to the mainland may be installed in two 500 m broad corridors, one running from the northern part of the wind farm to the coast north of Vejlby Klit, the second running from the southern part of the wind farm to the coast north of Ferring. A project description including installation methods is presented in a separate report (Energinet.dk 2015).

3.4 Foundation

The wind turbines will be supported by foundations fixed to the seabed. It is expected that the foundations at Vesterhav Syd will comprise one of the following options:

- Driven steel monopole;
- Concrete gravity base;
- Jacket foundations; or
- Suction buckets.

The different foundation types and installation methods are described in the technical project description.

The relevant information for the impact assessment in resting birds is the total area of the scour protection at the basis of the turbines that covers the seabed. The areas covered for the different turbine constellations are given in Table 3. For suction buckets no data are available.

Table 3: Total foot print area of scour coverage for different types of fundations and turbine sizes

Power of turbine **Type of foundation**	**3.0 MW (66 turbines)**	**10.0 MW (20 turbines)**
Monopile	99,000 m²	40,000 m²
Gravity base	66,000 - 85,800 m²	34,000-52,000 m²
Jacket	46,200 m²	32,000 m²

3.5 Decommissioning

The lifetime of the wind farm is expected to be between 25 and 30 years. The method for decommissioning will follow best practice and the legislation at that time.

The objectives of the decommissioning process are to minimise both the short and long term effects on the environment whilst making the sea safe for others to navigate. Based on current available technology, it is anticipated that the following level of decommissioning on the wind farm will be performed:

- Wind turbines – to be removed completely;

- Structures and substructures – to be removed to the natural seabed level or to be partly left in situ;
- Infield cables – to be either removed (in the event they have become unburied) or to be left safely in situ, buried to below the natural seabed level or protected by rock-dump;
- Export cables – to be left safely in situ, buried to below the natural seabed level or protected by rock-dump;
- Cable shore landing – to be either safely removed or left in-situ, with particular respect to the natural sediment movement along the shore; and
- Scour protection – to be left in situ.

The dismantling and removal of turbine components (blades, nacelle, tower etc.) is considered to be a reversal of the installation process and subject to the same constraints. If rock-dumping will be necessary to protect cables the decommissioning will cause further coverage of seabed.

4 BACKGROUND

The following section describes methodological background information on the investigations on resting birds.

4.1 Study area

The study area is the sea area which encompasses the wind farm footprint and a surrounding buffer of 8-10 km that equates to at least twice the minimum disturbance distance of the most sensitive bird species expected e.g. Common Scoter (see Figure 6). Coverage of this study area was possible within a day and therefore minimising on the possibility of double counting during surveying.

4.2 Aerial surveys

Data on the number and distribution of birds was gathered from aerial surveys conducted along twenty pre-defined transect lines at 2 km spacing over the study area. Aerial surveys were conducted from a twin-engined “Brittan Norman BN2” equipped with bubble windows (see Figure 5), flying at an altitude of 76 m (250 feet) and with a cruising speed of approximately 185 km/h (100 knots). The layout of the transects is shown in Figure 6 with the coordinates of waypoints listed in Table 4. An area of 1.032 km² was covered by the transects which averaged 27 km length and totalled at 500 km.

Figure 5: Aircraft used for surveys: “Brittan Norman BN2” with bubble windows

Figure 6: Investigation area with transects for aerial surveys

Table 4: Transect coordinates in ETRS 1989 UTM Zone 32N

Transect no	X start	Y start	X start	Y start
1	445450.553	6232489.794	417378.468	6232875.087
2	445522.083	6230433.053	417312.322	6230824.562
3	445577.791	6228483.278	417246.176	6228840.183
4	445076.420	6226449.941	417233.628	226823.184
5	444658.611	6224500.165	417205.774	6224873.408
6	444547.196	6222522.536	417205.774	6222895.779
7	444296.510	6220572.761	417094.358	6220901.437
8	444296.510	6218455.862	417094.358	6218840.246
9	443962.263	6216506.086	417038.650	6216862.617
10	443683.724	6214472.749	417038.650	6214884.987
11	443683.724	6212411.558	416955.089	6212795.942
12	443739.432	6210517.491	416955.089	6210874.021
13	444017.971	6208534.290	416927.235	6208896.392
14	444491.488	6206528.807	416871.527	6206890.908
15	445132.128	6204551.178	416871.527	6204885.425
16	445689.207	6202573.549	416787.965	6202935.650
17	446134.870	6200568.065	416760.111	6200958.020
18	446406.770	6198567.890	416641.784	6198936.601

The data analysed in this report were collected according to European Seabirds At Sea (ESAS) aerial survey methodology (Camphuysen et al. 2004). During the surveys, two observers with high experience in species identification covered each side of the aircraft. All observations were continuously recorded on dictaphones, including information on species, number, behaviour, transect band and time. On the beginning of each transect the weather conditions are noted (e.g. sea state, visibility, cloud cover, glare, turbidity of water) and updated during the transect if changes occurred. A computer locked flight tracks from a Global Positioning System (GPS) recording track positions every second. Observations were allocated to sites by time of observation. With a flight speed of 185 km/h this results in an accuracy of position of 52 m.

Based on the estimations of densities using distance sampling techniques according to Buckland et al. (2001) survey transects were divided into distance bands using an inclinometer (flight height 250 ft, approximately 76 m): Band 0 (0-44 m), Band A (44-163 m), Band B (163-284 m), Band C (284-431m) and Band D (413-1000 m). This division of bands improves the possibilities of calculating effective strip widths (ESW) and follows the recommendations of Buckland et al. (2012). In Table 5 the division of bands degrees (inclinometer), boundaries and band widths are presented. Recommendations by Diederichs et al. (2002) and Noer et al. (2000) for aerial survey with at width of transect of 387 m for bands A to C is followed (Band B is divided into B and C in order to achieve bands of

similar band widths). The perpendicular distance of the sighting is calculated from the angle and flight altitude.

Table 5: Definition of transect bands used for aerial surveys

Parameter	Band 0	Band A	Band B	Band C	Band D
outer bound (degrees)	60	25	15	10	*
outer bound (m from transect line)	44	163	284	431	1,000
band width (m)	44	119	121	147	569

Remark: * clinometre < 10° until the middle between transects

The general weather conditions during the six surveys are presented in Table 6. Detailed information on weather was noted at the beginning of each transect and at any change of conditions. Limits for analyses were set to a maximum sea state of three and to minimum visibilities of 5 km. In all surveys, data with sea state values higher than three did not occur and visibility was greater than 5km on every day. Sections with strong glare, negatively affecting recognition of birds, were also excluded from analyses. The exclusion of these transects/part of transects is reflected in the grid-based effort presented in Figure 7.

Table 6: Weather conditions during the six surveys

Date	Sea-state	Visibility (km)	Wind speed (knots)	Wind direction (°)	Cloud cover (x/8)	Rain	Temperature (°C)
25.11.2013	2	10	5	360	1-2	no	8
03.02.2014	2-3	8-10	10-14	140	1	no	5
11.02.2014	2	10	5	210	1-2	no	3
11.03.2014	1-2	10	5-7	40	0-1	no	8
25.03.2014	2	10	10	90	1	no	5
16.04.2014	3	10	7-10	240	3	no	8

During the period from November 2013 until April 2014 a total of six aerial surveys were performed within the study area. In the survey design it was intended to perform monthly surveys from November 2013 to April 2014 at regular intervals. Due to a long lasting period of stormy weather during December 2013 and January 2014 there was no suitable weather for aerial surveys in this period. The wintering period is covered by at least two surveys in February 2014. Possible consequences for relevant species according to their seasonal occurrence will be addressed in the section on the abundance in the study area for each species.

For each survey the effort was calculated as valid kilometers covered on each side, e.g. a 10 km track line covered by both observers results in 20 km survey coverage. The total length of transects was around 1,005 km if both sides of the airplane can be analysed. The valid effort for each survey is listed in Table 7 and in Figure 7 the effort per 2 km^2 is shown as kilometer flown per grid square. A total coverage would result in “2km x 6 surveys x 2 sides = 24 km”. Reduced effort resulted from exclusion of some transects or parts of transects due to strong glare.

Table 7: Valid effort for each survey (sum of kilometer on both sides of the aircraft)

Date	Effort (km)	Effort (%)
25.11.2013	772	77
03.02.2014	909	90
11.02.2014	879	87
11.03.2014	969	96
25.03.2014	893	89
16.04.2014	1.005	100
total	5.427	

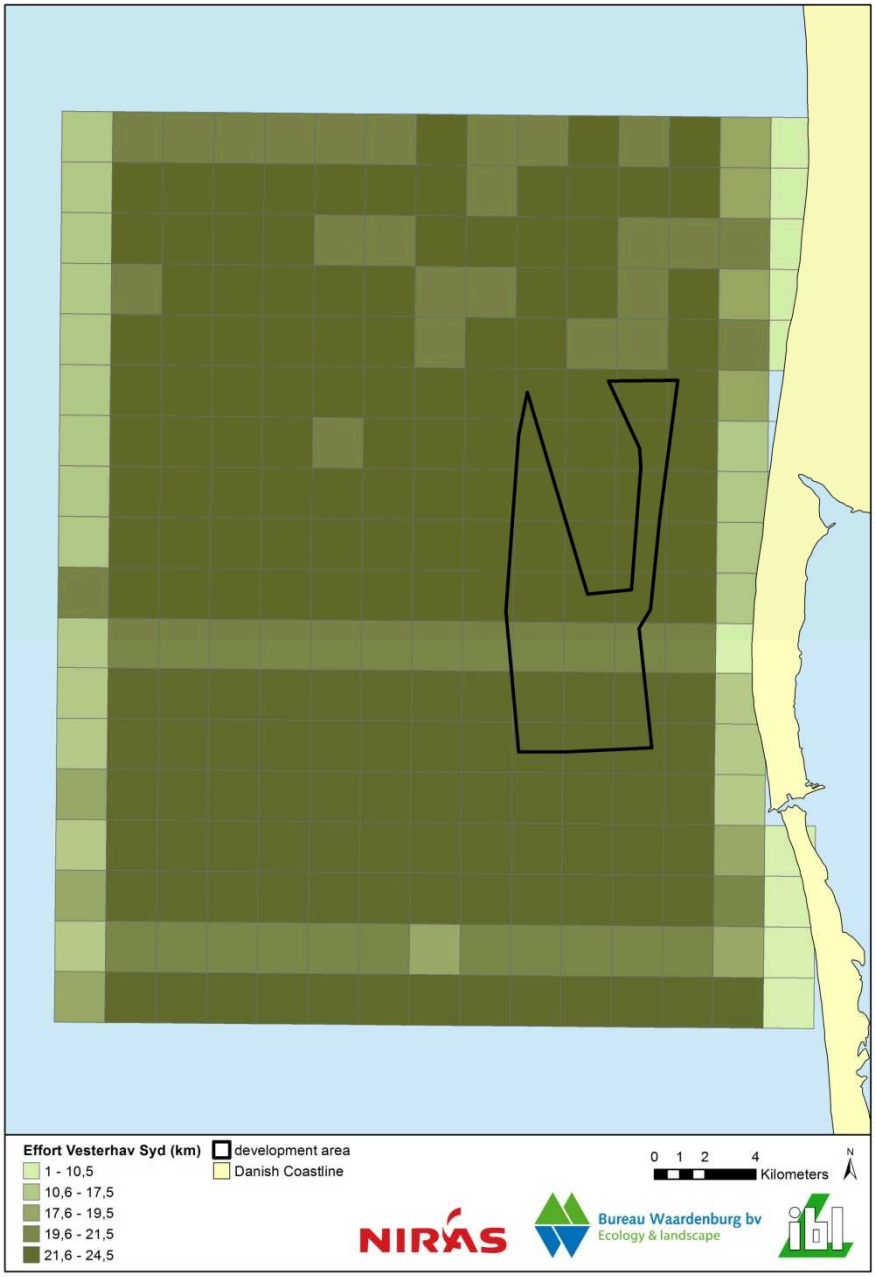


Figure 7: Survey effort (in km) per 2 x 2 km grid squares in the study area summed for all six surveys (see text for further explanation.

4.3 Data analyses

Estimation of densities and populations

One focus in data analyses is the determination of the effective strip width (ESW) as a basis for density and population estimation using distance sampling analyses. Package one includes Vesterhav Syd as well as Vesterhav Nord and

Bornholm and data analyses has been undertaken simultaneously by the same companies (IBL Umweltplanung GmbH, NIRAS, Bureau Waardenburg bv). As surveys were completed by the same persons for all three projects, a combined data set was used for the calculation of ESW values. The combination of data results in larger species-specific data sets and results are more robust than treating projects separately.

For the collision risk modelling those birds are selected that occurred within the wind farm area and a maximum buffer zone of 4 km according to Figure 8. These birds are expected to potentially encounter the wind farm.

The detection probability of birds decreases with increasing distance from the transect line. Therefore, reliable estimates of the densities and population sizes of birds can only be estimated with the application of the Distance Sampling Technique. Distance 6.2 software, developed by the Centre for Research into Ecological and Environmental Modeling (CREEM) at the University of St. Andrews, uses this technique to fit a species-specific detection curve through the data collected to determine the width of the strip in which species were effectively recorded (Thomas et al. 2010). Subsequently, the densities of birds in the study area can be calculated based on those within the area covered (transect line multiplied with the effective strip width).

A key assumption of this technique is that all birds along the transect line ($g(0) = 1$) are detected. This assumption is not always valid due to disturbance as a result of the survey aircraft causing birds to either dive, swim or fly away from the transect line to more distant transect bands. Furthermore, the calculated densities for species that regularly undertake long dives must be regarded as a lower limit as the proportion underwater remains unknown. In seabirds, the species with potentially lower detection rates ($g(0) \neq 1$) is likely to include Auks, and in particular the smaller species. If not all individuals of a certain species are detected ($g(0) \neq 1$), several analytical techniques can be used to correct for this imperfect detection.

The distance analysis included all observations of birds observed in five observation bands: 0-44 m (0-strip); 44-163 m (A-strip); 163-284 m (B-strip); 284-431 m (C-strip); and 431-1000 m (D-strip), see Table 5. These five observation bands give average perpendicular distances (used by the Distance 6.2 software) of 22 m, 103.5 m, 223.5 m, 357.5 m and 715.5 m respectively. So, automatically a ‘right truncation’ of the data was performed at the outer boundary of band D (1000 m).

The Distance software fitted detection functions through the distributions of sightings within five distance bands, based on uniform, half-normal and hazard-rate curves with cosine adjustments when necessary. Then all detection curves were visually inspected whether they were in line with realistic species-specific field characteristics.

As a general rule at least 60 positive observations are needed in order to be able to fit a reliable detection function. In order to correct for loss of detection due to factors such as sea state the number of observations needed increases with a multiple of the number explanatory parameters, including covariates in Distance analysis models. Therefore, in order to determine the most reliable detection function especially applicable for the scarce species, all available data from all study areas and observers were pooled to determine the detection functions.

Detection of seabirds on the water surface is influenced by observation conditions due to weather and sea state but also due to the size of groups of birds (cluster size). The Distance 6.2 software allows the analysis of sea state data as covariates during the modelling process via the 'MCDS module'. Cluster size can also be taken into account within Distance 6.2, although for stratified data the 'MRDS module' needs to be used. Model selection was mainly based on the Akaike Information Criteria (AIC) with lower AIC values representing models with a better fit. By applying this criterion, more appropriate models could be used to correct population estimates for the effect of sea state, resulting in more accurate estimates with smaller confidence intervals. However, selecting the model with the lowest AIC was not always applied to all species. Most of the exclusions have been made on the basis of the knowledge of bird, survey experience and the visual assessment of the detection functions. Especially in cases where the detection function overestimated the density on the track line by fitting a half-normal curve, often a hazard-rate function was applied instead. Most of the time this was in situations where birds were being detected disproportionately; often in the second band (due to birds flying up in the 0-44 m band and being recorded in the second band). As a robust, conservative approach, hazard-rate detection curves were then chosen. Alternatively pooling the two bands also reveals a smooth distance detection curve in one case.

As previously mentioned the key assumption for distance analysis is that all birds on the transect line are recorded (g(0) = 1), yet a number of species respond to the aircraft by either diving or swimming/flying away from the transect line.

When birds dive in response a so-called 'availability bias' is introduced, as all animals are no longer 'available at the surface for the observers'. Population estimates for these species need to be corrected afterwards with a certain correction factor estimating the ratio between birds at and below the surface. Another option is to exclude the 0-strip during analysis and assume the border between the 0-strip and the A-strip is the transect line. Several methodologies are in use to correct the population figures, and one of the most common to use is to use dive-behaviour data (based on visual observations or telemetry data) to calculate a fraction of the total time that birds spend underneath the water. Available correction factors range between 0.6 for divers and 0.9 for alcids (APEM, unpublished data). In other words, the population estimate for divers might be almost double the numbers reported here, whereas for Auks these figures need

to be extrapolated with approximately 10%. The correction factors needed to be used for Scoters and Long-tailed Duck remains unknown. These species tend to forage nocturnally, which would imply that the correction factor should be small. Yet in other regions (Dutch waters) mostly diurnal foraging activity is reported. As correction factors are unpublished material they are not applied to the data, but it is addressed in the results and impact assessment section.

When birds fly off in response, this causes elevated levels of (flying) birds in the A- and sometimes B-strip. These are mostly corrected for by the detection function modelling within the Distance software.

Almost all species respond to the survey airplane and to assess whether a species mainly dives or takes off in response an overview of the ratio between flying and sitting birds in the 0-strip, A-strip and B-strip was produced. It was concluded that diving species were Red-throated Divers, divers in general, Common Guillemots and Auks in general. For these species we chose to analyse only the data from the A-, B-, and C-strip. Gannets, Scoters, and Gulls responded by flying off. For these species we chose to analyse the data from all strips.

Based on these analyses density estimates per 2x2 km grid cell were conducted and mapped for each survey. Finally, the overall density and population estimate including 95% confidence intervals are calculated for each survey.

For species with low sample sizes (total number of flocks below 60) no distance sampling analyses were performed. Instead, densities were estimated by using only birds recorded in Band A. This is a standard method for calculation of bird density estimates from aerial survey according to German guidance of standard investigations (StUK; BSH 2007). This assumes that all birds in this band are accurately recorded.

For a general overview on the spatial distribution of birds the relative abundance with a resolution of 2x2 km grids is calculated using pooled data of all surveys presented as the number of birds per kilometer flown transect. These data are corrected for effort and coverage.

The species specific use of these areas is compared with the use of the total area in order to determine possible preferences of the wind farm site. This comparison is done for most numerous species by calculating an index of selectivity (Jacobs Index; Jacobs 1974) according to the following formula:

$$D = \frac{(r - p)}{(r + p - 2rp)}$$

Where:

D= Jacobs index

r=proportion of birds in the area of interest compared to the birds in the whole study area

p= proportion of transect length in the area of interest compared to the total transect length in the whole study area.

The difference between the two proportions is tested as the difference between the observed number of birds in the area of interest and the number expected in this area, estimated from the share of the length of transect in relation to transect length in the total area (one-sample χ^2-test).

For the investigation of habitat use with respect to water depth the water depth available (along flight transect lines) is compared with the water depth used by the birds. Frequency distribution of both usage of water depth is compared on the basis of 2 m depth classes (e.g. interval 10-11 m is the depth from 10 m to 11.999 m). Further, a Jacobs selectivity index is calculated indicating possible selections of water depth by the birds. The same formula is applied to each class of water depth as in the investigation of preference of development area (s above), in this case the parameter are defined as:

r=proportion of birds using the respective class of water depth compared to all birds; and

p=proportion of water depth class available.

Further, a map with bathymetry and all observation points per species demonstrated the spatial distribution of birds in relation to water depth.

Buffer zones around the development area have been defined in order to assess the potential disturbance effects of wind turbines and to assess the importance of the wind farm area and the adjacent waters. The wind farm layout with the highest anticipated disturbance effects is used for these considerations (worst case scenario: park layout B in Figure 4, see also Section 4.5 for selection of this park layout). A 500 m buffer around each turbine is calculated and further buffer distances of 1 km, 2 km, 3 km and 4 km are created (see Figure 8). Population sizes for each sub-zone were calculated as a proportion of the population of the entire area based on the ratios of observed numbers of the different sub-zones. The population sizes for each sub-zone are presented along with lower and upper ranges, which are based on the confidence intervals. These have also been calculated proportionally to the relative sighted numbers of each sub-zone. As such, these intervals have lost their strict statistical meaning, so should be regarded as ranges and treated as indicative only.

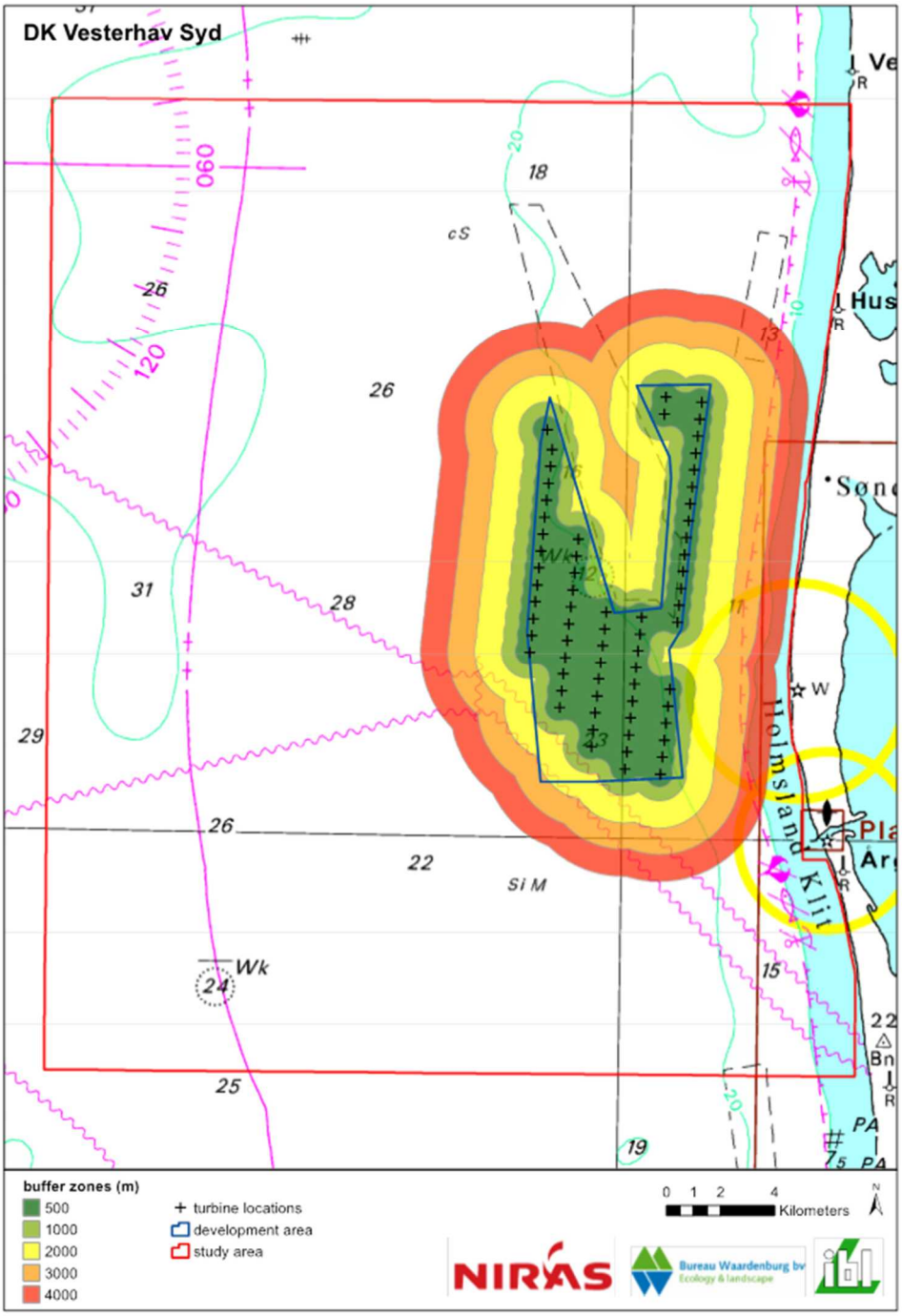


Figure 8: Study area including buffer zones

Collision risk modelling

For various bird species, the level of collision-related mortality was estimated by collision risk modelling. The model used was published by the Crown Estate

Strategic Ornithological Support Services(SOSS) group in 2012 (Band 2012) available from http://www.bto.org/science/wetland-and-marine/soss/projects). This model, based on the SNH Band collision risk model (Band et al. 2007) (available from http://www.snh.gov.uk/planning-and-development/renewable-energy/onshore-wind/assessing-bird-collision-risks/), has been extended to allow the direct input of density data and to allow the comparison of various avoidance rates on the estimated collision risks. Unlike the SNH Band model (2007), the SOSS Band model (2012) was specifically developed for offshore situations.

A working example for collision modeling is added in Appendix 16.1 for the Herring Gull.

Based on the physical characteristics of both the turbine and species of bird, a turbine/species-specific probability of collision for a single bird crossing the rotor-swept area can be calculated. This probability is then applied to the number of birds crossing the rotor-swept area of an entire wind farm, which is estimated based on the density of flying birds, the flight speed and the size and number of turbines. Finally, an avoidance factor is applied that accounts for birds avoiding turbines. This avoidance factor includes both macro and micro avoidance, where macro avoidance is defined as species avoiding the wind farm in general and micro avoidance as species evading the individual turbines. The model also allows a correction factor for large arrays, which assumes a decreasing density of birds across the wind farm that is relative to numbers of birds that have been assumed to collide. For the current wind farm scenarios, this correction factor will only reduce the estimates of the numbers of collisions by a fraction of a percent, and has therefore not been applied.

The collision risk model makes a number of assumptions and is further sensitive to changes in avoidance rates (Chamberlain et al. 2006), which urge caution when interpreting the results. Here, four different avoidance rates have been applied: 95%, 98%, 99% and 99.5%. SNH gives recommendations on avoidance rates (SNH 2010). Based on flight behaviour and collision monitoring studies an avoidance rate of 98% is recommended in Red-throated Divers. Avoidance rates for scoters and auks are not given, but flight behaviour with low maneuverability, flight at low altitudes and disturbance behaviour are similar to divers (Furness et al. 2013). Therefore, for scoters and auks an avoidance rate of 98% is the most appropriate.

The worst case scenario for collisions depends on a number of parameters (particularly those relating to the turbines used) which makes judgment in advance of modelling difficult. Collision risk modelling has therefore been conducted for both 66 x 3 MW turbine scenario and the 20 x 10 MW turbine scenario i.e. using maximum build scenarios for turbines at either end of the likely capacity range. The layout with 66 turbines of 3 MW capacities was found to result in a higher number of total collisions compared to 22 turbines of a 10 MW capacity. In order to present data on the worst case scenario the number of collisions is presented for

the first wind farm layout (66 turbines with 3 MW each). The collision risks are calculated for each survey. If surveys are performed each month around the year the rates can be calculated and a value for the total yearly number of collisions can be presented. The surveys in this study focused on wintering birds and covered only the time period from November until following April. Due to adverse weather conditions in December and January, no surveys were performed in these months. Instead, both in February and March two surveys were performed.

For the calculation of collisions during the period birds are present in the area average collisions per months are calculated and summed up for these months. For the months not covered the maximum monthly collision rate from survey data was taken as worst case and multiplied with the number of months not covered. The sum of these two values gives the number of anticipated collisions during the period birds are present. Table 8 gives an example of calculations for divers where a resting period of 8 months from October to May is anticipated (Skov et al. 1995) from which four months are covered by surveys. In this example, assuming an avoidance rate of 98% a seasonal number of 1.56 collisions is expected.

Table 8: Example of calculations of collision rates in divers

Date	**Avoidance rate**			
	95%	98%	99%	99,50%
26.11.2013	0.33	0.13	0.07	0.03
04.02.2014	0.49	0.20	0.10	0.05
26.02.2014	0.07	0.03	0.01	0.01
11.03.2014	0.36	0.14	0.07	0.04
24.03.2014	0.95	0.38	0.19	0.09
11.04.2014	0.02	0.01	0.00	0.00
Calculations for seasonal collisions				
No. collisions November	0.33	0.13	0.07	0.03
No. collisions February	0.28	0.11	0.06	0.03
No. collisions March	0.65	0.26	0.13	0.07
No. collisions April	0.02	0.01	0.00	0.00
No. months covered	4	4	4	4
No. months not covered	4	4	4	4
Monthly collisions for months not covered (max. collisions from months covered)	0.65	0.26	0.13	0.07
Sum of collisions in months covered	1.28	0.51	0.26	0.13
Sum of collisions for months not covered	2.61	1.04	0.52	0.26
Total sum of collisions	3.89	1.56	0.78	0.39

Data for the wind farm variants were determined and turbine-specific data were provided by Energinet.dk and are given in Table 9. Data for species-specific parameters, such as length, wingspan and flight speed, were obtained from literature. These are also given in the Appendix 16.2. Not all data were available for all wind farm scenarios or for all species modelled. Missing data were estimated based on similar turbines or on similar species. The proportions of each species flying at rotor height were calculated according to Johnston et al. (2014). The SOSS Band (2012) model provides an excel sheet with percentage of birds at intervals of one metre from 0 to 300m for different bird species (to be downloaded from SOSS project: http://www.bto.org/science/wetland-and-marine/soss/projects). These data are calculated based on the publication of flight altitudes in Johnston et al. (2014). A selection of the relevant altitude classes according to the specifications of the project specific turbines and a summation of the percentages in 1-m classes results in the percentage of birds flying at rotor height.

The collision risk has been calculated based on the densities of flying birds per survey and give the potential number of collisions per survey. This can be interpreted as the collision risk for that month. Collision risk for “large gulls” and “small gulls” are calculated and presented in the Appendix, but are not used for further interpretation. For the collision modeling these groups consist of a sum of unidentified “large gulls” and identified large gulls (same in “small gulls”; note, that in contrast to CRM the data in Table 10 “Great” and “Small” gulls only refer to unidentified birds). These mixed groups (which often consist of large flocks) cause skewed or abnormal detection functions. Band modeling is based on a number of assumptions regarding physical aspects of the birds (e.g. wingspan, length etc.) and behaviour (e.g. flight speed, proportion at rotor height, proportion of day active etc.). In all these cases of small gulls, these parameters are averaged for the different species, but species contribute very differently to the total numbers. Therefore, working with individual species gives the best results which then have to be regarded as minimum values.

Table 9: Turbine characteristics used for collision modelling

Variant	66 x 3 MW	20 x 10 MW
Number of blades	3	3
Rotation speed (rpm)	15.79	10
Rotor radius (m)	56	95
Minimum rotor height (lowest point over water; m)	25	30
Maximum blade width (m)	3.5	5.41
Pitch (^{o})	6	5
Number of turbines	66	20
Latitude (DD)	56.07	56.07

The survey aircraft can result in disturbance to birds so that those birds sitting prior to the aircraft's presence are recorded as "flying" in the database. As a differentiation is not possible, all flying birds were included in the Collision Risk Modelling (CRM). This implies that for some species the CRM results are over-estimates of the actual collision figures. This is particularly the case for scoters, but also for some gull species, and may lead to higher numbers of expected collisions. This ensures a conservative, precautionary approach, and the reported collision figures should be regarded as worst case unless stated otherwise in the individual species assessments.

4.4 Legal basis / legislation

The ornithological assessment in this report is based on the legislative background around bird management and protection. The legal framework is implemented in the Danish and the international EU legislation.

The main international EU legislation is based on the Habitat Directive (92/43/EEC), Birds Directive (1009/147/EC) and the Ramsar Convention. The Habitat Directive and the Birds Directive forms the joint Natura 2000 network of protected sites and species.

The Birds Directive protect natural populations of birds as well as sensitive species. The Annex 1 of the Birds Directive lists species which are:

- in danger of extinction;
- vulnerable to specific changes in their habitat;
- considered rare because of small populations or restricted local distribution;
- requiring particular attention for reasons of the specific nature of habitat.

For these species member states must conserve their most suitable territories in number and size as Special Protection Areas. Today (July 2014), the list includes 193 species and sub-species.

The Habitat Directive conserve natural habitats through designated sites and conserve flora and fauna. Annexed to the directive there are lists of designated sites as well as lists on species included in the designations.

The Ramsar Convention is a treaty for the conservation and sustainable utilization of international important wetlands, including birds. Some species migrate over long distances why e.g. collision with wind turbines may be an important issue in the assessment of impact.

- In addition to compliance with the international bird protection, the main Danish legislation includes:
- Nature Protection act: Naturbeskyttelsesloven. Bekendtgørelse af lov om naturbeskyttelse (LBK nr. 933 af 24/09/2009);
- Wildlife Management act: Bekendtgørelse af lov om jagt og vildtforvaltning (LBK nr. 930 af 24/09/2009);
- Marine Strategy act: Lov om havstrategi (LOV nr. 522 af 26/05/2010);
- Environmental act: Miljømålsloven. Bekendtgørelse af lov om miljømål m.v. for vandforekomster og internationale naturbeskyttelsesområder (Miljømålsloven) (LBK nr. 932 af 24/09/2009)
-

Finally, Denmark maintain a red-list of bird species. The list identifies vulnerable and/or threatened species. The red-list is regularly updated and comply with the regulations in the Biodiversity Convention.

4.5 Worst case –scenario assumptions

The final turbine specifications, layout and number of turbines are yet to be determined. A worst case scenario, meaning the layout with the highest anticipated impact on resting birds, has been considered in order to conduct an impact assessment. Project pressures (e.g. disturbance, barrier effect, collisions) have been assessed regarding impact on birds using the worst case scenario number, size and layout of turbines.

With respect to avoidance behaviour, there is very limited knowledge in the comparison of wind farms with a high number of smaller turbines and wind farms with low number of larger turbines. The smaller distances between turbines and the greater total number of turbines (and therefore larger area covered) of a wind farm with smaller turbines is assumed to cause stronger reactions in resting birds with regard to disturbance and barrier effect than a smaller number of larger turbine with greater distance to each other. In addition, the faster moving rotor

blades of smaller turbines is likely to increase visibility and disturbance potential. Therefore, the layout with 66, 3 MW turbines is regarded as the worst case for the disturbance and barrier effect in resting birds. In resting birds, the collisions are calculated for both 3 MW and 10 MW versions, as knowledge on turbine specific influence on collision is limited. Results showed that collisions with 66 turbines (3 MW) are estimated to be higher than in the 10 MW scenario. Therefore, the results from the CRM utilising 66 3 MW turbines are presented and discussed in the following sections and the calculations for the 10 MW turbines are listed in the Appendices (Section 16.5, Table 66). As the wind farm layout including the north eastern part of the development area covers a larger area than the layout without this part, the park layout with 66 turbines covering the largest area is chosen (see Figure 4: chart at top right).

4.6 0-alternative

If the project is not executed, the existing environmental impacts on resting birds in the offshore area will develop in future according to expected changes in existing pressures (e.g. ship traffic).

5 EXISTING CONDITIONS

5.1 Introduction

This section describes the existing conditions for resting birds in the study area based on a literature review for the regional area combined with project-specific aerial surveys (Section 4.2).

Petersen and Nielsen (2011) estimated abundance and modelled distributions of selected species of waterbirds in Danish waters, including the Vesterhav Syd study area based on aerial surveys. The analyses included data from the nationwide monitoring program NOVANA (National Monitoring and Assessment Programme for the Aquatic and Terrestrial Environment) as well as further data collected by NERI. The data are based on the time period from 2006 to 2009. Further general information on densities and distribution of seabirds in the North Sea including the Danish coast are available from Skov et al. (1995). No further site specific investigations in or adjacent to the Vesterhav Syd area are known to exist.

The studies on Horns Rev wind farm projects (Horns Rev 1, 2 and 3) located about 30 km south of the development area of Vesterhav Syd, provided a further source of information on the bird community present in Danish waters off the west coast (Noer et al. 2000, Christensen et al. 2003, 2006, Petersen et al. 2004, 2006a, 2006b, 2014a). At Blåvands Huk systematic bird observations from the coast since 1963 document migration activities in the coastal area of Horns Rev (Kjær 2000, Jakobsen 2008).

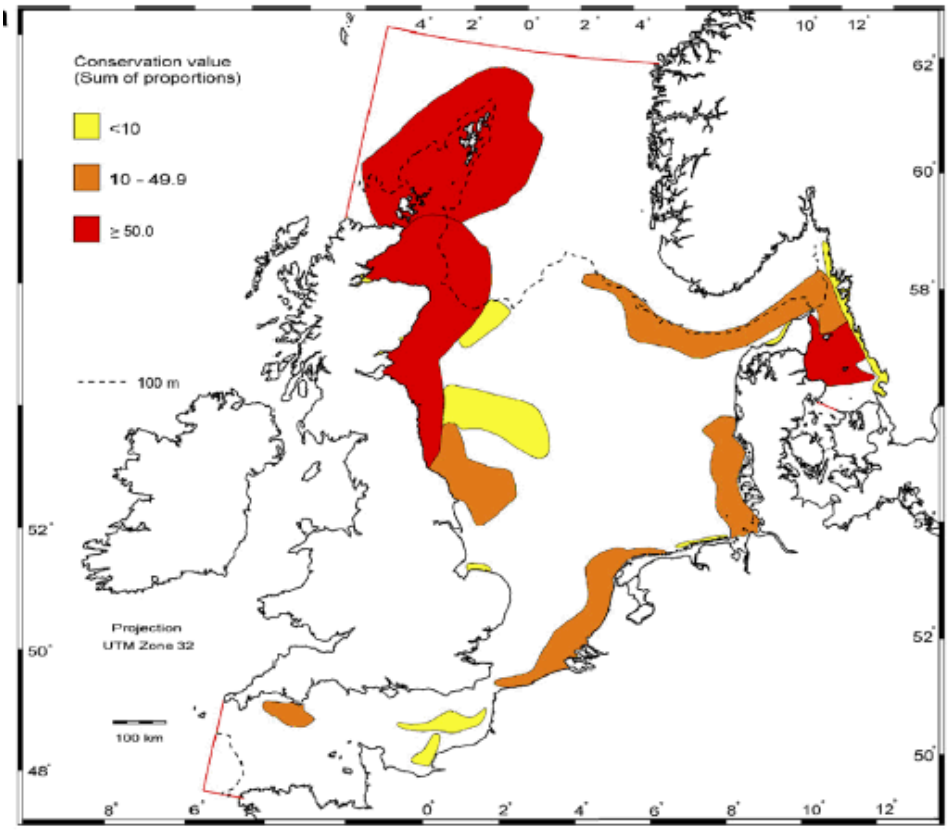


Figure 9: Map of North Sea with indication of conservation values according to Skov et al. (2007)

The development area of Vesterhav Syd wind farm does not lie within protected areas and when compared to the total area of the North Sea the waters west and north of Denmark are not ranked as area with high conservation values (Figure 9). It is located north of a coastal area with medium ratings of conservation status reaching from the south of the Ringkøbing Fjord to the estuarine areas of the rivers Elbe and Weser in Germany. The MCC (Marine Classification Criterion) applied by Skov et al. (2007) is a measure of concentrations of seabirds.

5.2 Overview on bird numbers

During the six surveys from November 2013 to April 2014 17 bird species were identified to species level (Table 10). As species identification during aerial surveys is difficult in some species, a further five categories of species groups were defined. In total, 6,377 birds were counted, the most numerous being the Common Scoter (2,341 individuals) followed by Common Gulls (1,142 individuals) and divers (979 individuals, 148 identified as Red-throated Divers, corresponding to 15% of all divers). A total of 597 auks were counted, 28 % identified as Common Guillemot). Some species occurred only in very low numbers and at single surveys (Duck species, Common Eider, Tufted Duck, Black-headed Gull, Cormo-

rant, Common/Arctic Tern, Sandwich Tern). They are listed in the overview Table 10, but not further treated for density calculations and estimations of population.

Due to adverse weather conditions no surveys were possible in December 2013 and January 2014. The first survey after this period was undertaken on 03rd February 2014, and the following survey was completed after a rather short period of time on 11th February 2014. In spite of the short period of time between surveys the number of birds on 11th February exceeded the data from 3rd February nearly four times for total data (3rd February: 511 individual, 11th February: 1,917). This difference was not caused by a particular species, but was observed in nearly all species as such: divers, scoters, auks and gulls. The observation conditions were a little better on 11th February (sea state 2; 3rd February: 2-3) but basically good on both days.

Differences in numbers of divers or auks can be expected due to varying observation conditions (birds are mostly swimming and feather colour has little contrast to water surface, depending on light conditions), but there was also a strong difference in numbers of gulls that are generally less sensitive to problems in detection due to weather conditions (often flying, white colour means good contrast to water surface). Also, exactly the same aircraft and the same observers were involved. Therefore, this difference in numbers can be interpreted as a “real” difference and not as a consequence of variation in detections caused by weather or observers. As the 11th of February lies within the wintering period bird numbers reflect fluctuations within this period.

Table 10: Numbers of birds counted during six aerial surveys (sum of individuals)

Species	25.11. 2013	03.02. 2014	11.02. 2014	11.03. 2014	25.03. 2014	16.04. 2014	Total
Survey no.	**13-01**	**14-02**	**14-03**	**14-04**	**14-05**	**14-06**	
Diver spec. (*Gavia* spec)	111	52	226	283	116	43	831
Red-throated Diver (*Gavia stellata*)	22	9	47	55	14	1	148
Northern Gannet (*Sula bassana*)	0	0	0	5	25	41	71
Cormorant (*Phalacrocorax carbo*)	0	0	1	1	0	0	2
Duck spec. (*Anas* spec.)	5	0	0	0	0	0	5
Tufted duck (*Aythya fuligula*)	0	0	0	0	5	0	5
Common Eider (*Somateria mollissima*)	3	0	19	0	0	0	22
Common Scoter (*Melanitta nigra*)	310	242	1,031	478	168	112	2,341
Velvet Scoter (*Melanitta fusca*)	5	32	33	49	53	1	173
Black-legged Kittiwake (*Rissa tridactyla*)	18	9	11	3	15	4	60
Black-headed Gull (*Larus ridibundus*)	1	3	8	1	0	0	13
Little Gull (*Hydrocoloeus minutus*)	10	1	23	7	0	0	41
Common Gull (*Larus canus)*	303	35	197	221	369	17	1,142
Herring Gull (*Larus argentatus)*	43	5	24	123	183	27	405
Lesser Black-backed Gull (*Larus fuscus*)	0	0	0	14	15	5	34
Great Black-backed Gull (*Larus marinus*)	3	10	6	0	4	8	31
Gull spec. (*Larus* spec.)	72	12	38	2	223	0	347
"Great" gull (Larus spec.)	1	0	3	0	16	0	20
"Small" gull (Larus spec.)	0	0	48	16	12	1	77
Common/Arctic Tern (*Sterna hirundo / S. paradisaea*)	0	0	0	0	0	3	3
Sandwich Tern (*Sterna sandvicensis*)	0	0	0	0	0	9	9
Common Guillemot (*Uuria aalge*)	88	10	52	10	0	5	165
Razorbill (*Alca torda*)	0	0	0	0	0	2	2

Common Gil-lemot/Razorbill	92	91	150	81	11	5	430
Total number	1,087	511	1,917	1,349	1,229	284	6,377

Table 10 presents the total raw data of all surveys. For further analyses, a selection of data was done correcting for inappropriate observation conditions (sea state, glare) as described in Section 4.3.

Based on the buffer zones around the development area (according to Figure 4 independent of the locations of turbines) the proportion of birds within the development area (DA+0) and buffer zones of 2 km (DA+2)and 4 km (DA+4) were determined and a selectivity index (D, Jacobs index value) calculated followed by a test analysing the difference between observed and expected birds (Table 11). In four of 12 species (or groups of species), the percentage of presence in the development area was higher than expected by survey coverage (6%) and therefore showed a positive selectivity index. In Common Scoter the observed presence in the development area was significantly higher than expected. For the distance ”DA +2km”, also Common Eider, Velvet Scoter and Herring Gulls show a significant positive selection. Auks were less frequent than expected (negative D for all distance classes and highly significant difference in observed and expected number of birds).

Table 11: Percentage of birds (based on number of individuals) encountered in the development area (DA) based on six aerial surveys as well as D (Jacobs Index value for selectivity) and significance of difference of observed and expected birds (one sample Chi²). Data presented for DA as well as in areas covering of 2 km (DA+2) and 4 km (DA+4) around the development area

Species	DA %	D for DA +0	p	DA+2	D for DA +2	p	DA+4	D for DA +4	p	N
divers, undetermined	3.8	-0.23	ns	19.1	0.03	ns	30.8	0.03	ns	831
Red-throated Diver	5.6	-0.04	ns	15.4	-0.10	ns	19.6	-0.26	ns	143
divers, all	4.1	-0.20	ns	18.5	0.01	ns	29.2	-0,.1	ns	974
Northern Gannet	5.9	-0.01	ns	20.6	0.08	ns	23.5	-0.15	ns	68
Common Eider	0.0	-1.00	ns	86.4	0.97	***	100.0	1.00	***	22
Common Scoter	13.2	0.41	***	52.2	0.66	***	77.4	0.78	***	2301
Velvet Scoter	2.5	-0.42	ns	47.1	0.60	***	55.4	0.50	***	157
Black-legged Kittiwake	3.6	-0.26	ns	5.5	-0.59	ns	7.3	-0.68	*	55
Little Gull	0.0	-1.00	ns	4.9	-0.63	ns	4.9	-0.78	*	41
Common Gull	7.5	0.12	ns	19.5	0.04	ns	60.5	0.57	***	1066
Herring gull	7,9	0,14	ns	34,8	0,41	***	75,9	0,77	***	382
Lesser Black-backed Gull	1.,8	0.35	ns	41.2	0.52	ns	47.1	0.36	ns	34
Great Black-backed Gull	0.0	-1.00	ns	12.9	-0.20	ns	48.4	0.38	ns	31

Species	DA %	D for DA +0	p	DA+2	D for DA +2	p	DA+4	D for DA +4	p	N
auks, all	1.4	-0.65	***	1.9	-0.84	***	3.7	-0.83	***	588
% total survey coverage	6.0			18.2			29.5			

Significance levels: * p<0.05, ** 0.05≤p≥0.001; *** p<0.001
Note: analysis based on data set reduced by observations on transects with strong glare (see Section 4.3)

5.3 Divers

5.3.1 Abundance in the Vesterhav Syd area

As a basis for the calculation of bird abundance in the study area, distance sampling analyses were performed. As mentioned in Section 4.3, these data are based on all three ”package 1” projects Vesterhav Syd, Vesterhav Nord and Bornholm in order to increase the statistical power and robustness of models. Therefore the number of included cases differs from other values for the single project ”Vesterhav Syd”. The calculation of the effective strip width (ESW) is presented once in the following for divers, for other species the results of distance analyses is given in the appendix in Section 16.3.

Distance analyses

A total of 1,334 individual divers were recorded in 763 sightings during the aerial surveys at Bornholm, Vesterhav Syd and Vesterhav Nord. This species-group consists of sightings of Red-throated Divers and unidentified divers.

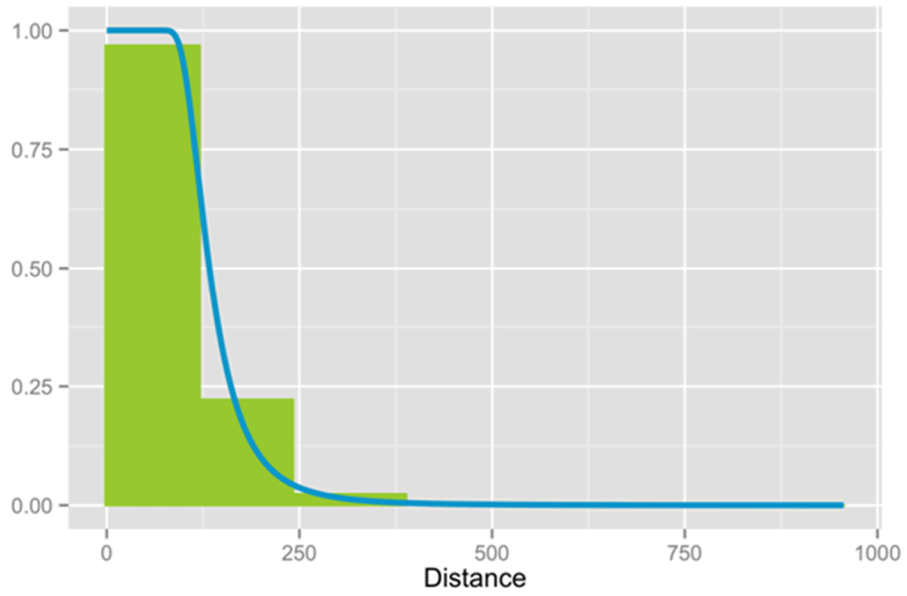


Figure 10: Detection function of divers (left side: detection probability). Band 0 is omitted and 0 distance is 44m off the centre line (see Section 4.3 for further explanations).

Model function	Hazard-rate
Covariates	NA
Analysed distance strips	A, B, C strip
Selection criterium	Visual assessment of Detection Function
ESW (lower and upper 95% CI)	145.55 (137.30 – 154.29)

In this group avoidance of birds from the 0-strip was expected, yet visual inspection of the data showed that these birds avoided by diving instead of flying away from the transect line. Hence the analysis of only the strips A – C and exclude sightings in the 0-strip (89 sightings) was chosen. A Half-normal detection function yielded the lowest AIC, but would lead to a strong overestimation of birds in strip A as inspected by visual assessment of the detection function. Therefore, a Hazard-rate model was chosen by visual assessment (Figure 10) leading to an effective strip width of 145.55 m and 95% confidence intervals between 137.3 and 154.29 m. These data are the basis for the assessment of bird densities and population estimates including estimations of confidence intervals.

Abundance

The recoded densities of divers (all divers including identified Red-throated divers) ranged between 0.15 birds/km² (16th April 2014) and 0.93 birds/km² (11th March 2014) with population estimates between 159 and 959 birds in the surveyed area (Table 12). The population estimates have to be regarded as minimum values as an unknown proportion of divers may be missed due to diving as normal feeding behaviour. Only few divers were seen flying. The seasonal phenology shows highest population estimates during the surveys in February (11th February 2014) and the beginning of March (11th March.2014, Figure 11). From 2nd to 11th of February a strong increase in bird numbers was recorded (see also explanation on total bird numbers in Section 5.2). In April 2014 lowest densities and population estimates were recorded. The densities of flying divers was low with maximum values of 0.05 birds/km².

Garthe et al. (2007) determine the the season ”winter” from the beginning of November to the end of February and Skov et al. (1995) allocate the months December to March as the period of wintering population for Red-throated and Black-throated Divers. Therefore, at least three surveys (five surveys according to Skov et al. 1995) covered the wintering period and the lack of surveys in December and January is supposed to have little effect on the estimation of wintering birds. Divers are not known to show peak values in these months. Due to the high variation of bird numbers in surveys in February, surveys in December and January would have improved data quality.

Table 12: Densities and population estimates of divers (unidentified diver including Red-throated divers) for each of the six surveys. Lower 95% confidence interval (LCI) and higher 95% confidence interval (HCI) are given

Date	Density (birds/km²)	Study area population estimate	LCI	HCI	Density of flying birds (birds/km²)
25.11.2013	0.52	533	379	750	0.01
03.02.2014	0.22	226	141	362	0.02
11.02.2014	0.85	881	664	1,171	0.02
11.03.2014	0.93	959	647	1,423	0.01
25.03.2014	0.39	404	252	646	0.05
16.04.2014	0.15	159	75	338	0.01

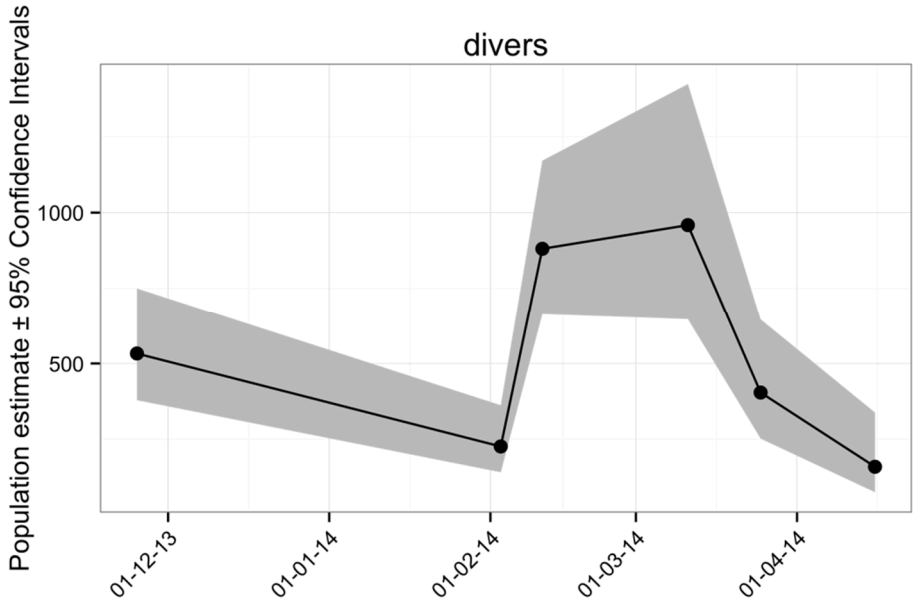


Figure 11: Population estimates (black line) and 95% confidence intervals (grey area) of divers during the six surveys

The phenology of identified Red-throated divers followed the one of ”all divers” (Figure 12) with population estimates ranging from 4 to 190 birds (densities from less than 0.01 to 0.18 bird/km², Table 13).

Table 13: Densities and population estimates of Red-throated Divers for each of the six surveys. Lower 95% confidence interval (LCI) and higher 95% confidence interval (HCI) are given

Date	Density (birds/km²)	Study area population estimate	LCI	HCI	Density of flying birds (birds/km²)
25.11.2013	0.07	77	30	198	0.00
03.02.2014	0.04	40	12	132	0.00
11.02.2014	0.18	190	92	391	0.00
11.03.2014	0.15	151	71	324	0.00
25.03.2014	0.06	61	28	133	0.00
16.04.2014	<0.01	4	1	24	0.00

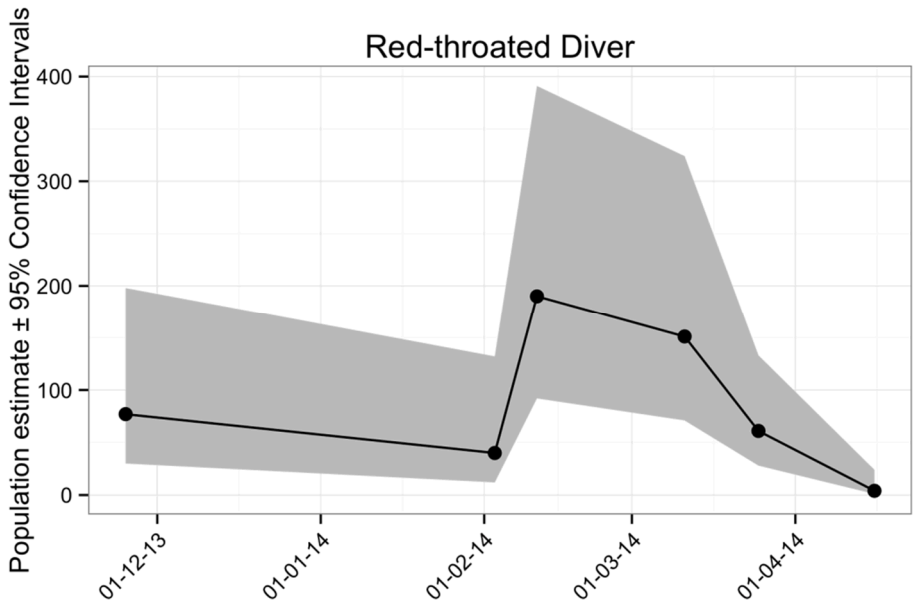


Figure 12: Population estimates (black line) and 95% confidence intervals (grey area) of identified Red-throated divers during the six surveys

5.3.2 *Distribution in the Vesterhav Syd area*

The distribution map in Figure 13 combines all six surveys and shows relative densities in number of individuals per kilometre flown transect. It shows that one concentration area was located near the coast in the north eastern part of the study area. Generally, the densities were low in the western parts of the area and also in the southern parts close to the coastline. The development area was also used by divers, the densities were low in most 2 x 2 grid cells (<0.2 individ-

uals/km) with higher values in the northern parts of the development area. There was no significant selectivity of the area by divers (Table 11).

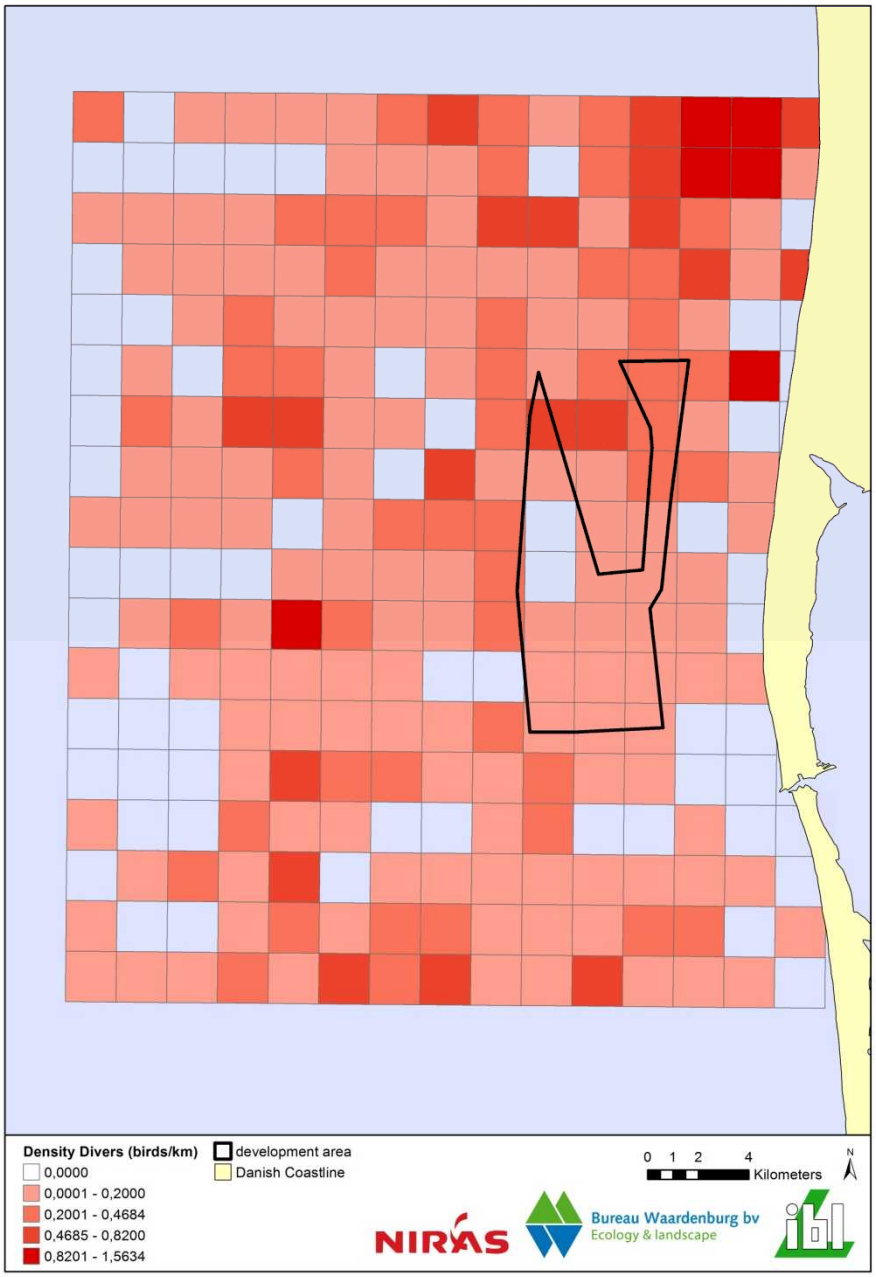


Figure 13: Relative density of divers based on six surveys. Data represent the number of observed birds per kilometer of flown transect in each 2 x 2 km grid square

There was considerable variation in the spatial distribution of divers between surveys (Figure 14). During the survey with the highest densities (11th March 2014), divers were more frequent in the northern part of the study area with a preference of the coastal areas (but also some concentrations at higher distanc-

es from coastline). In all but the last survey high densities were found in the north eastern part of the study area. High concentrations of divers within and around the development area were found in the first survey on 25th November 2013 and on 11th March 2014.

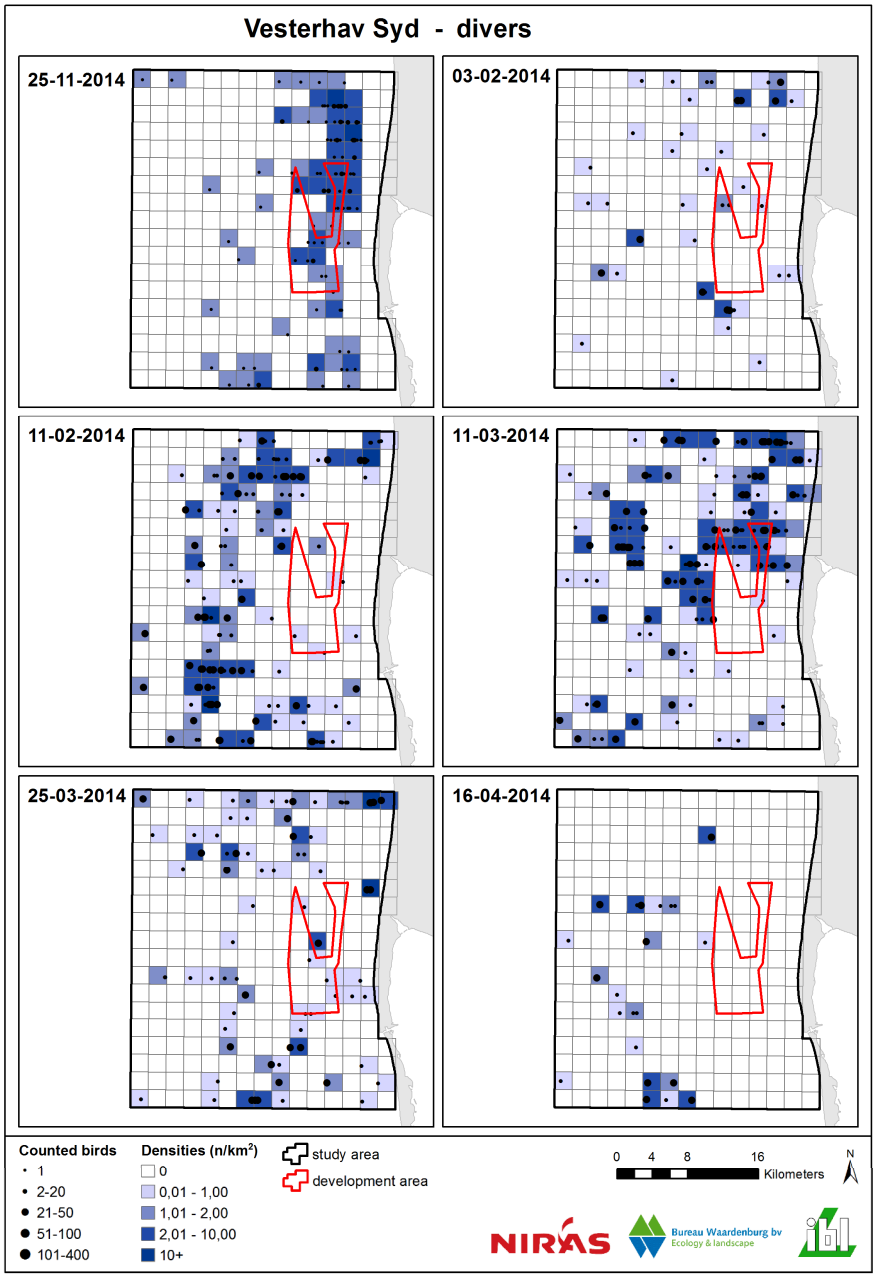


Figure 14: Counted numbers and density (n/km²) of divers based on six surveys. Data represented for 2 x 2 km grid square

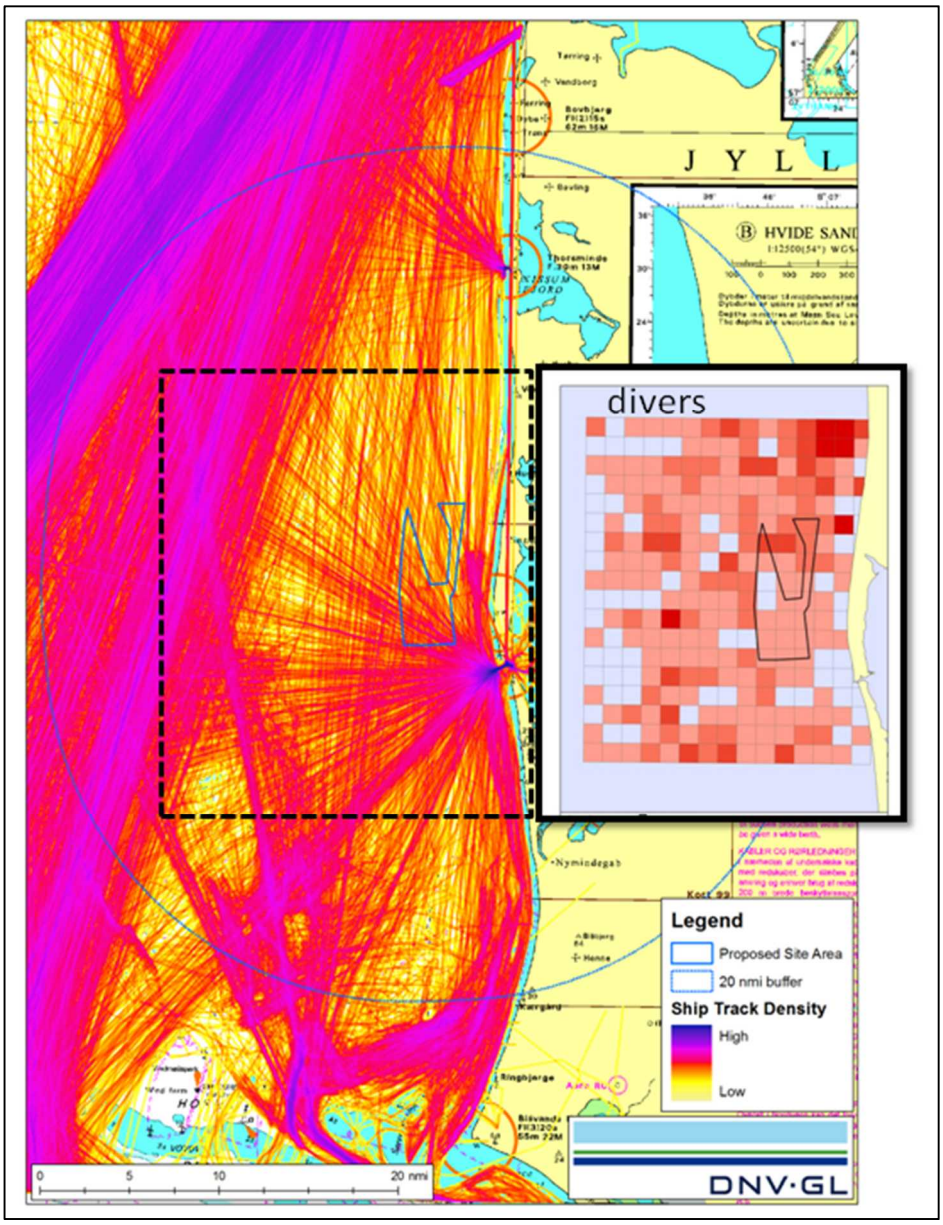


Figure 15: Ship track densities in the area around Vesterhav Syd development area from September to December 2013 (Det Norske Veritas 2015) and distribution map of divers

Divers are known to avoid areas with dense and regular ship traffic (Bellebaum et al. 2006, Schwemmer et al. 2011). Figure 15 demonstrates relative densities of ship traffic close to the Vesterhav Syd site in relation to the distribution of divers (see Figure 13). There are several obvious effects of ship traffic on the distribution of divers. The low abundance of divers in the western parts of the study area could be caused by high densities of vessel traffic. The high concentrations of divers in the north eastern part of the study area coincide with low densities of vessel traffic. Close to the sound to the Ringkøbing Fjord there is a relatively high ship traffic density and no divers were recorded in this area.

Figure 16 shows all sightings (raw numbers of counted birds) in relation to water depth profile of the area.

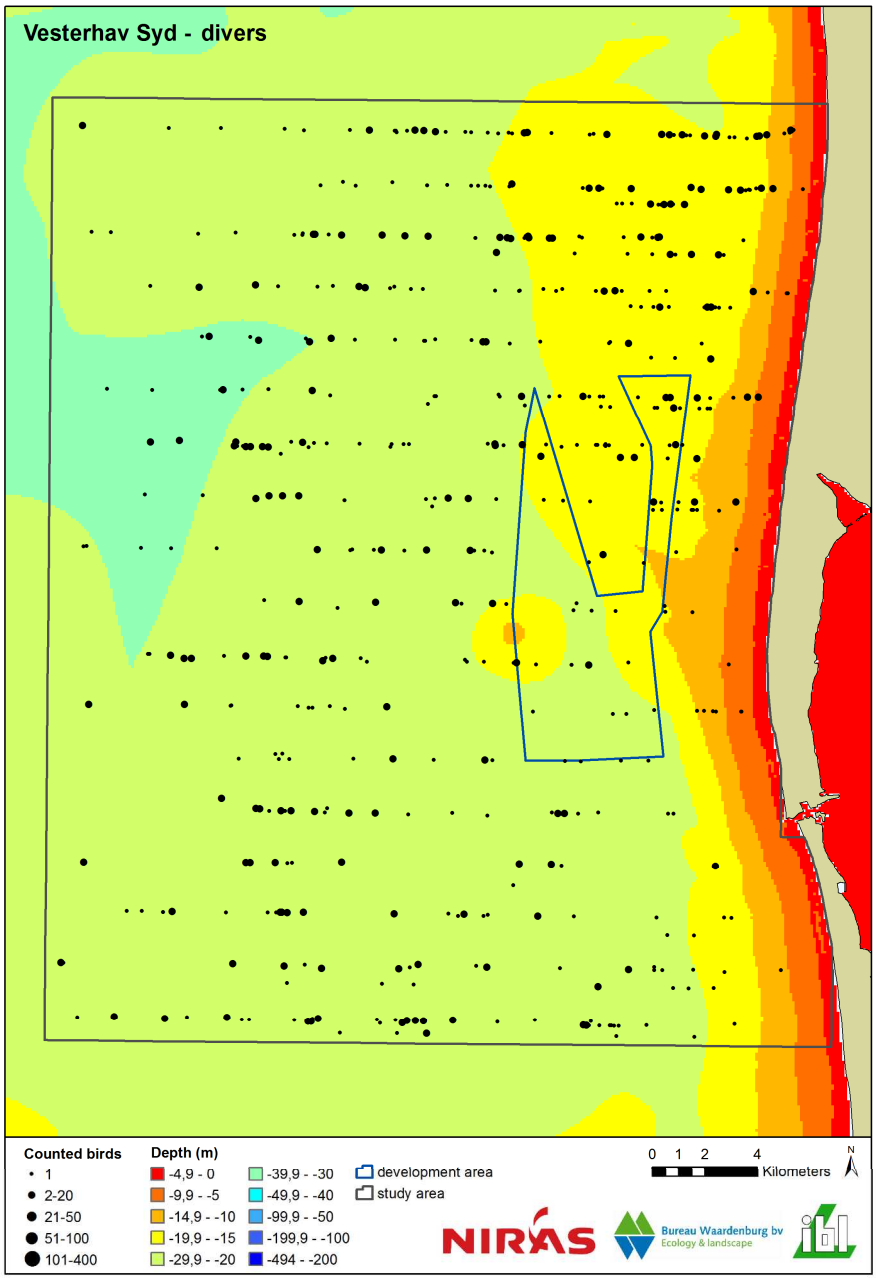


Figure 16: Distribution of counted divers as a sum of all six surveys in relation to water depth

Most divers used water depths between 16 and 30 m (Figure 17). The pattern of selectivity index is unclear with no water depths preferred. Most indices are around zero and the two strong negative values are based on low numbers of birds and frequency of depth interval resulting in limited conclusions. This lack of preference of water depth is consistent with the regular distribution of divers with respect to classes of water depths (see Figure 16).

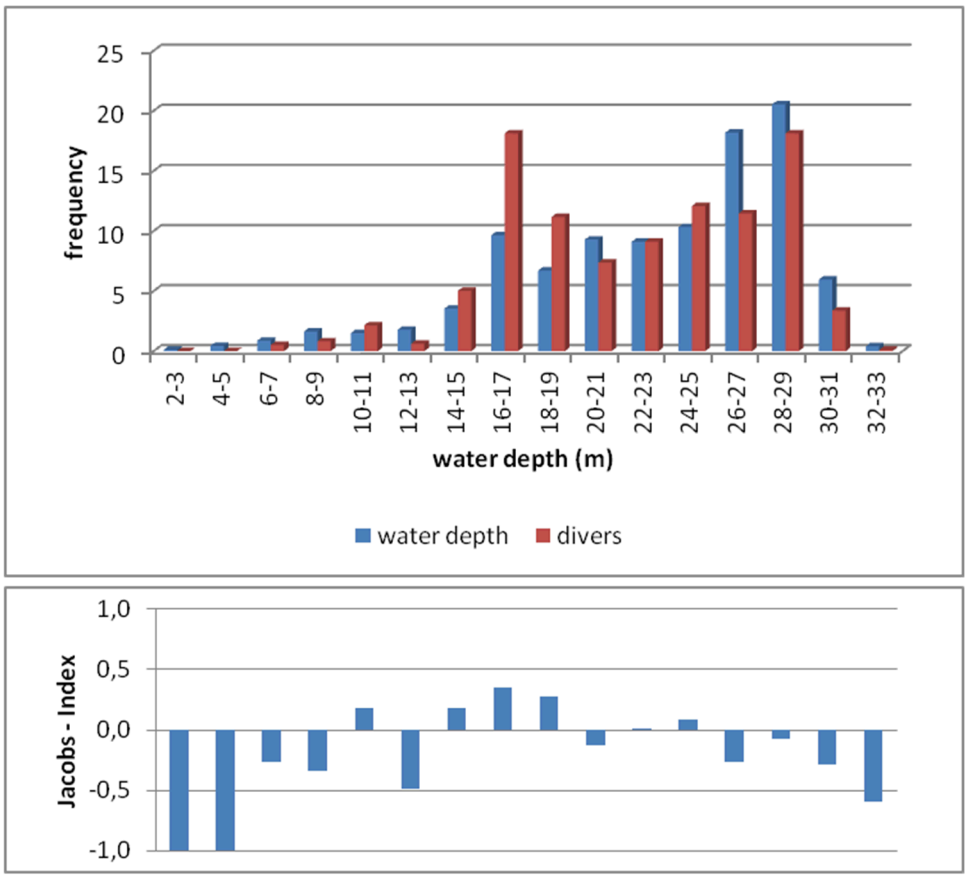


Figure 17: Frequency distribution of water depths and frequency distribution of the use of water depths by divers (2m-depth intervals, top) as well as Jacobs-Index of selectivity for each water depth category (bottom)

5.3.3 *Abundance and distribution according to other studies*

Red-throated Diver is the most common diver species in the North Sea (Dierschke et al. 2012). Based on the results from the ship surveys in 1999 in the Horns Rev 1 area, 78% of the identified divers were Red-throated and 22% Black-throated Divers (Christensen et al. 2006). During land-based surveys in the same area 98% of all divers were determined as this species and 2% were Black-throated divers (Piper et al. 2007). Great Northern diver and White-billed Divers were only recorded rarely.

Petersen & Nielsen (2011) modelled diver distribution along the Danish west coast in spring. They reported higher densities of divers, especially Red-throated

Divers, in spring than in winter. Therefore, only spring data were evaluated intensively. In the Vesterhav Syd study area the densities of divers is relatively low (c. 0.04-0.15 birds/km², Figure 18) with highest values in the west and north west of the study area.

According to Skov et al. (1995) densities of divers around the Vesterhav Syd development area range are between 0.4 and 0.5 birds/km² for the months October / November and April / Mail. During winter months (December – March) high densities of divers are expected south of the development area and only low densities are expected directly west of the Ringkøbing Fjord. The densities recorded in the Vesterhav Syd study are within the range given by Skov et al. (1995) and higher than those modelled by Petersen & Nielsen (2011).

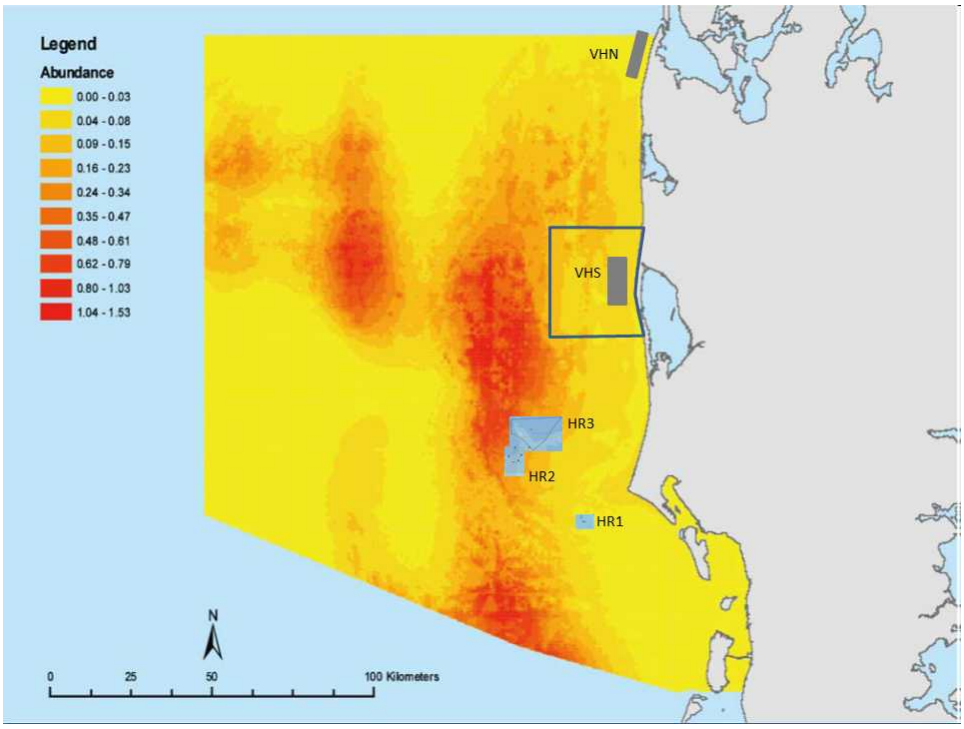


Figure 18: Model distribution of divers in spring (April 2008, 2009) and schematic location of development area of Vesterhav Syd (VHS, grey) and investigation area of VHN (grey line). Figure modified from Petersen & Nielsen (2011)

Explanation: positions of further wind farms Vesterhav Syd (VHN), Horns Rev 1 (HR1), Horns Rev 2 (HR2) and Horns Rev 3 (HR3) are indicated schematically

Studies of Horns Rev 1, 2 and 3 give further information on abundance and distribution of divers along the west coast of Denmark. The wind farms are located approximately 30 km south of Vesterhav Syd study area. The most recent study at Horns Rev 3 reported spring densities of up to 2.2 individuals/km² in early May but winter numbers were generally around 0.5 individuals/km² (HR3: Orbicon 2014a). Densities were high directly at the coastline but also in a band 10-30 km in front of the coast. Christensen et al. (2006) reported lower spring densities in

Horns Rev 2 with 0.8 Ind/km². For Horns Rev 1 a similar distribution occurred with high densities in coastal areas and again higher densities 30 km away from the coast (Christensen et al. 2003). Petersen et al. (2006a) presented data from 1999 to 2005 from the Horns Rev projects. Bird numbers increased significantly in all years in spring. Months with high densities were February, March and April. Surveys in May were conducted only twice, but only few divers were counted. Before the installation of the wind farm Horns Rev1 high densities were recorded occasionally around Blåvands Huk. Following construction, birds were mainly recorded in areas further offshore. The spatial distribution of divers in the North Sea could not be explained with a preference to certain water depths but depends on hydrographic conditions (Skov & Prins 2001).

According to Topping & Petersen (2011) numbers of resting birds in the Horns Rev area are high in January to April and much lower in May. However, this is the month were maximum numbers are recorded from land-based seawatching in Blåvand. Therefore, high counts of migrating birds do not necessarily reflect high numbers of resting birds. A similar pattern arises in autumn when migration is relatively high in September/October but numbers of resting birds build up only very slowly.

In the Vesterhav Syd area densities of divers in spring did not reach the peak values as in the Horns Rev area. Densities in winter survey fluctuated strongly but were of comparable magnitude than in the Horns Rev area. In contrast to the prediction of Petersen & Nielsen (2011) diver densities were lowest further offshore and peaked relatively close to the coastline.

5.4 Northern Gannet

5.4.1 Abundance in the Vesterhav Syd area

During the winter surveys the densities and estimated population of Northern Gannets was low (no birds during the first three surveys) whereas in spring the densities increased to 0.06 birds/km² and an estimated number of 57 birds on 16th April 2014 (Table 14). Most of the birds were seen flying indicated by the same or similar density of flying birds compared to the total densities.

The seasonal trend is also shown in Figure 19 with increasing numbers in spring.

Table 14: Densities and population estimates of Northern Gannets for each of the six surveys. Lower 95% confidence interval (LCI) and higher 95% confidence interval (HCI) are given

Date	Density (birds/km²)	Study area population estimate	LCI	HCI	Density of flying birds (birds/km²)
25.11.2013	0.00	0	0	0	0.00
03.02.2014	0.00	0	0	0	0.00
11.02.2014	0.00	0	0	0	0.00
11.03.2014	0.01	7	3	20	0.01
25.03.2014	0.03	35	22	56	0.03
16.04.2014	0.06	57	31	106	0.05

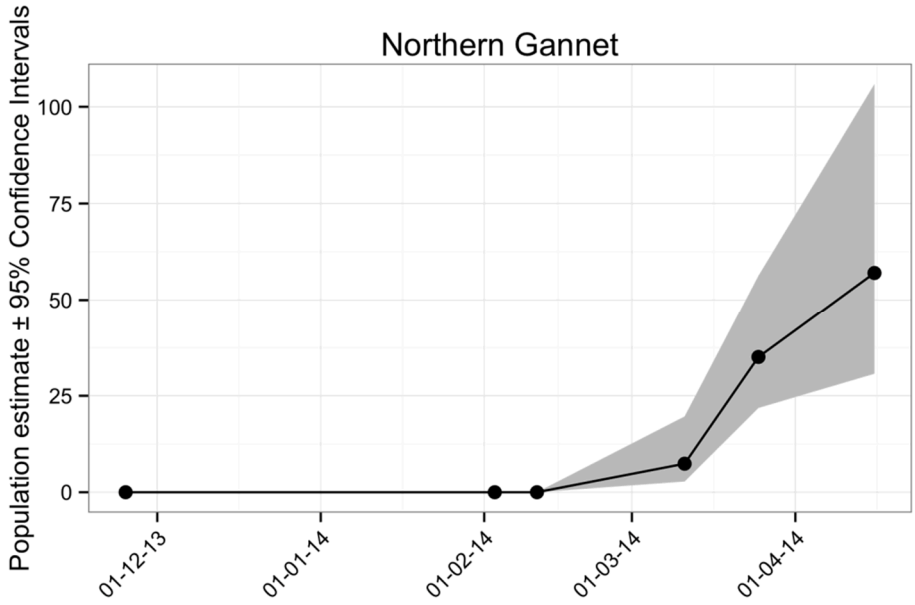


Figure 19: Population estimates (black line) and 95% confidence intervals (grey area) of Northern Gannets during the six surveys

5.4.2 *Distribution in the Vesterhav Syd area*

The overall distribution map shows a scattered distribution with some higher concentrations in the north and west of the study area. There was no selectivity of the development area for any impact distance (Table 11).

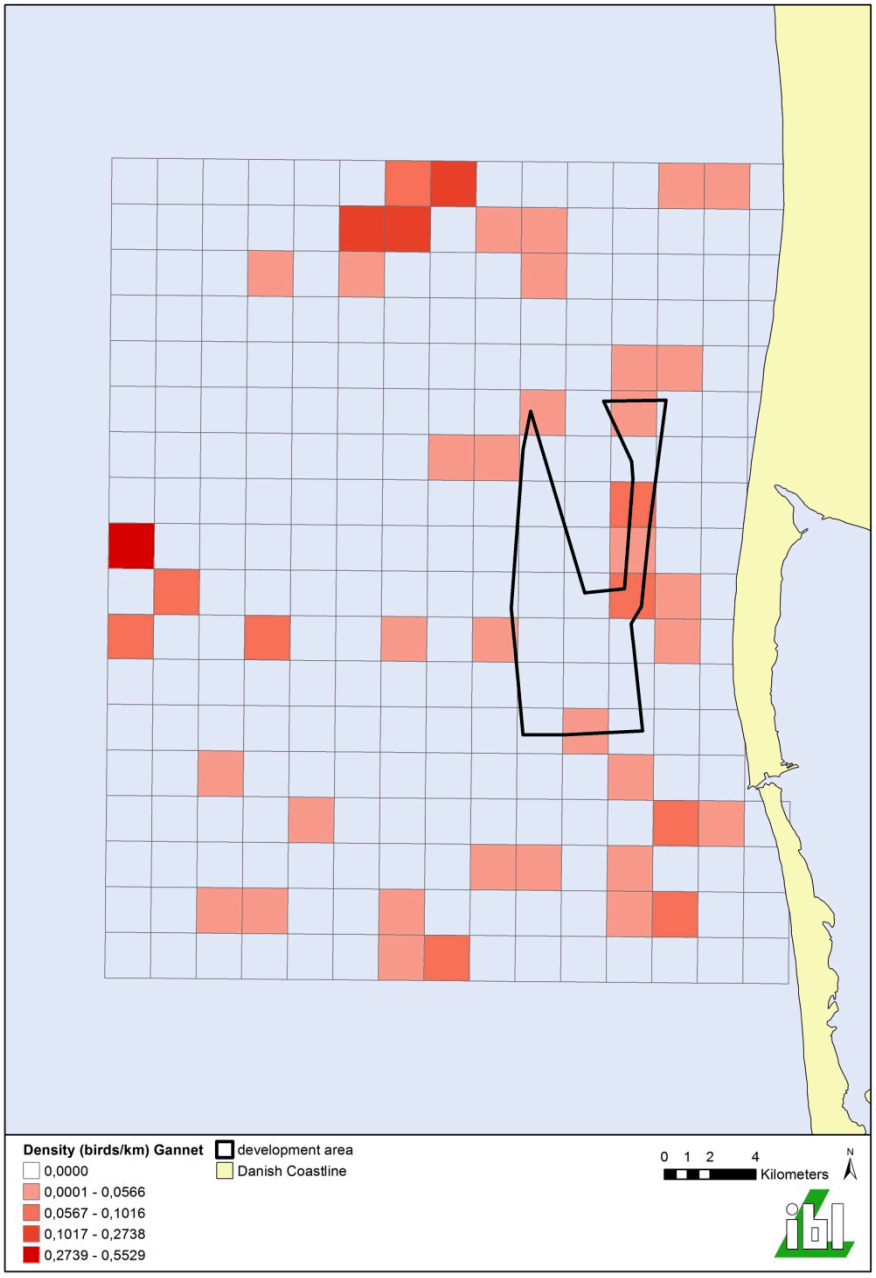


Figure 20: Relative density of Northern Gannets based on six surveys. Data represent the number of observed birds per kilometer of flown transect in each 2 x 2 km grid square

A high variation in the spatial distribution was found between consecutive survey flights (Figure 21). The concentrations in the north and west of the study area were found only on 16th April 2014 whereas on the other two days with Northern Gannets present in the area birds were located more often in the eastern part of the study area.

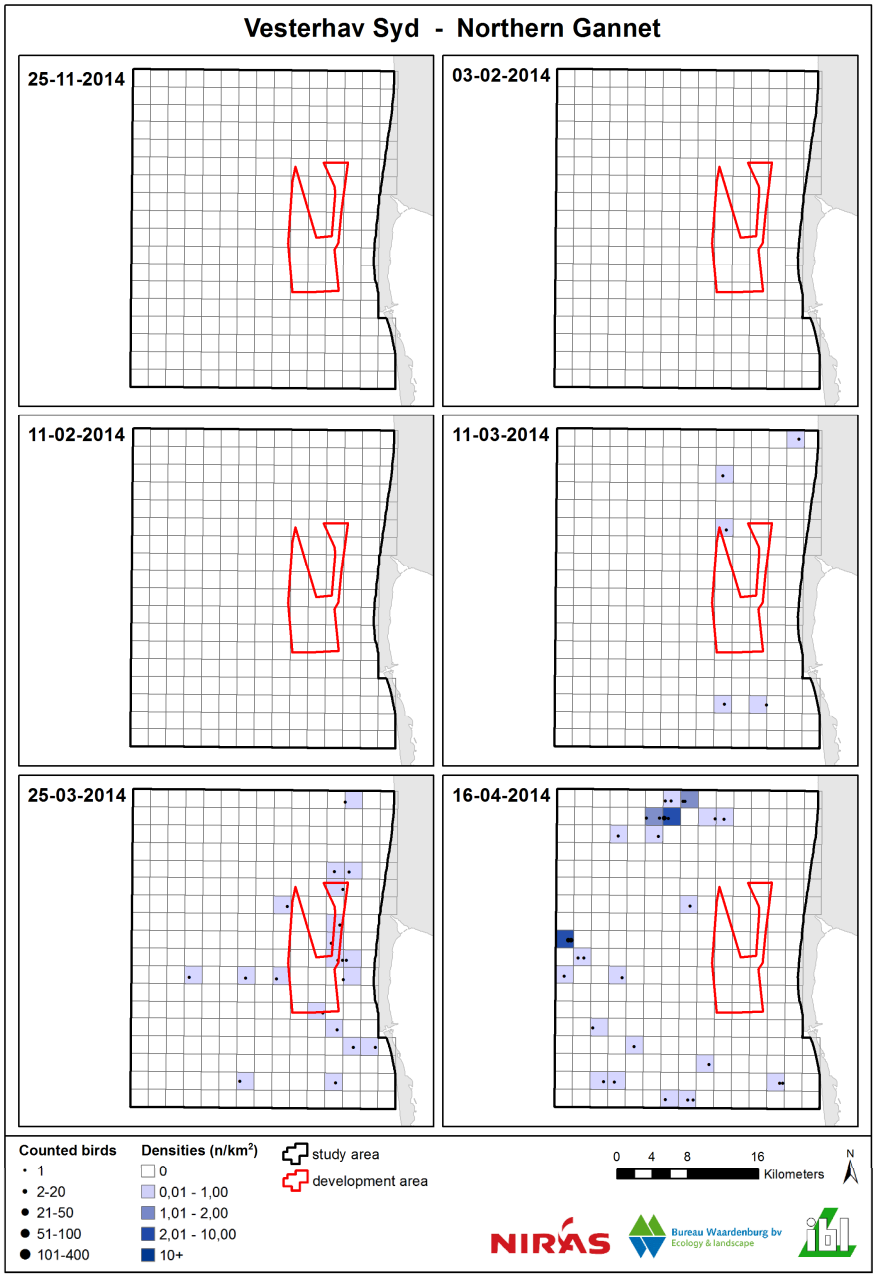


Figure 21: Counted numbers and density (n/km²) of Northern Gannets based on six surveys. Data represented for 2 x 2 km grid square

The analysis of water depths showed no clear pattern of preference of particular water depths and birds were mostly seen in water depths from 14 to 30 m. A distribution map of bird observations in relation to water depths is presented in Figure 68 in the Appendix (Section 16.4).

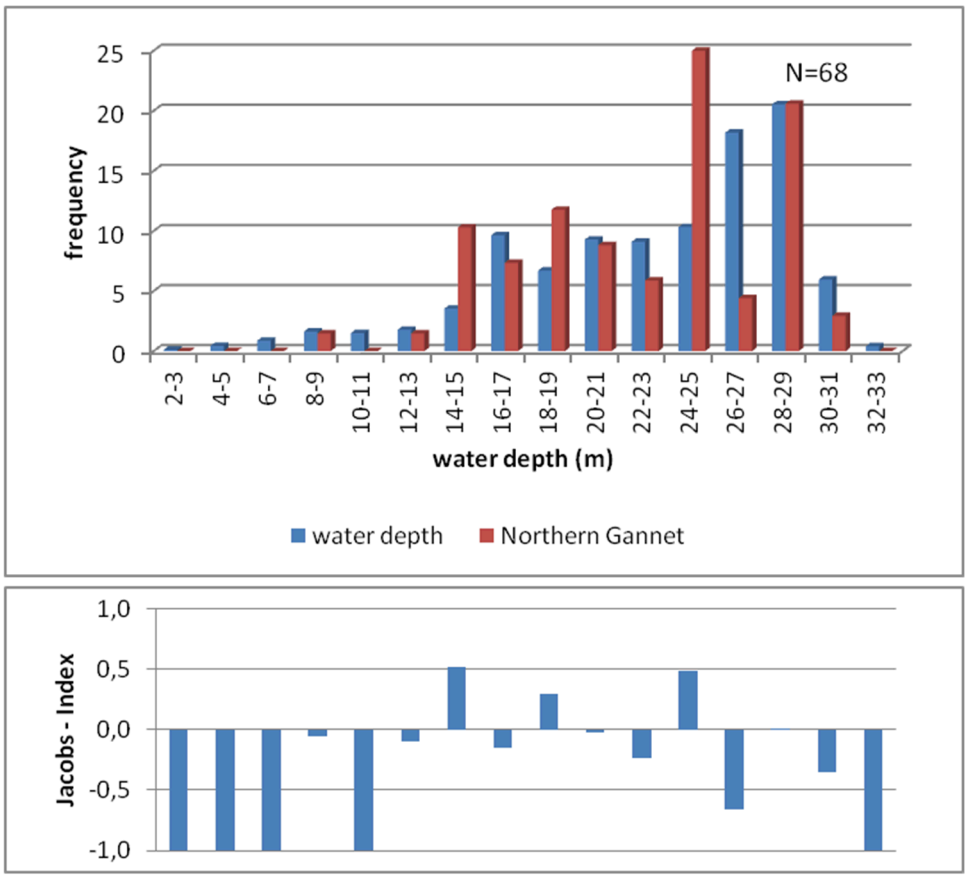


Figure 22: Frequency distribution of water depths and frequency distribution of the use of water depths by Northern Gannets (2m-depth intervals, top) as well as Jacobs-Index of selectivity for each water depth category (bottom)

5.4.3 *Abundance and distribution according to other studies*

In the Horns Rev 3 area high numbers of Northern Gannet were found in April/May and more pronounced in August/September with the highest density in early September with around 0.15 individuals/km² (HR3: Orbicon 2014a). During all other surveys densities were below 0.1 individuals/km². A clear spatial pattern within the study area was not detectable. Also in Horns Rev 2 the distribution of Northern Gannets was variable and an accumulation in the western part of the area resulted from single survey days (Christensen et al. 2006).

During surveys in relation to the Horns Rev 1 wind farm densities and phenology of Northern Gannets were similar to Horns Rev 3 studies with a maximum number in September 1999 resulting in a density of 0.18 individuals/km². However, the average number was much lower and only during single surveys was a density higher than 0.02 individuals/km² recorded (Christensen et al. 2003). Most birds occurred in spring and autumn but numbers were strongly fluctuating between years (Petersen et al. 2006a). In total, 1,144 birds were seen during surveys between 1999 and 2005 (Petersen et al. 2006a). A clear spatial pattern was

recorded with higher numbers seen in the western parts of the study area which are further offshore (Christensen et al. 2003).

Similar to the Horns Rev studies densities of Northern Gannets in the Vesterhav Syd area was continuously below 0.1 individuals/km² with highest numbers in spring (March/April). In the present study at Vesterhav Syd, the period of summer and early autumn (August/September) was not covered and a comparison with other studies is not possible. A concentration of birds in more offshore areas such as Horns Rev 1 could not be found in Vesterhav Syd, where distribution was variable.

5.5 Common Scoter

5.5.1 Abundance in the Vesterhav Syd area

The densities of Common Scoters fluctuated between 0.20 individuals/km² in April 2014 and 1.93 individuals/km² on 11th February 2014 (Table 15). The highest estimated population size was found during the survey on 11th February 2014 with a calculated 1,996 individuals. In other surveys population sizes ranged from 209 to 880 individuals. The contribution of flying birds to the total density was relatively high (> 65% in all surveys). Figure 23 shows the seasonal occurrence of bird numbers including confidence intervals for subsequent surveys. From 3rd February to 11th February 2014 a strong increase in bird numbers was recorded with continuously decreasing numbers in the following surveys.

Garthe et al. (2007) determine the season ”winter” for Common Scoter in German waters from the beginning of December to the end of February. Similarly, Skov et al. (1995) allocate the months December to February as the period of wintering population for Common Scoters in the North Sea. Therefore, the two surveys in February with rather different results covered the wintering period and the lack of surveys in December and January means some degree of uncertainty for estimating winter population. As bird numbers on 11th February 2014 were higher than on 3rd February 2014 many other species were also recorded in high numbers on 11th February probably as a result of short term changes in bird stock due to weather condition. Therefore, the high value taken from the 11th February survey is probably an overestimation of wintering numbers.

Table 15: Densities and population estimates of Common Scoters for each of the six surveys. Lower 95% confidence interval (LCI) and higher 95% confidence interval (HCI) are given

Date	Density (birds/km²)	Study area population estimate	LCI	HCI	Density of flying birds (birds/km²)
25.11.2013	0.72	742	390	1,411	0.58

Date	Density (birds/km²)	Study area population estimate	LCI	HCI	Density of flying birds (birds/km²)
03.02.2014	0.51	530	262	1,072	0.37
11.02.2014	1.93	1,996	991	4,019	1.26
11.03.2014	0.85	880	350	2,212	0.61
25.03.2014	0.31	316	94	1,067	0.23
16.04.2014	0.20	209	85	513	0.16

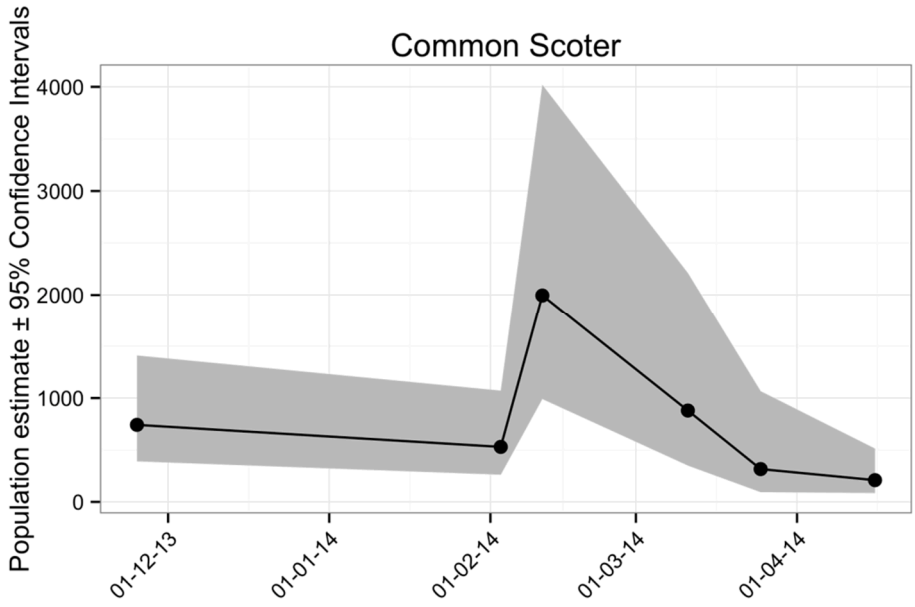


Figure 23: Population estimates (black line) and 95% confidence intervals (grey area) of Common scoters during the six surveys

5.5.2 *Distribution in the Vesterhav Syd area*

The relative densities of Common Scoter based on all surveys reveals two areas of concentrations: one in the coastal area in the south east of the study area and a second around the north eastern part of the development area. This pattern corresponds with positive indices of site selection (Jacobs index, Table 11) for all distance intervals investigated (DA+0, DA+2, DA+4) with significantly more birds found than expected in comparison with the total study area.

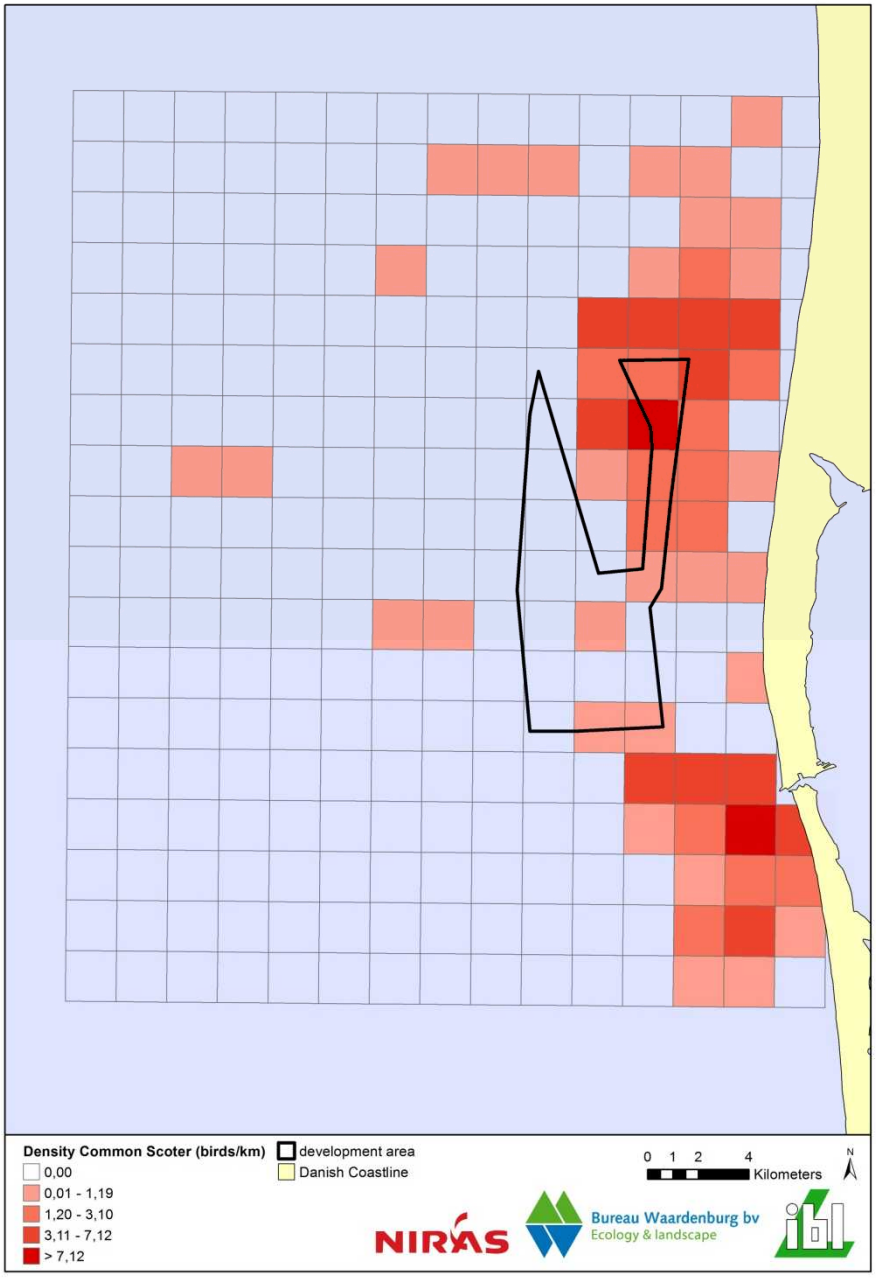


Figure 24: Relative density of Common Scoter based on six surveys. Data represent the number of observed birds per kilometer of flown transect in each 2 x 2 km grid square

The described concentration areas were very consistent during the surveys (Figure 25). Only in the last two surveys, when bird numbers had markedly decreased, were few birds found in the south eastern part of the study area. Outside of the concentration areas Common Scoters were only seen occasionally.

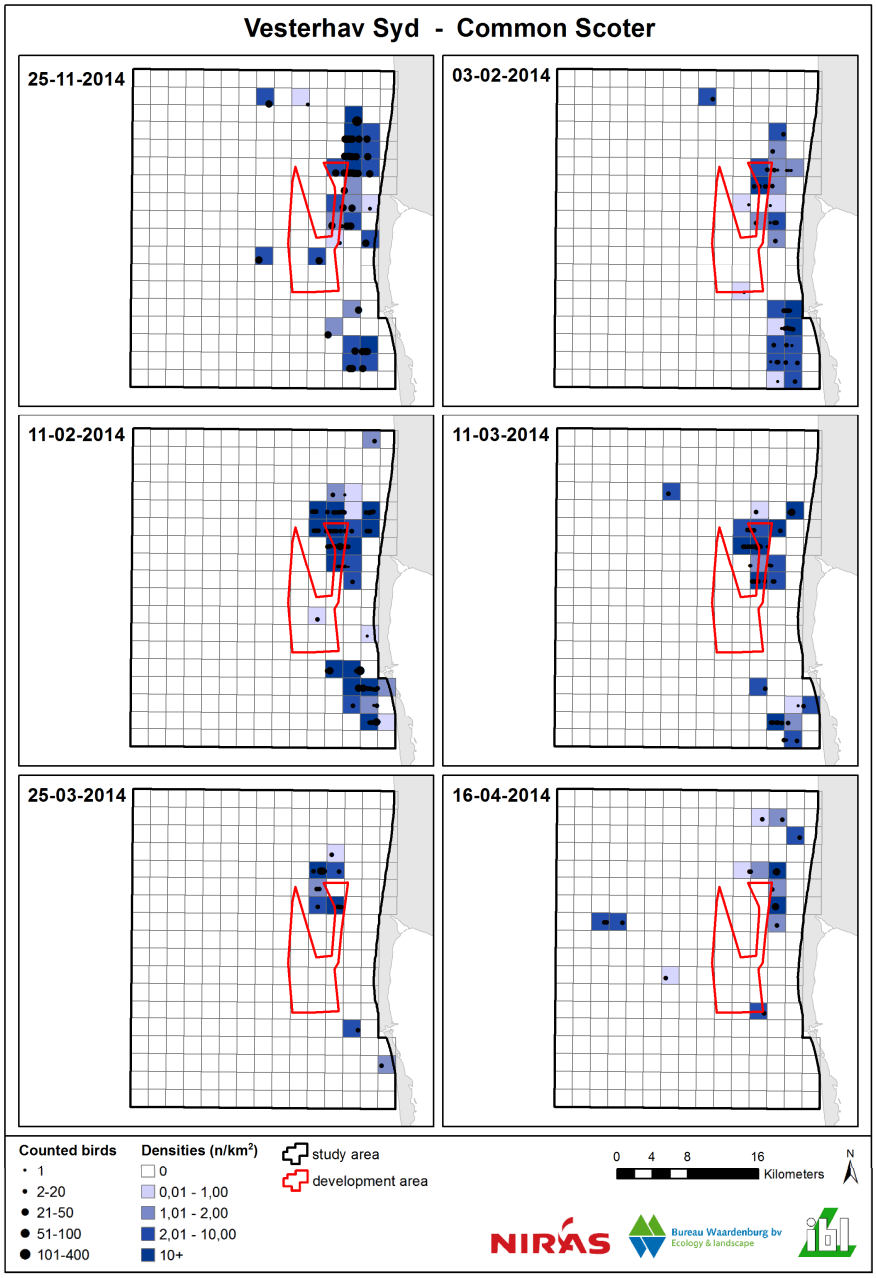


Figure 25: Counted numbers and density (n/km²) of Common Scoters based on six surveys. Data represented for 2 x 2 km grid square

Common Scoters were found almost exclusively in water depths between 10 and 18 m (Figure 26). More than 70 % of all birds were present from 14 to 18 m. The adjacent depths showed neutral indices and water depth above 22 m and below 6 m were almost entirely not utilised.

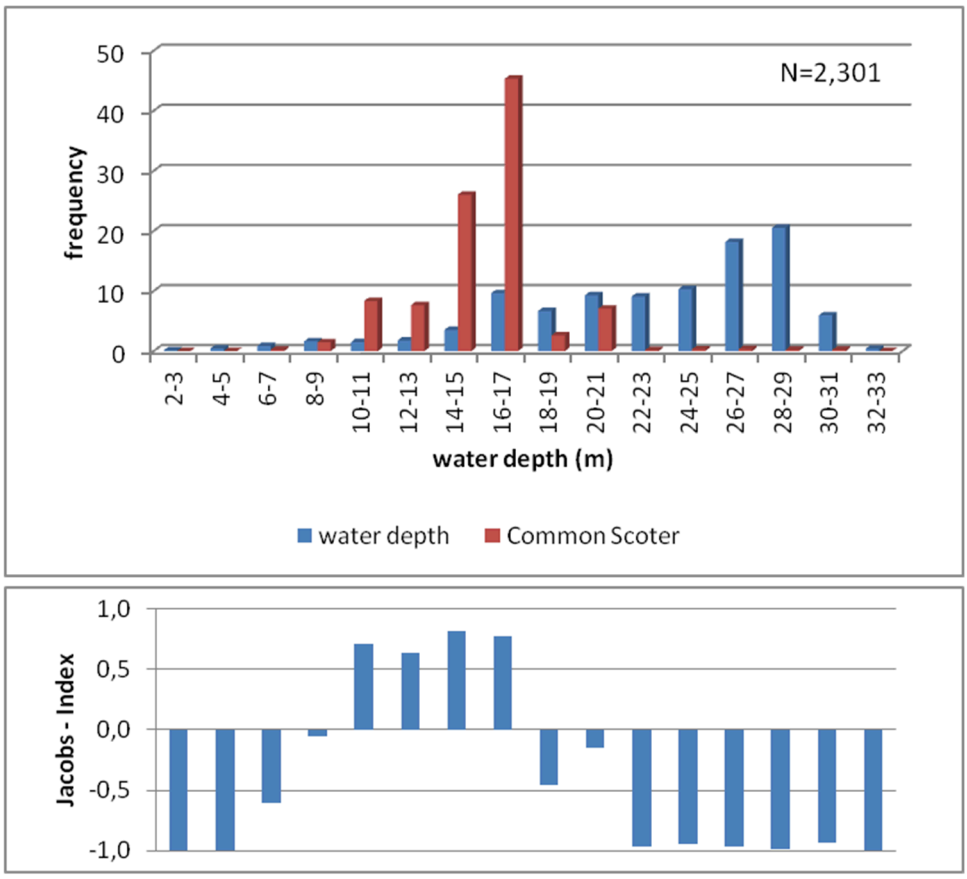


Figure 26: Frequency distribution of water depths and frequency distribution of the use of water depths by Common Scoter (2m-depth intervals, top) as well as Jacobs-Index of selectivity for each water depth category (bottom)

Figure 27) shows the spatial distribution of all sightings of Common Scoters in relation to the water depths.

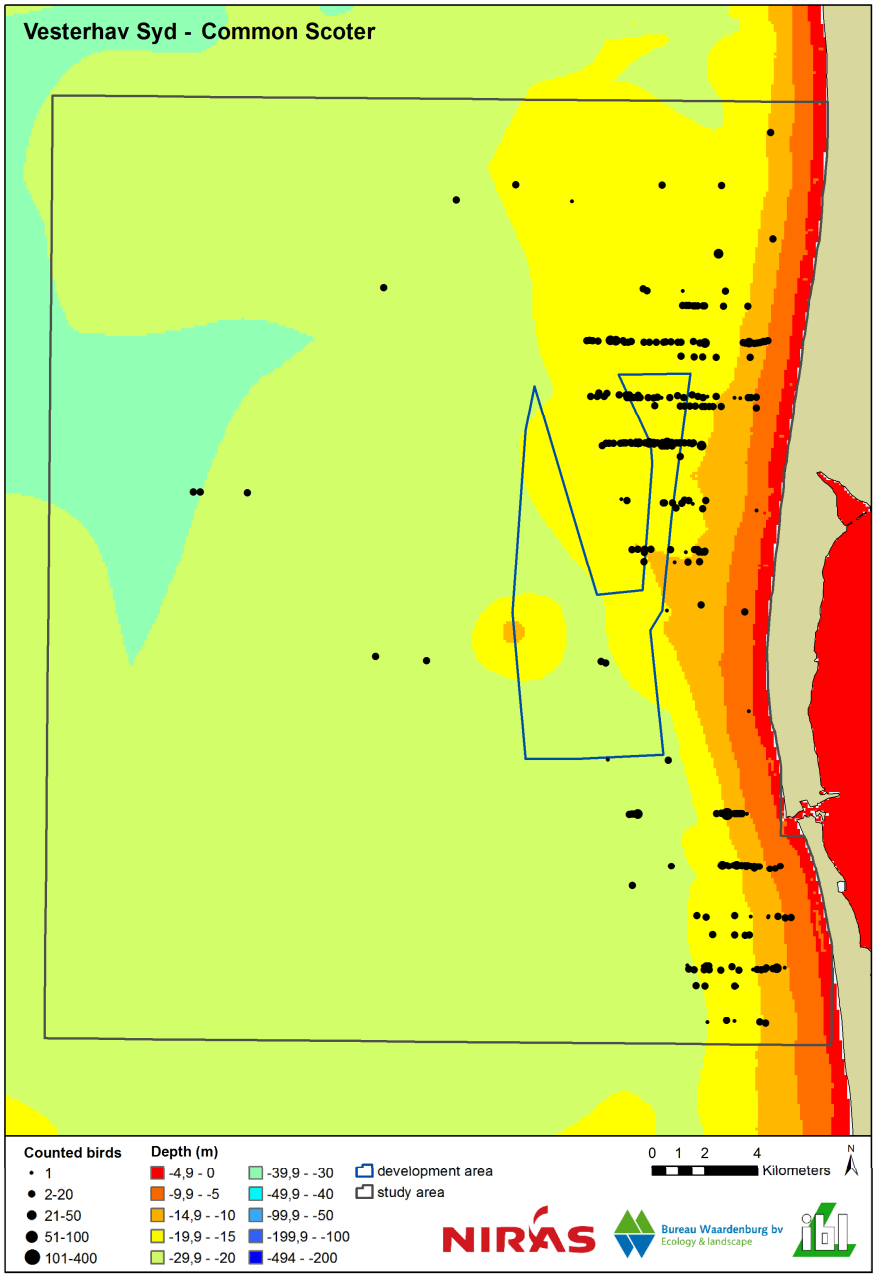


Figure 27: Distribution of counted Common Scoter as a sum of all six surveys in relation to water depth

The distribution of Common Scoters depends on the availability of food. In the Horns Rev area the bivalves *Spisula subtruncata* and *Ensis americanus* are the main prey species used by Common Scoter, and are regarded as the most important prey for Common Scoter in the Danish North Sea (Skov et al. 2008). Neither species were found during benthos surveys in the Vesterhav Syd area

(NIRAS 2015a). The Vesterhav Syd area used by Common Scoter (north eastern part) is dominated by the biotope type “Sand with *Tellina fibula*” (Figure 28) with the bivalve mollusc Bean-like Tellin *Tellina fabula* being the most dominant bivalve (abundances of up to 260 ind./m² in respective benthos sampling stations). Therefore, it can be assumed that the Common Scoter mainly feed on *Tellina fabula*. The analyses of Common Scoter distribution in relation to water depth at Horns Rev project and at Vesterhav Syd showed a strong selection of water depth with only few birds going deeper than 17 m at Vesterhav Syd. The bathymetry of the area shows that the north eastern part of the development area shows water depths of 17 m and less, whereas in the other parts water is deeper than 20 m (Figure 3).

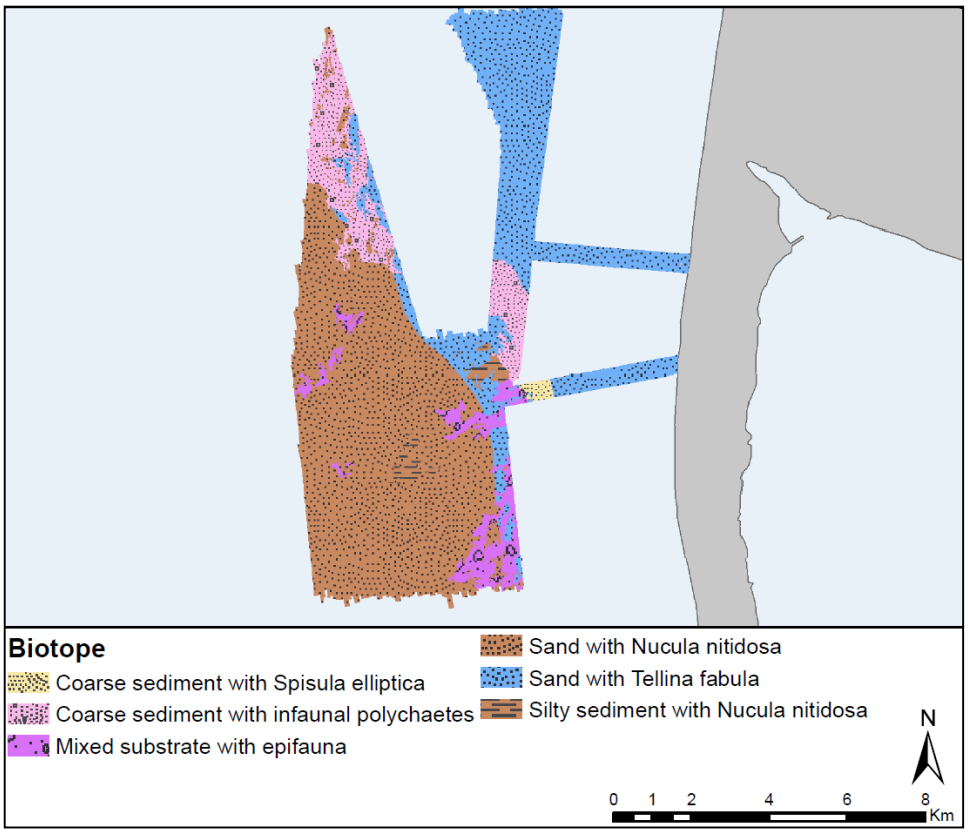


Figure 28: Biotope map of the Vesterhav Syd area (scource: NIRAS 2015a)

5.5.3 *Abundance and distribution according to other studies*

Common Scoter occur in high numbers in the coastal waters of Denmark with a well defined distribution (Petersen & Nielsen 2011). In the North Sea important roosting areas are found west and south of Blåvands Huk (including areas around the Horns Rev wind farms) and in front of the islands further south. In contrast, only low numbers of Common Scoter occur further north along the west

coast of Jutland. However, the data are considered insufficient for those areas (Petersen & Nielsen 2011).

Bird densities in all studies on Horns Rev wind farms were highest in winter and spring. For Horns Rev 3, maximum densities reached nearly 45 birds/km² in February for the entire study area, although scoters were absent in parts of the study area (HR3: Orbicon 2014a). Also in the Horns Rev 2 study area highest numbers were found in the beginning of February (approximately 94.000 individuals in February 2005). The spatial distribution is determined by water depth and the occurrence of suitable prey species. Christensen et al. (2006) found a strong preference of Common Scoter in areas with a water depth of 6 -14 m. This is a shift to deeper waters than described in earlier studies (preference of 4 - 10 m water depth). This is explained by a shift in the preferred diet species. Common Scoter are known to feed on American Razor Clam (*Ensis americanus*) which are found in deeper water. Therefore, distribution might be adapted to this food resource. A shift to deeper waters later in the season was found at Horns Rev 3 suggesting a change in prey species, from Surf Clams (*Spisula subtruncata*) to the American Razor Calm (HR3: Orbicon 2014a). A distribution linked to the availability of biomass was also reported in other areas (Kaiser et al. 2006). According to Skov et al. (1995) Common Scoter use the Danish west coast for wintering (December – February) with densities of less than 1 bird/km², with higher densities from October to November and from March to May. Birds are supposed to occur only very close to the coastline. The Vesterhav Syd area is part of the area “Danish west coast” where densities of 4.7 birds/km² and total estimates of 3,525 Common Scoter are expected in October / November.

The results from Vesterhav Syd surveys confirm the suggestion of low numbers of Common Scoters further north in relation to the Horns Rev / Blåvand area. Densities below 1.9 bird/km² and a maximum population estimated of approximately 2,000 birds are far below the data from the Horns Rev area. The numbers during the November survey were below those expected according to Skov et al. (1995). The preferred water depths of between 14 and 18 m at Vesterhav Syd are only slightly deeper than the preferred water depth at Horns Rev.

5.6 Velvet Scoter

5.6.1 Abundance in the Vesterhav Syd area

Maximum densities of Velvet Scoter were found on 11th March 2014 with a value of 0.11 birds/km². The population estimates ranged from 2 (16th April 2014) to 118 individuals (11th March 2014, Table 16, Figure 29).

Table 16: Densities and population estimates of Velvet Scoters for each of the six surveys. Lower 95% confidence interval (LCI) and higher 95% confidence interval (HCI) are given

Date	Density (birds/km²)	Study area population estimate	LCI	HCI	Density of flying birds (birds/km²)
25.11.2013	0.01	13	3	50	0.01
03.02.2014	0.08	79	30	208	0.06
11.02.2014	0.04	37	12	112	0.00
11.03.2014	0.11	118	34	406	0.09
25.03.2014	0.05	49	2	1,011	0.05
16.04.2014	<0.01	2	0	12	0.00

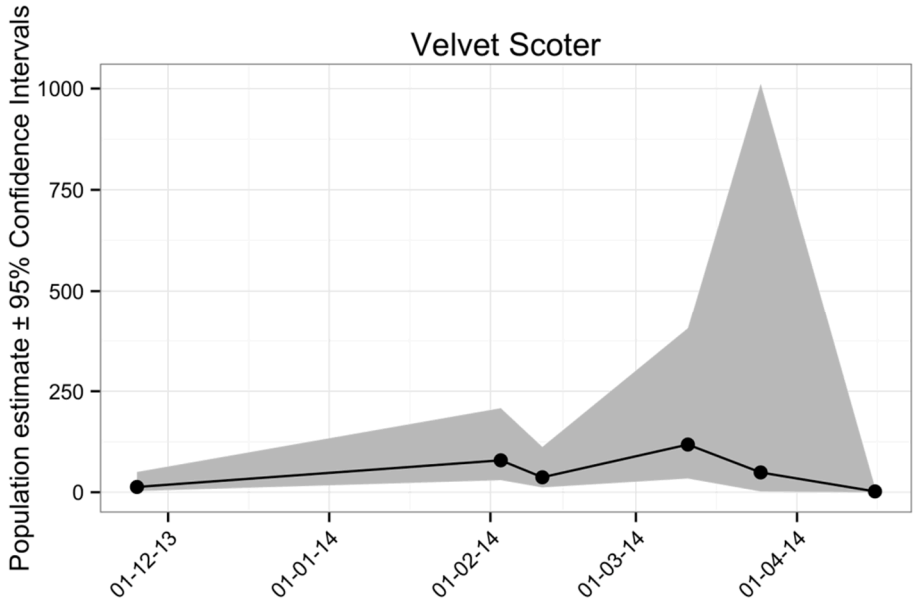


Figure 29: Population estimates (black line) and 95% confidence intervals (grey area) of Velvet Scoters during the six surveys

5.6.2 *Distribution in the Vesterhav Syd area*

Velvet Scoter were found in association with Common Scoter in two areas: first, in the south eastern part of the study area and second, in the north eastern part of the development area (Figure 30). No Velvet Scoter were seen outside of these areas.

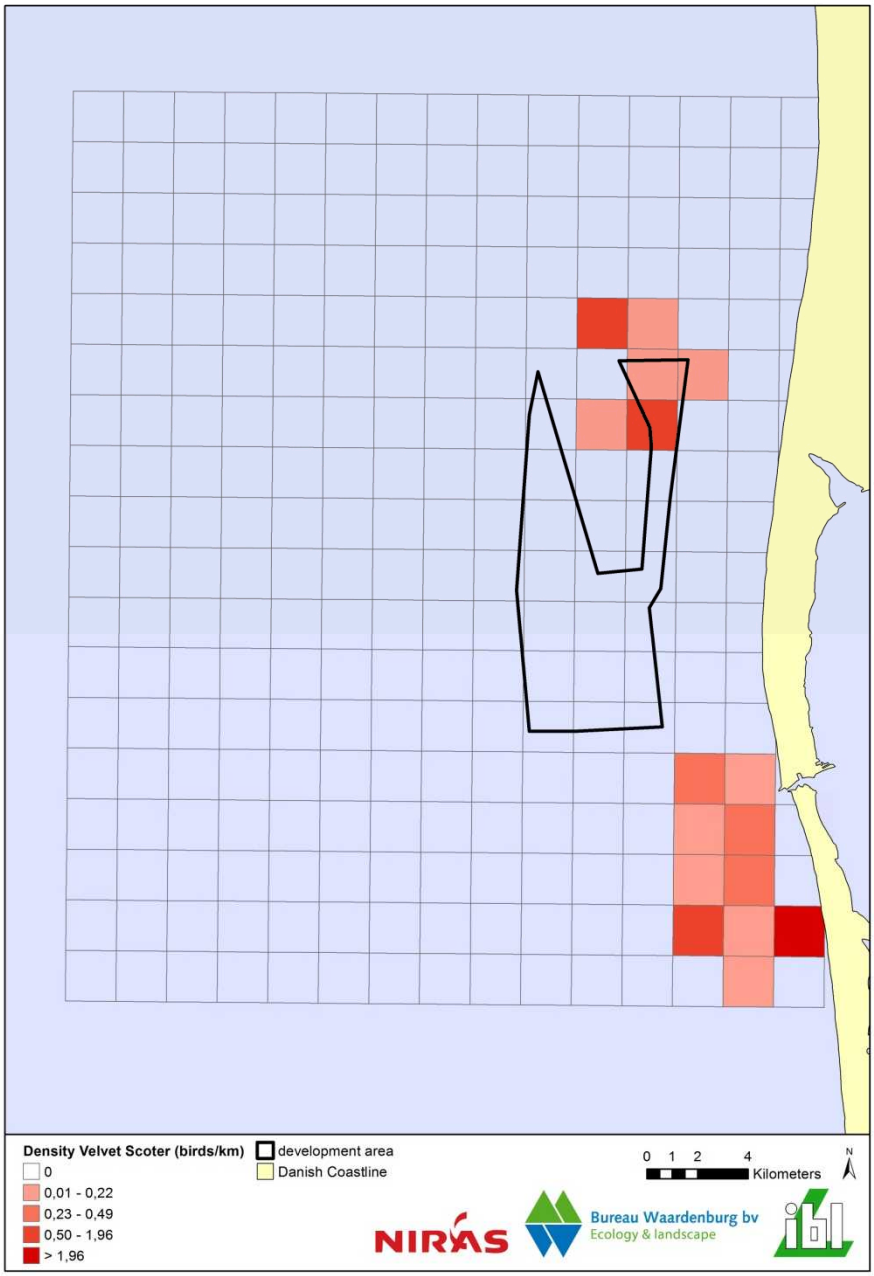


Figure 30: Relative density of Velvet Scoter based on six surveys. Data represent the number of observed birds per kilometer of flown transect in each 2 x 2 km grid square

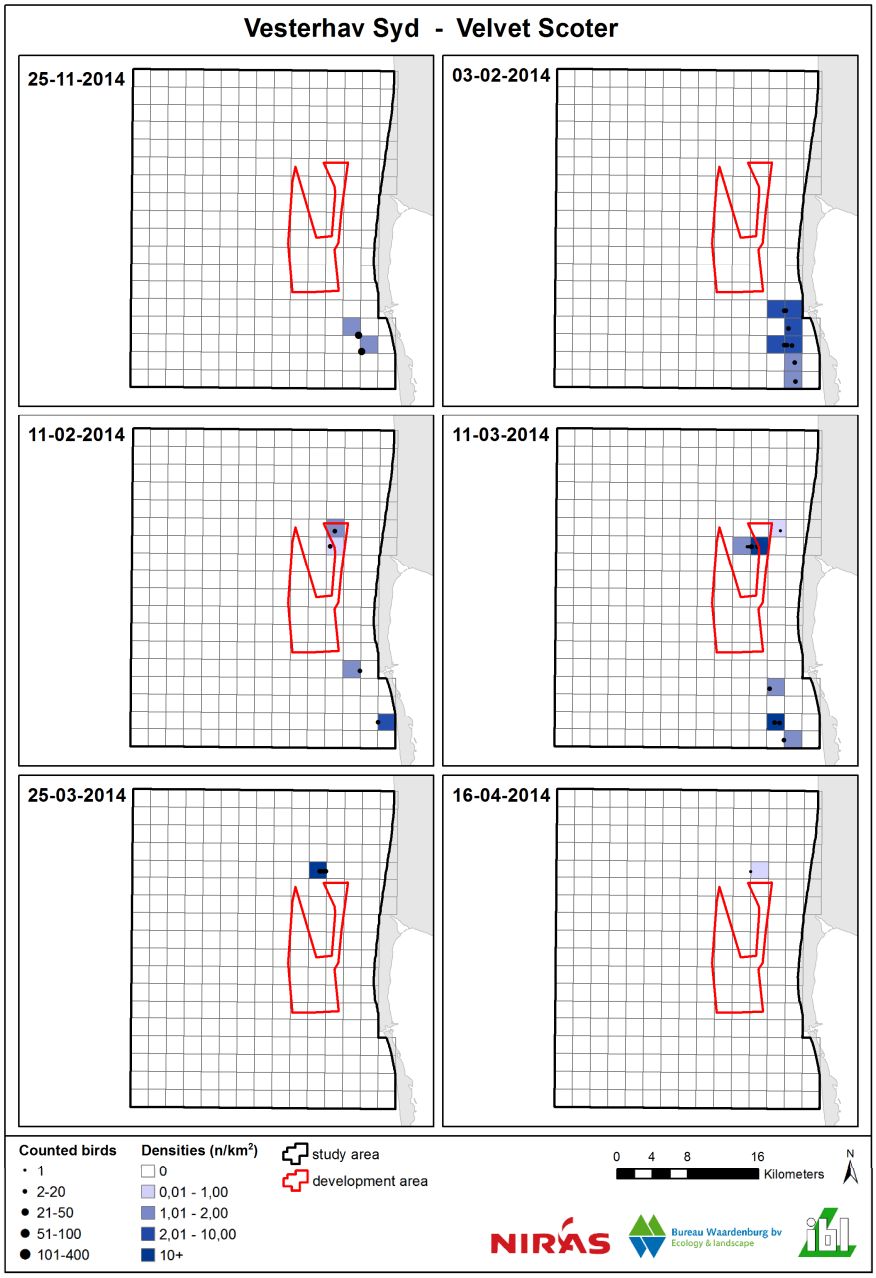


Figure 31: Counted numbers and density (n/km²) of Velvet Scoters based on six surveys. Data represented for 2 x 2 km grid square

The distribution differed between surveys. Velvet Scoter were only observed in the south east on surveys on 25th November 2013 and 3rd February 2014). On the last two surveys, observations were made only in the north east and on the 11th February 2014 and 11th March 2014 at both sites.

The selection of water depths observed in Velvet Scoter was similar to that of Common Scoter: most Velvet Scoters were seen at water depths between 10 and 18 m with high selectivity indices of these depth classes (Figure 32).

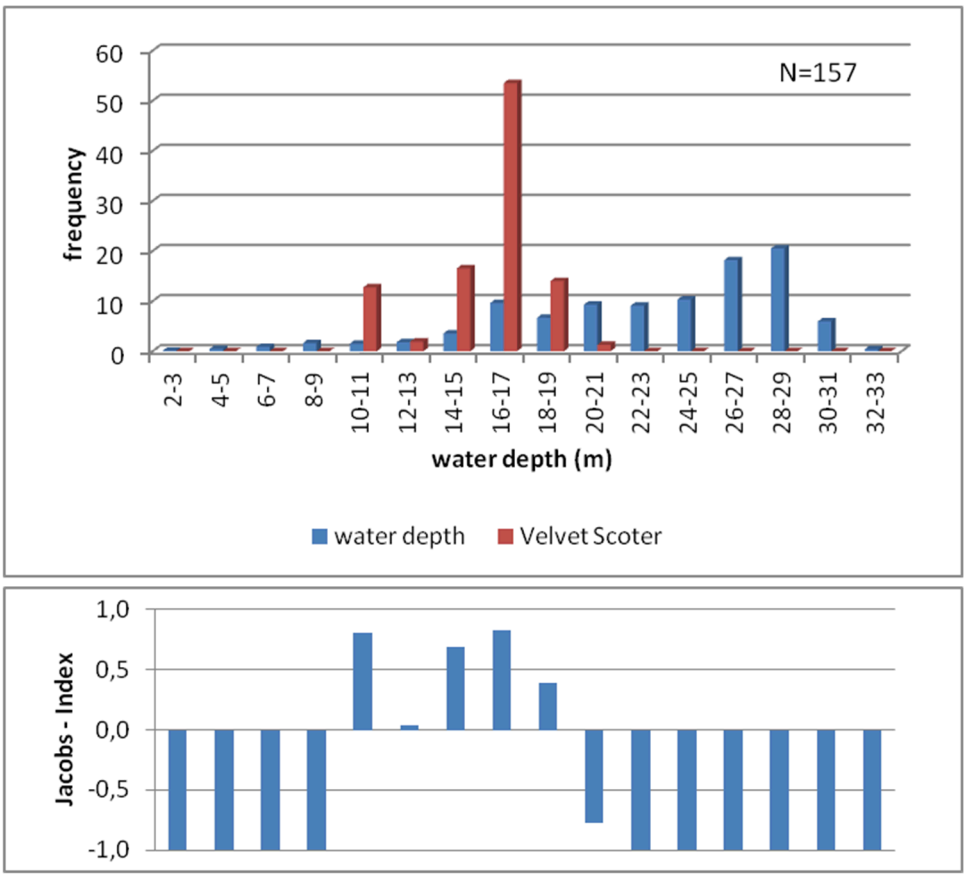


Figure 32: Frequency distribution of water depths and frequency distribution of the use of water depths by Velvet Scoter (2m-depth intervals, top) as well as Jacobs-Index of selectivity for each water depth category (bottom)

5.6.3 *Abundance and distribution according to other studies*

In Horns Rev 3 studies, Velvet Scoters were mainly observed in spring (March, April) resulting in the highest density in April with 1.5 individuals/km² (HR3: Orbicon 2014a). Those birds were mainly close to the shore line near Blåvands Huk. During surveys for Horns Rev 1 wind farm Velvet Scoter were even rarer (Christensen et al. 2003) and for Horns Rev 2 Velvet Scoter were almost absent (Christensen et al. 2006), probably as this study did not include the coastal areas.

The highest density of Velvet Scoters in the Vesterhav Syd area was also found in March (11th March 2014), but densities were much lower than in the Horns Rev 3 study. Compared to Horns Rev 3 maximum estimate of 4,037 individuals

the numbers in Vesterhav Syd made up about one tenth (406 individuals). In support of this Skov et al. (1995) indicate very low densities in this area.

5.7 Little Gull

5.7.1 Abundance in the Vesterhav Syd area

As 21% of all gull observations were not identified to species level and therefore not included into estimates of densities and numbers for species, the abundance value for Little Gull has to be regarded as a minimum value.

In four of the six surveys Little Gulls were present with highest densities (0.06 individuals/km²) and population estimates (60 birds) on the 11th February 2014 (Table 17, Figure 33). From 2nd to the 11th February 2014 a strong increase in numbers was recorded, similar to other species.

Garthe et al. (2007) define the wintering period of Little Gulls in the German North Sea from the 1st of November to 31st March. Therefore, all except the survey in April can be allocated to the wintering period of Little Gulls meaning only low effect of missing survey data from December and January surveys. The North Sea is mainly important during spring and autumn migration. Wintering birds represent about 0.7% of the total population (Skov et al. 1995).

Table 17: Densities and population estimates of Little Gulls for each of the six surveys. Lower 95% confidence interval (LCI) and higher 95% confidence interval (HCI) are given

Date	Density (birds/km²)	Study area population estimate	LCI	HCI	Density of flying birds (birds/km²)
25.11.2013	0.03	33	10	108	0.01
03.02.2014	0.00	3	1	17	0.00
11.02.2014	0.06	60	31	116	0.04
11.03.2014	0.02	17	6	47	0.01
25.03.2014	0.00	0	0	0	0.00
16.04.2014	0.00	0	0	0	0.00

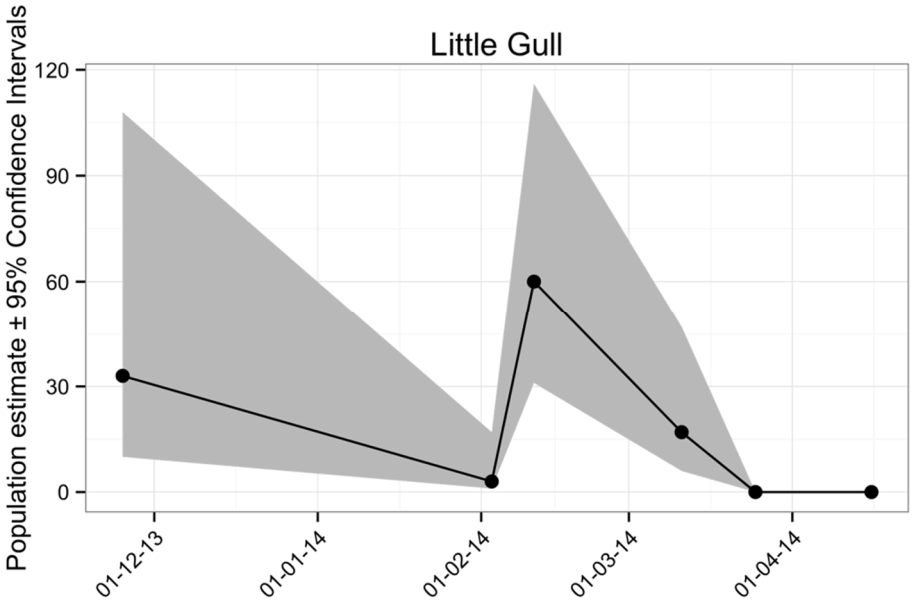


Figure 33: Population estimates (black line) and 95% confidence intervals (grey area) of Little Gulls during the six surveys

5.7.2 *Distribution in the Vesterhav Syd area*

Little gulls were mainly observed in the western part of the study area (Figure 34). No birds were seen close to the coastline and the development area was not utilised by the species – only in two adjacent 2x2 grids were Little Gulls recorded.

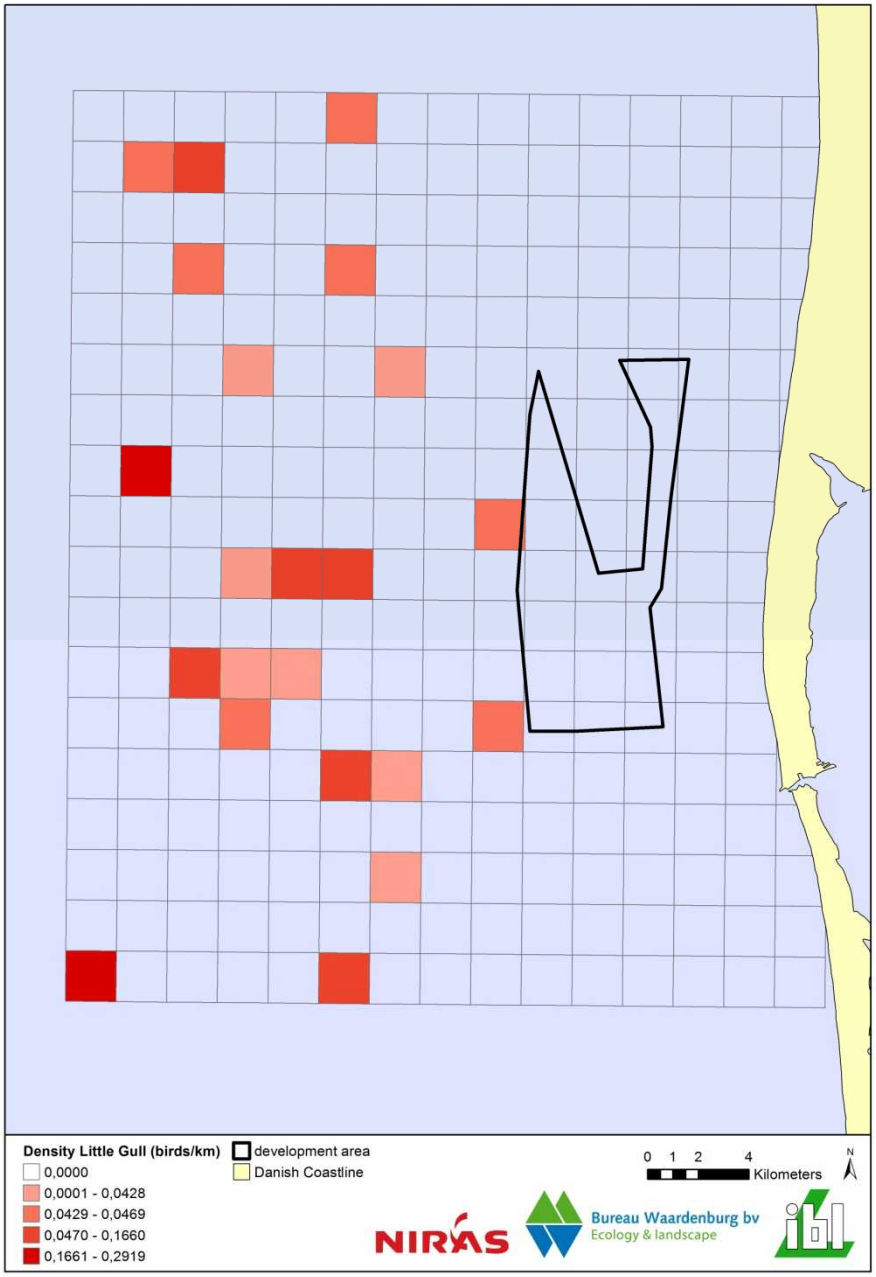


Figure 34: Relative density of Little Gulls based on six surveys. Data represent the number of observed birds per kilometre of flown transect in each 2 x 2 km grid square

Differences can be observed when comparing the single surveys (Figure 35). During the first survey gulls were seen in the southern part of the study area, whereas in the following three surveys they were present in middle and northern parts of the study area.

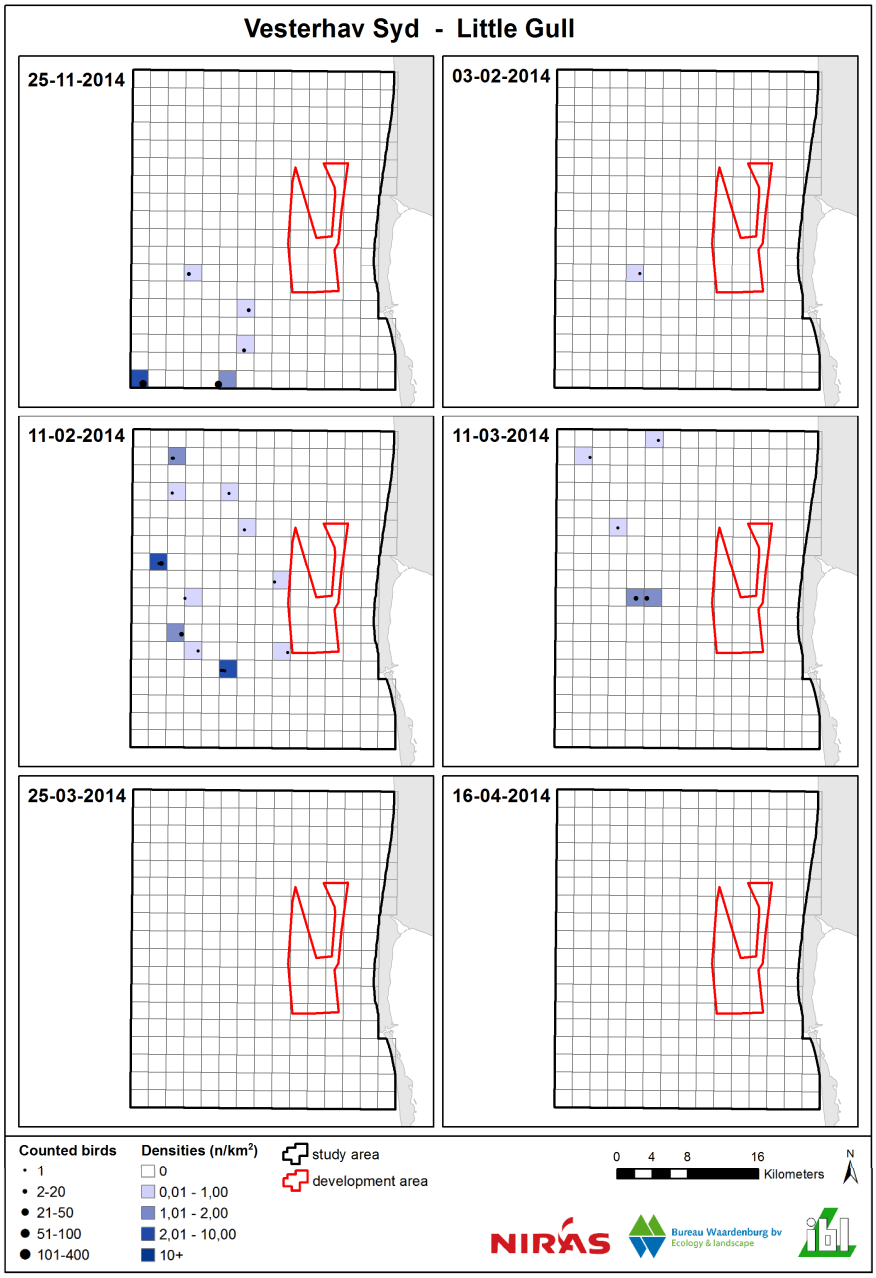


Figure 35: Counted numbers and density (n/km²) of Little Gulls based on six surveys. Data represented for 2 x 2 km grid square

Corresponding to the occurrence in the western part of the area Little Gulls were seen in areas with water depths between 22 and 32 m (Figure 36). For shallower waters they showed a strong avoidance with negative selectivity indices. Positive selection was found for some depth intervals between 22 and 32 m whereas in other intervals the area was used according to the general occurrence (selectivity index near zero).

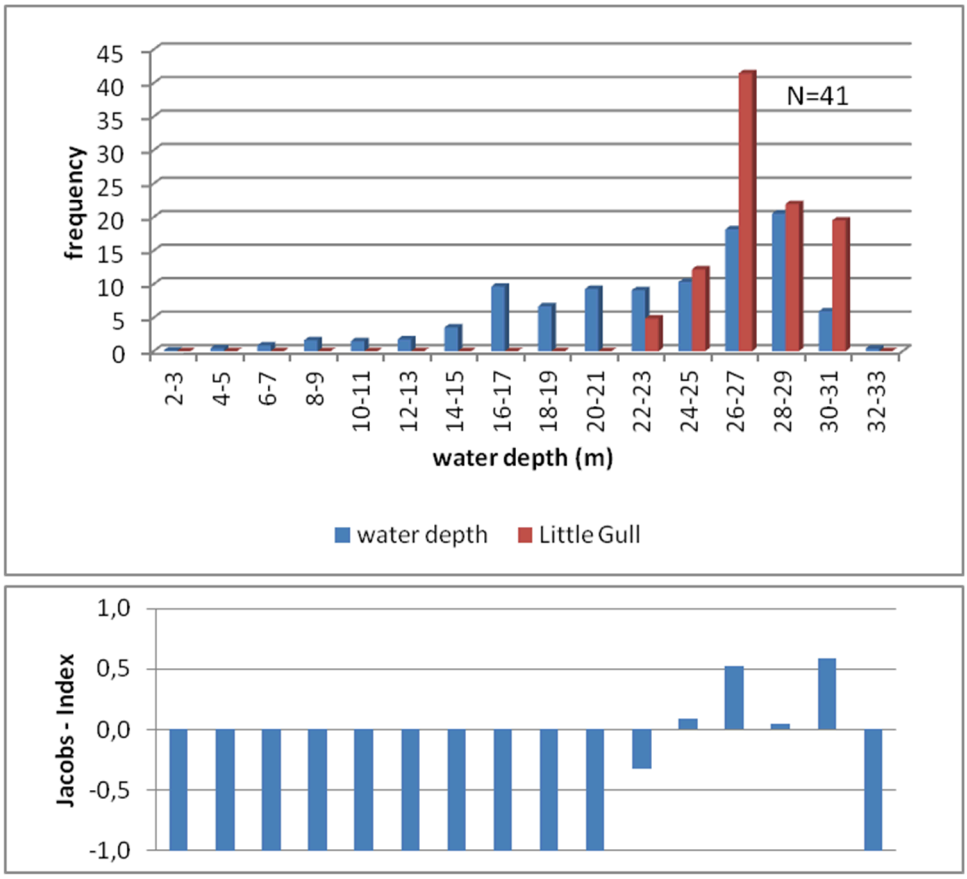


Figure 36: Frequency distribution of water depths and frequency distribution of the use of water depths by Little Gulls (2m-depth intervals, top) as well as Jacobs-Index of selectivity for each water depth category (bottom)

5.7.3 *Abundance and distribution according to other studies*

Little Gulls are regularly recorded during the studies of Horn Rev 1, 2 and 3. Recently, the Horns Rev 3 study area was categorised as an important area for this species (HR3: Orbicon 2014a). Highest densities of 1.8 birds/km² were found in early March, however, lower numbers were recorded regularly throughout the year. The spatial distribution changed considerably between surveys. Therefore a general pattern was not apparent, although areas close to the coast were avoided in most cases. The maximum annual densities varied greatly from less than 0.01 birds/km² in 2000 (Christensen et al. 2003) to 1.8 Ind./km² in 2013. Petersen (2006a) recorded 1,451 Little Gulls between 1999 and 2005. Those

were relatively regularly distributed, potentially preferring water depths between 8 and 14 m.

Low numbers of Little Gulls in the Vesterhav Syd site compared to the Horns Rev area may indicate a low use of this area during wintering and migration. Skov et al. (1995) also report very low densities of Little Gulls from that area.

5.8 Common Gull

5.8.1 Abundance in the Vesterhav Syd area

As 21% of all gull observations were not identified to species level and therefore not included into estimates of densities and numbers for species, the abundance value for the Common Gull has to be regarded as a minimum value.

The densities of Common Gulls showed high variation between surveys. Values ranged from 0.04 individuals/km² on 16th April 2014 (population estimate: 72 birds) to 0.74 individuals/km² in late March 2014 (estimated population: 760 birds, Table 18, Figure 37). The relatively high densities of flying birds compared to the total density (over 30 % on all surveys) indicates that most birds were seen flying. Figure 37 shows the seasonal pattern with highest population estimates in early March 2014.

The wintering period in the German North Sea is defined as the period from the beginning of November to the end of February (Garthe et al. 2007). Skov et al. (1995) allocated the months of December to February to the period of wintering. Therefore, three (or two according to Skov et al. 1995) of the six surveys covered the wintering period. As bird numbers between November and February surveys are different, surveys in December and January would have improved data quality (no surveys possible due to adverse weather conditions).

Table 18: Densities and population estimates of Common Gulls for each of the six surveys. Lower 95% confidence interval (LCI) and higher 95% confidence interval (HCI) are given

Date	Density (birds/km²)	Study area population estimate	LCI	HCI	Density of flying birds (birds/km²)
25.11.2013	0.55	563	368	861	0.20
03.02.2014	0.08	84	50	142	0.06
11.02.2014	0.15	158	118	212	0.13
11.03.2014	0.39	399	245	650	0.33
25.03.2014	0.74	760	533	1,084	0.26
16.04.2014	0.04	43	25	72	0.03

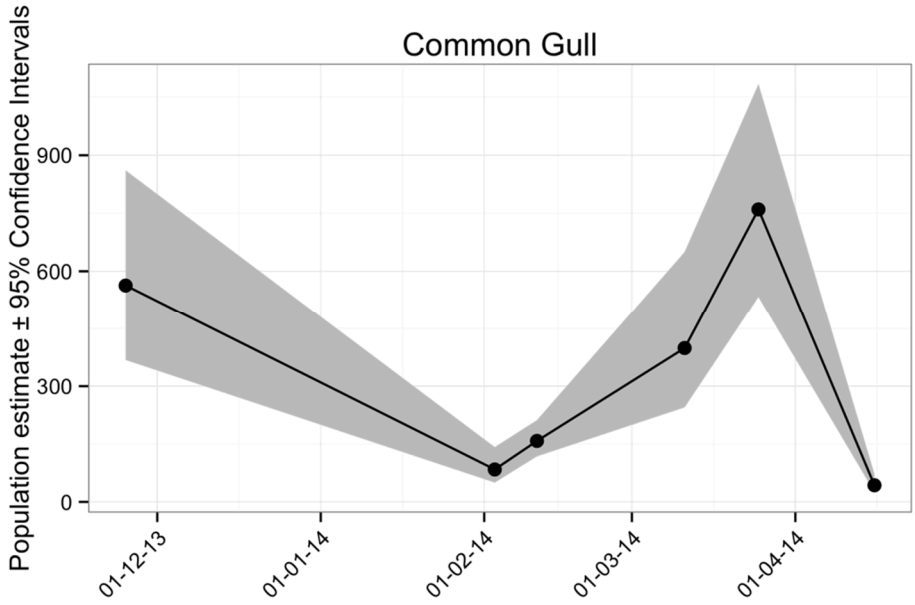


Figure 37: Population estimates (black line) and 95% confidence intervals (grey area) of Common Gulls during the six surveys

5.8.2 *Distribution in the Vesterhav Syd area*

Based on data of all surveys the distribution pattern of Common Gulls showed a preference of coastal areas whereas in the most western offshore parts of the study area only few Common Gulls were seen (Figure 38). The preference of the development area detected by Jacobs-Index on the basis of 4 km around the development area (Table 11) is mainly a result of this general overall pattern of preference of coastal waters. Highest concentrations were found south of the sound connecting Ringkøbing Fjord and the North Sea south of Hvide Sande and also east of the northern part of the development area.

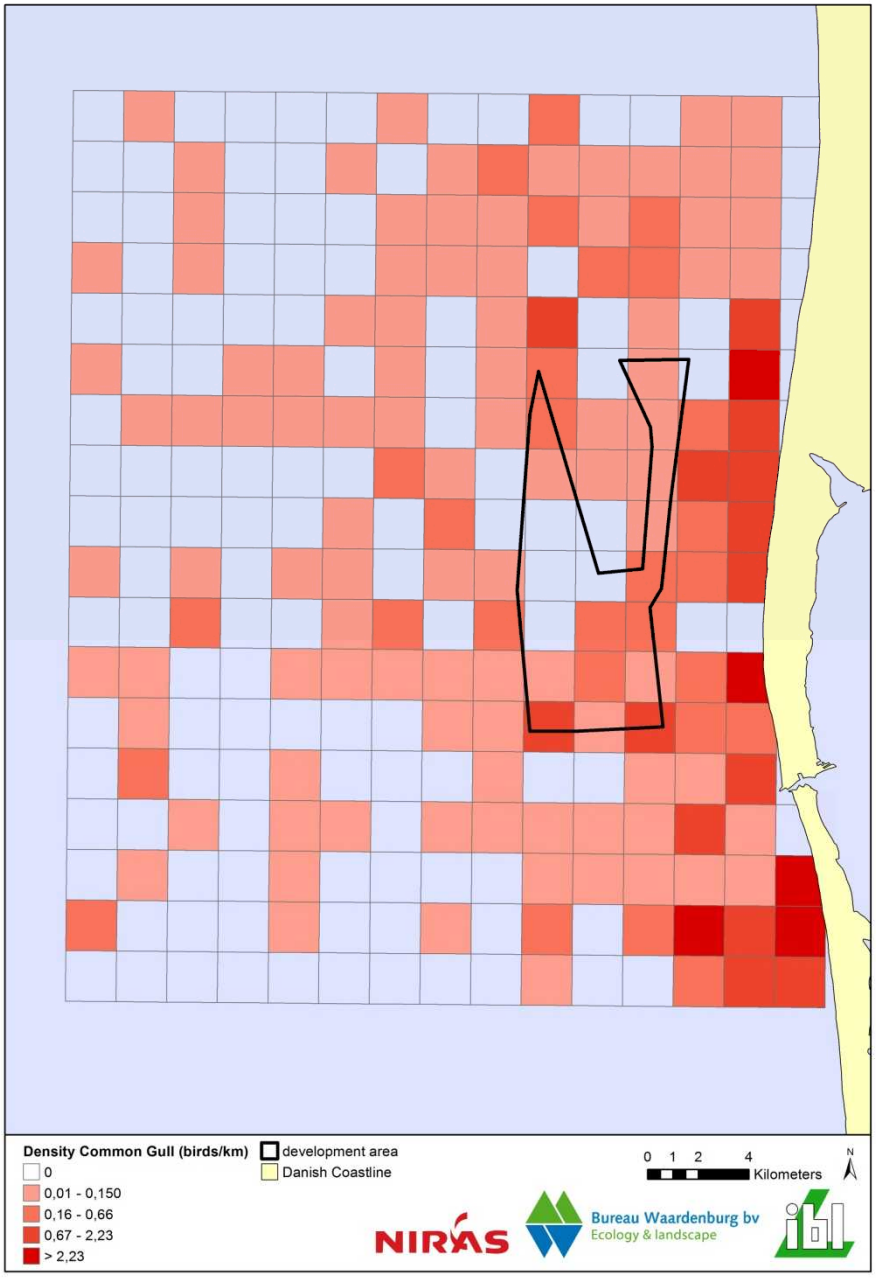


Figure 38: Relative density of Common Gulls based on six surveys. Data represent the number of observed birds per kilometer of flown transect in each 2 x 2 km grid square

The distribution was variable across different surveys (Figure 39). The concentration in the south east of the study area was observed during two surveys: on 25th of November 2013 and in the beginning of March 2014. Particularly on the day of maximum densities (25th March 2014), many Common Gulls were associated with water fronts (high density with 65 % of birds swimming). These locations are likely to offer good feeding opportunities. They are presumably espe-

cially common in this area where water from the Ringkøbing Fjord mixes with water from the North Sea. These fronts were especially common in the north eastern part of the study area leading to a concentration of Common Gulls there, and particularly east of the development area.

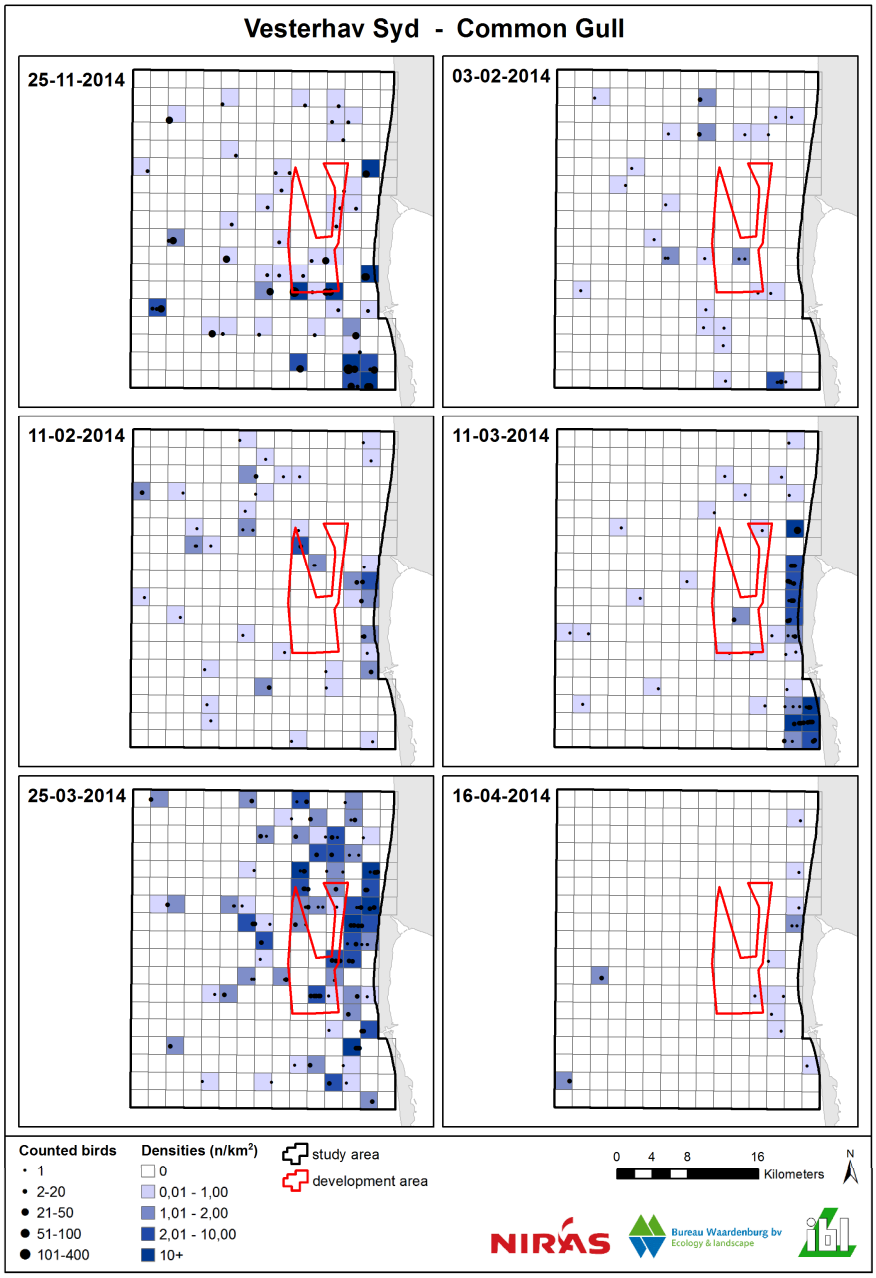


Figure 39: Counted numbers and density (n/km²) of Common Gulls based on six surveys. Data represented for 2 x 2 km grid square

The frequency of observations of Common Gulls was highest in areas of water depths of 8-9 m to 20-21 m (Figure 40). Taking the frequency distribution of the available water depths into account a clear pattern of preference of shallower water gets clear. Water depths below 16 m are preferred (most strongly between 4 and 10 m) and water depths greater than 24 m are avoided. A distribution map of observations in relation to water depths is presented in Figure 70 in Appendix 16.4.

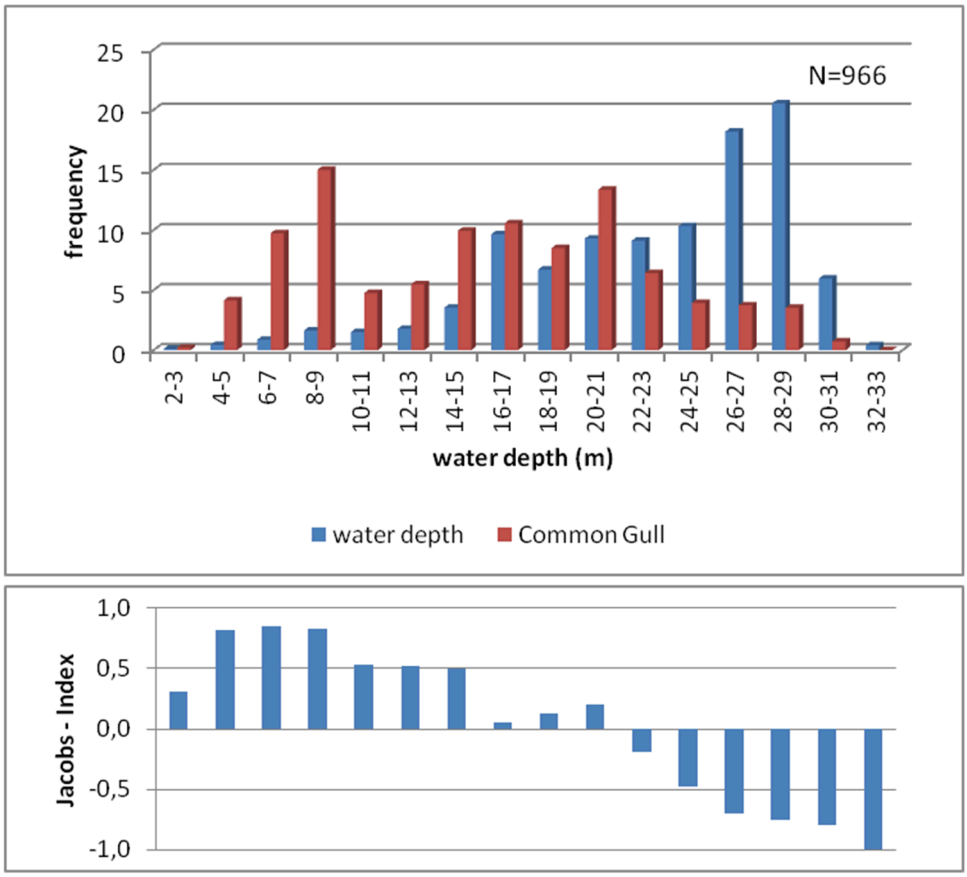


Figure 40: Frequency distribution of water depths and frequency distribution of the use of water depths by Common Gulls (2m-depth intervals, top) as well as Jacobs-Index of selectivity for each water depth category (bottom)

5.8.3 *Abundance and distribution according to other studies*

Common Gulls are present all year round at the Horns Rev study sites. Whereas they mainly prefer waters near the coastline or shallow waters, their winter distribution is more regular with birds also present further offshore. Highest densities were recorded during winter, while from February to April 2013 densities ranged from 0.10 to 0.31 birds/km². The phenology was not constant across the years. The reasons may be a strong dependence on weather and hydrographical fronts. Further, Common Gulls could group at sea when they do not find enough food on land when the ground is frozen during winter months. Mendel et al. (2008)

reported for the German North Sea relatively high densities of Common Gulls in a water depth of up to 20 m.

The detected densities of Common Gulls in the Vesterhav Syd area are comparable to those found in the Horns Rev area. Also the spatial distribution is consistent with the situation in the Horns Rev area. In both studies Common Gulls preferred coastal area but were still present further offshore in lower densities.

5.9 Lesser Black-backed Gull

5.9.1 Abundance in the Vesterhav Syd area

As 21% of all gull observations were not identified to species level and therefore not included into estimates of densities and numbers for species, the abundance value for the Lesser Black-backed Gull has to be regarded as a minimum value.

The Lesser Black-backed Gull is a migratory species spending the winter months in the Mediterranean or Africa. First birds in the Vesterhav Syd study area were recorded during the survey on 11th March 2014 with an estimated number of 36 individuals (density estimate: 0.03 individuals/km²; Table 19). In the following survey at the end of March the densities and bird numbers were very similar to the previous survey and dropped in the April survey to a density of 0.01 birds/km². It has to be considered that the summer months, where the Lesser Black-backed Gull is likely to be more common, were not covered. The seasonal phenology is shown in Figure 41.

The lack of surveys during December and January did not affect population estimates of this species. However, summer months, where the Lesser Black-backed Gull is likely to be more common are not covered by surveys.

Table 19: Densities and population estimates of Lesser Black-backed Gulls for each of the six surveys. Lower 95% confidence interval (LCI) and higher 95% confidence interval (HCI) are given

Date	Density (birds/km²)	Study area population estimate	LCI	HCI	Density of flying birds (birds/km²)
25.11.2013	0.00	0	0	0	0.00
03.02.2014	0.00	0	0	0	0.00
11.02.2014	0.00	0	0	0	0.00
11.03.2014	0.03	36	16	77	0.02
25.03.2014	0.04	39	22	69	0.03
16.04.2014	0.01	11	2	53	0.01

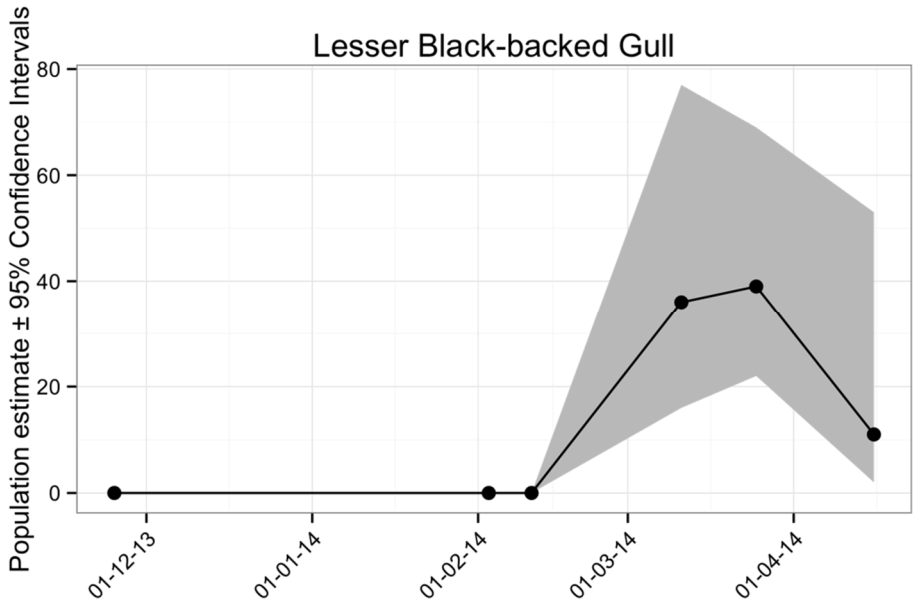


Figure 41: Population estimates (black line) and 95% confidence intervals (grey area) of Lesser Black-backed Gulls during the six surveys

5.9.2 *Distribution in the Vesterhav Syd area*

Lesser Black-backed Gull distribution was very scattered with high concentrations in some 2x2 km grid cells near the coastline (Figure 42). Birds were also seen in and close to the development area.

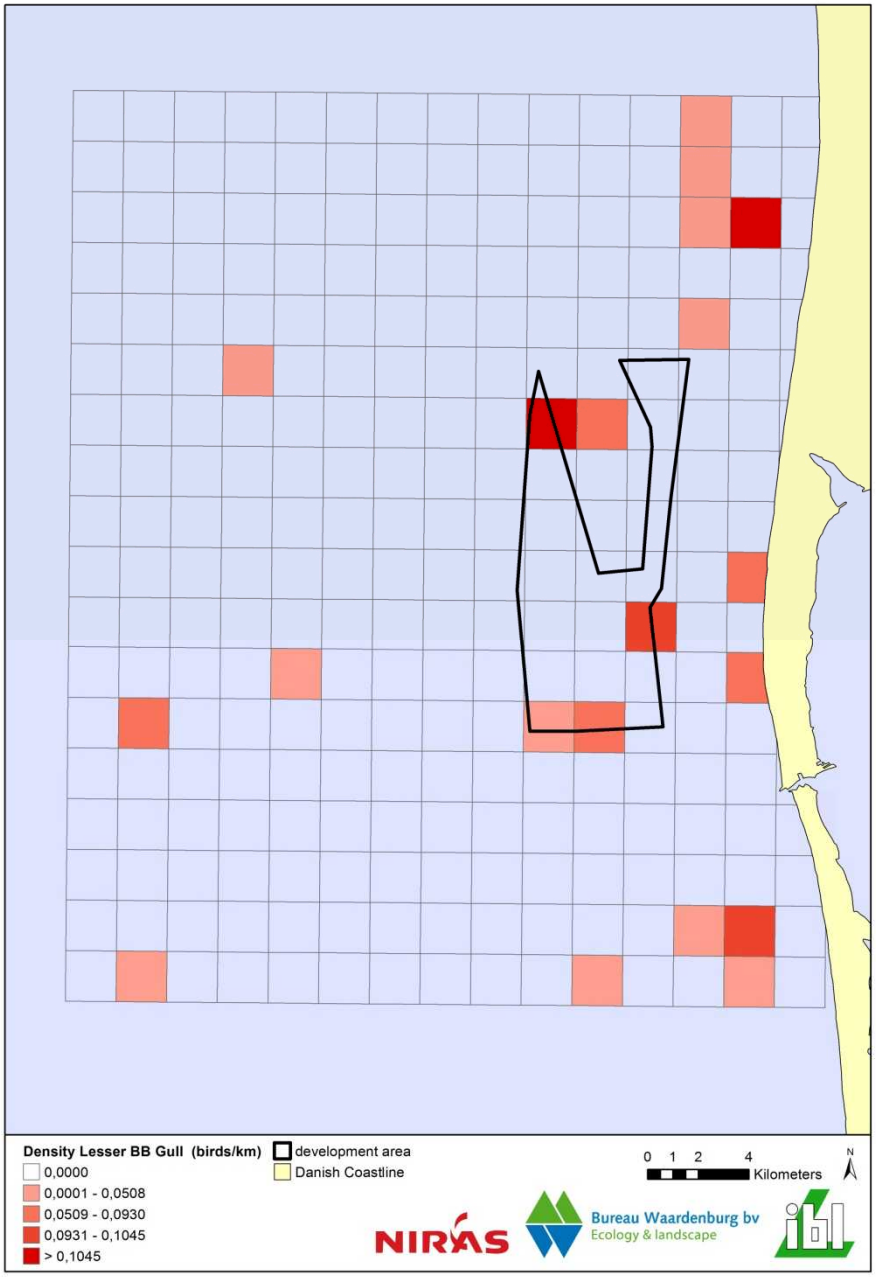


Figure 42: Relative density of Lesser Black-backed Gulls based on six surveys. Data represent the number of observed birds per kilometer of flown transect in each 2 x 2 km grid square

The distribution maps of single surveys demonstrate a scattered occurrence of Lesser Black-backed Gulls in each of the three surveys when birds were present (Figure 43).

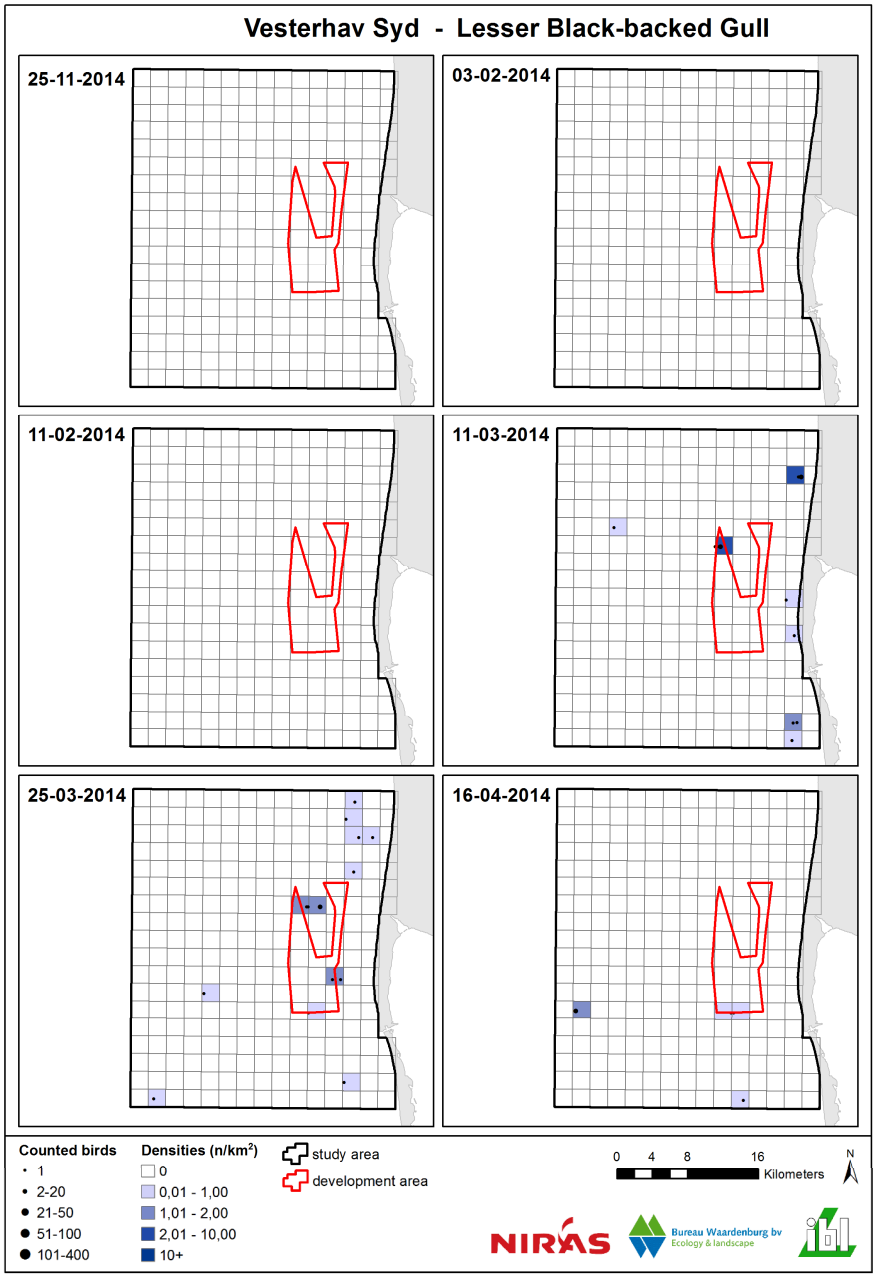


Figure 43: Counted numbers and density (n/km²) of Lesser Black-backed Gulls based on six surveys. Data represented for 2 x 2 km grid square

Lesser Black-backed Gulls used water depths of the whole range from 4 to 30 m depth (Figure 44). Due to the relatively low sample size a clear pattern of use of water depths is not present but there are indications that water depths higher than 24 m are avoided and shallower water depths selected. A distribution map in relation to water depth is presented in Figure 71 in Appendix 16.4.

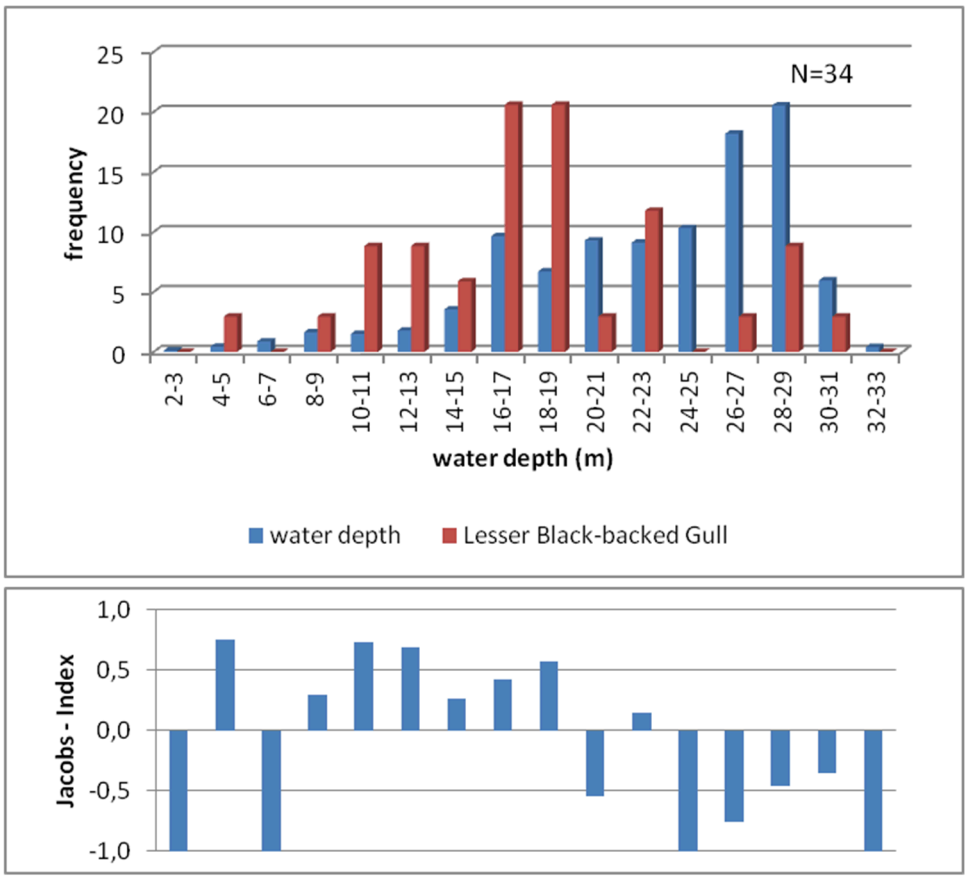


Figure 44: Frequency distribution of water depths and frequency distribution of the use of water depths by Lesser Black-backed Gulls (2m-depth intervals, top) as well as Jacobs-Index of selectivity for each water depth category (bottom)

5.9.3 *Abundance and distribution according to other studies*

Lesser Black-backed Gulls are typical summer visitors to the North Sea with only single birds staying in winter (Mendel et al. 2008). Therefore, peak numbers were recorded in July during the surveys on Horns Rev wind farm projects. In the Horns Rev 3 study area a maximum density of 1.2 birds/km² was recorded in July 2013 (HR3: Orbicon 2014a). Birds were distributed relatively evenly in the study area. Lesser Black-backed Gulls often follow fishing vessels and therefore local concentrations of this species are often found around fishing vessels (Schwemmer & Garthe 2005). Similar to the Vesterhav Syd study, the aerial surveys for Horns Rev 1 and 2 were conducted during the winter months and no data from summer are available. Therefore, relatively few Lesser Black-backed Gulls were recorded (Christensen et al. 2003, 2006).

The densities in March and April surveys during Horns Rev 3 studies were 0.03 and 0.02 respectively (HR3: Orbicon 2014a) and therefore very similar to those recorded at Vesterhav Syd (March: 0.03/0.04; April: 0.01).

5.10 Herring Gull

5.10.1 Abundance in the Vesterhav Syd area

As 21% of all gull observations were not identified to species level and therefore not included into estimates of densities and numbers for species, the abundance values for the Herring Gulls has to be regarded as a minimum value.

Highest densities of Herring Gulls were recorded during the surveys in March. A maximum population of 322 individuals was estimated for the survey on 25th March 2014. In contrast, during the surveys in February only low numbers of Herring Gulls were present (Table 20, Figure 45).

Herring Gulls are present in the North Sea all year round with highest wintering estimates from November to February (Skov et al. 1995); the same period is defined by Garthe et al. (2007) for the German part of the North Sea. Accordingly, the first three surveys cover the wintering and resting period. As numbers fluctuate from November to the beginning of February surveys in December and January would have improved data quality (no surveys because of adverse weather conditions).

Table 20: Densities and population estimates of Herring Gulls for each of the six surveys. Lower 95% confidence interval (LCI) and higher 95% confidence interval (HCI) are given

Date	Density (birds/km²)	Study area population estimate	LCI	HCI	Density of flying birds (birds/km²)
25.11.2013	0.12	126	55	289	0.08
03.02.2014	0.01	8	3	22	0.01
11.02.2014	0.02	21	9	50	0.01
11.03.2014	0.22	226	127	401	0.08
25.03.2014	0.31	322	192	542	0.06
16.04.2014	0.06	60	34	106	0.03

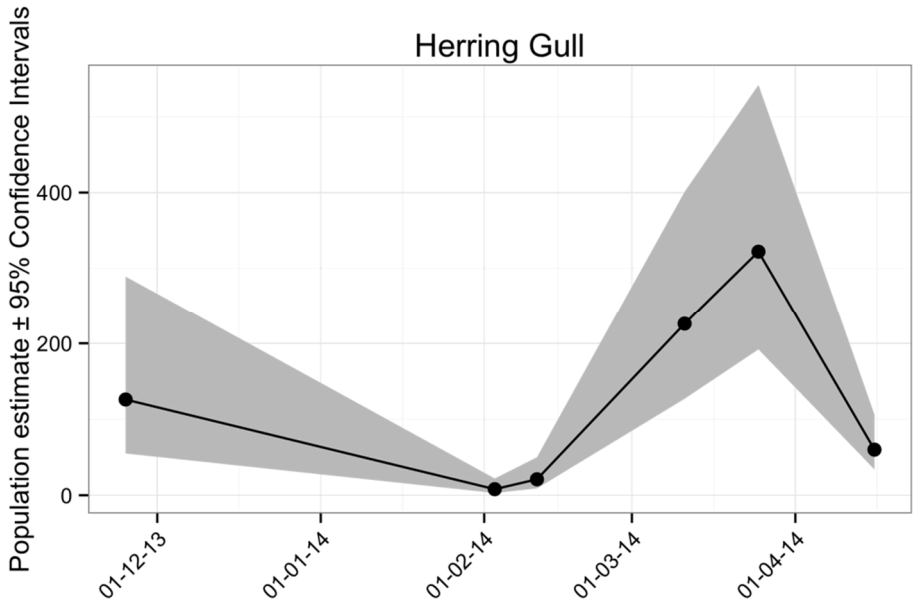


Figure 45: Population estimates (black line) and 95% confidence intervals (grey area) of Herring Gulls during the six surveys

5.10.2 Distribution in the Vesterhav Syd area

Herring Gulls showed concentrations in coastal areas east of the development area and also in the south eastern part of the study area (Figure 46). Herring Gulls showed a positive selectivity index (Jacobs-index; Table 11) with significant differences between observed and expected number of birds for the distances of 2 and 4 km around the development area. This is mainly a result of the general preference of coastal areas.

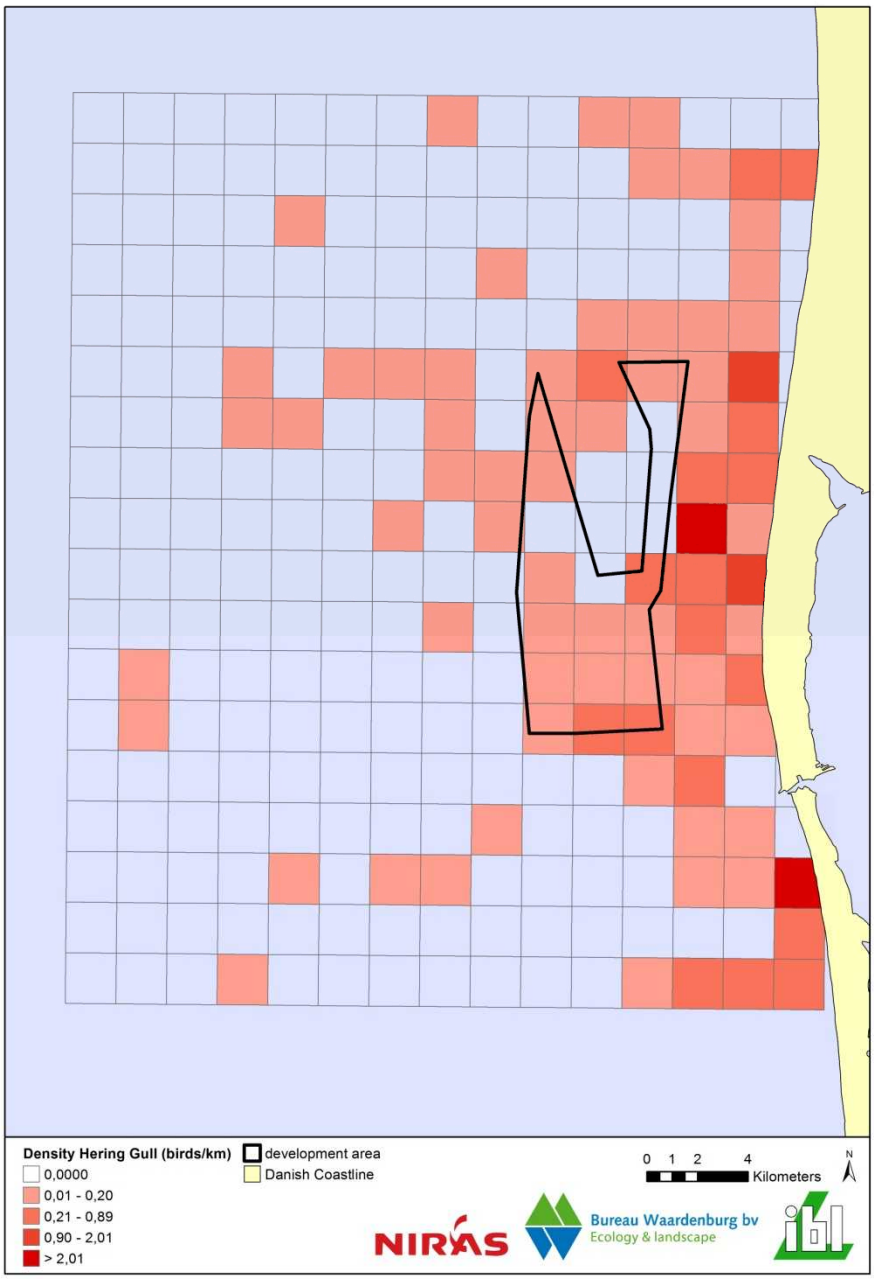


Figure 46: Relative density of Herring Gulls based on six surveys. Data represent the number of observed birds per kilometre of flown transect in each 2 x 2 km grid square

The coastal distribution was particular expressed during the survey on 11th March 2014 and on 16th April 2014 with densities of more than 10 individuals/km² in distances of up to 4 km from coastline (2 grid cells, Figure 47). On the day with highest densities (25th March 2014) birds were concentrated in a distance of about 2 to 10 km from coastline.

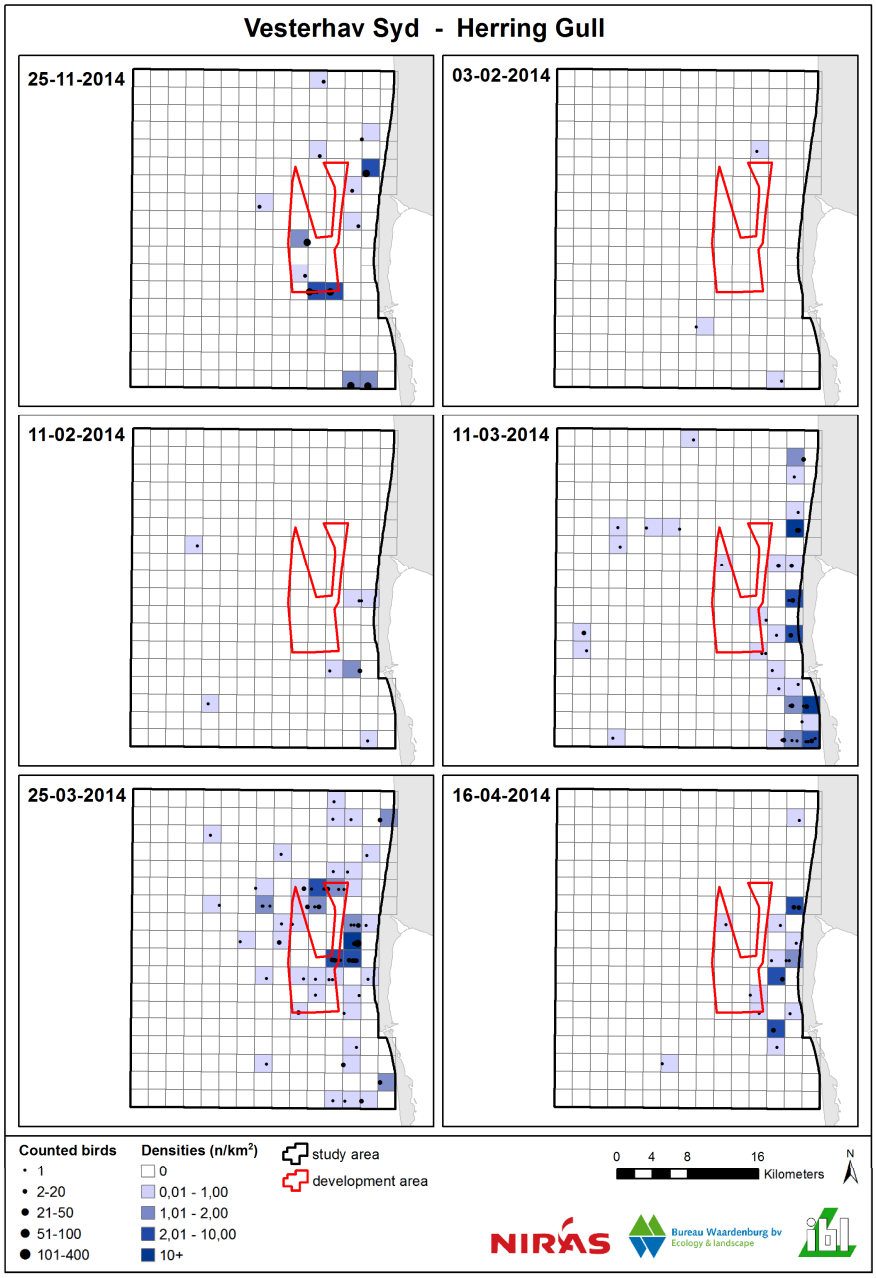


Figure 47: Counted numbers and density (n/km²) of Herring Gulls based on six surveys. Data represented for 2 x 2 km grid square

Herring Gulls were mainly present in water depths between 4 and 24 m (Figure 48). Considering the distribution of water depths available birds showed a clear selectivity pattern with a selection of water depths between 2 and 14 m and avoided areas with water deeper than 22 m. A map with sightings and water depth is shown in Figure 72 in Appendix 16.4.

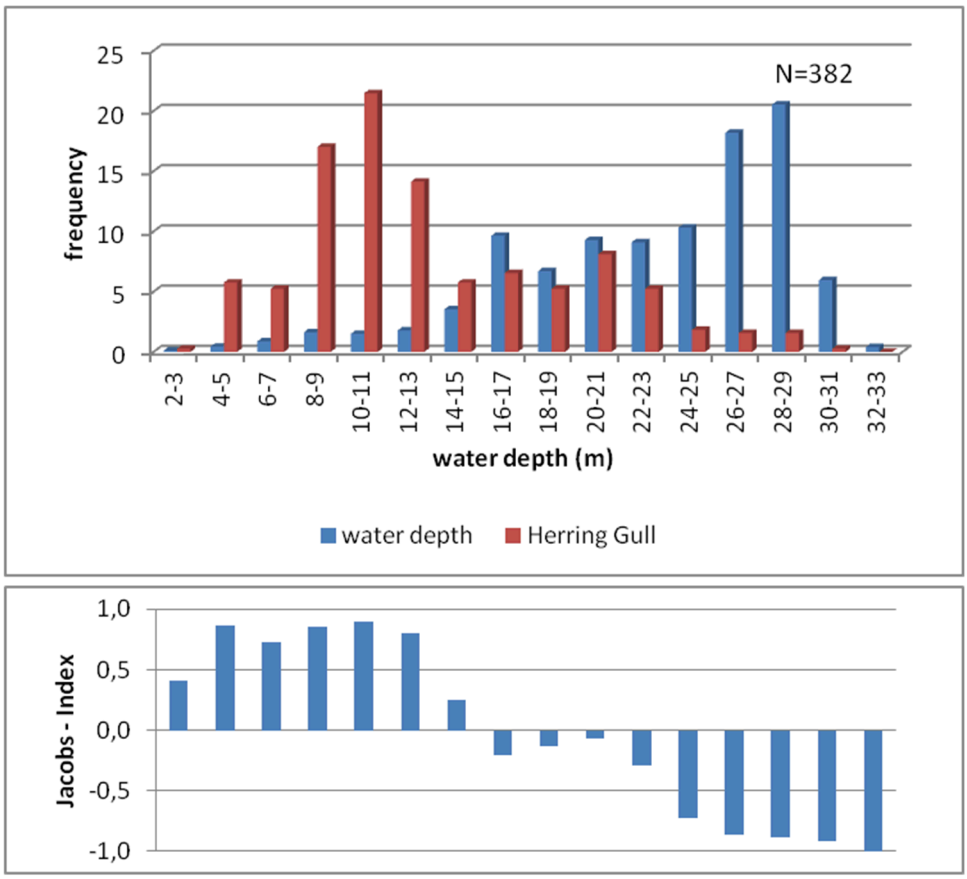


Figure 48: Frequency distribution of water depths and frequency distribution of the use of water depths by Herring Gulls (2m-depth intervals, top) as well as Jacobs-Index of selectivity for each water depth category (bottom)

5.10.3 *Abundance and distribution according to other studies*

Herring Gulls are found in the Horns Rev area all year, although the phenology is flexible. In all three studies from Horns Rev wind farm project a high concentration of this species along the coast is reported. A preferred distribution in near-shore areas is also identified in the German North Sea where Herring Gulls are mainly restricted to the Wadden Sea. Only in winter are Herring Gulls known to use offshore areas more intensively (Mendel et al. 2008). During 1999 to 2005, a total 45,974 Herring Gulls were counted in the Horns Rev 1 and 2 studies (Petersen et al. 2006a). One third of these were in areas of water depths lower than 6 m. Maximum densities for the entire study area are reported as 3.0 ind./km² (Nov 2013, Horns Rev 3, HR3: Orbicon 2014a) or 2.5 ind./km² (Feb 2000, Horns Rev 1, Christensen et al. 2003). From January to April 2013 densities ranged from 0.10 to 0.25 individuals/km². Herring Gulls show strong attraction to fishing vessels (Skov & Durinck 2001) and therefore, records further offshore are often associated with fishing vessels.

The estimated densities of Herring Gulls in the Vesterhav Syd area did not reach the maximum values of Horns Rev studies but averages from January to April were in similar range in both areas.

5.11 Great Black-backed Gull

5.11.1 Abundance in the Vesterhav Syd area

As 21% of all gull observations were not identified to species level and therefore not included in estimates of densities and numbers for species, the abundance value for the Great Black-backed Gull has to be regarded as a minimum value.

Great Black-backed Gulls were recorded with maximum densities of 0.02 individuals/km² (Table 21). No birds were seen on 11th March 2014 and estimated population ranged from nine (25th November 2013) to 25 individuals (03rd February 2014). Most birds were seen flying.

The North Sea is an important area for wintering Great Black-backed Gull with wintering period being defined for the months from November to February (Skov et al. 1995, Garthe et al. 2007). Hence, three of the six surveys covered the wintering period and as densities and population estimates were very similar between these surveys the missing surveys in December and January are supposed to have little impact on the estimations. Within the wintering period Great Black-backed Gulls are not known to peak in December or January. Similar to Lesser Black-backed Gulls also Great Black-backed Gulls are supposed to be present in the North Sea in relatively high numbers during late summer and autumn (Skov et al. 1995) when no surveys were performed.

Table 21: Densities and population estimates of Great Black-backed Gulls for each of the six surveys. Lower 95% confidence interval (LCI) and higher 95% confidence interval (HCI) are given

Date	Density (birds/km²)	Study area population estimate	LCI	HCI	Density of flying birds (birds/km²)
25.11.2013	0.01	9	3	27	0.01
03.02.2014	0.02	25	9	70	0.02
11.02.2014	0.02	16	6	48	0.01
11.03.2014	0.00	0	0	0	0.00
25.03.2014	0.01	11	4	27	0.01
16.04.2014	0.02	20	9	48	0.01

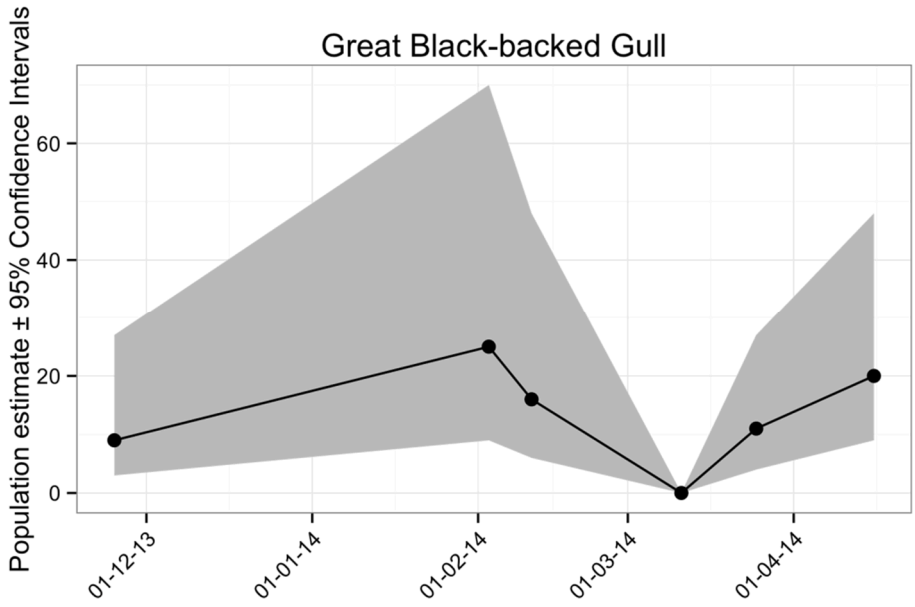


Figure 49: Population estimates (black line) and 95% confidence intervals (grey area) of Great Black-backed Gulls during the six surveys

5.11.2 Distribution in the Vesterhav Syd area

Great Black-backed Gulls showed a very scattered distribution pattern with no obvious preference of any area (Figure 50).

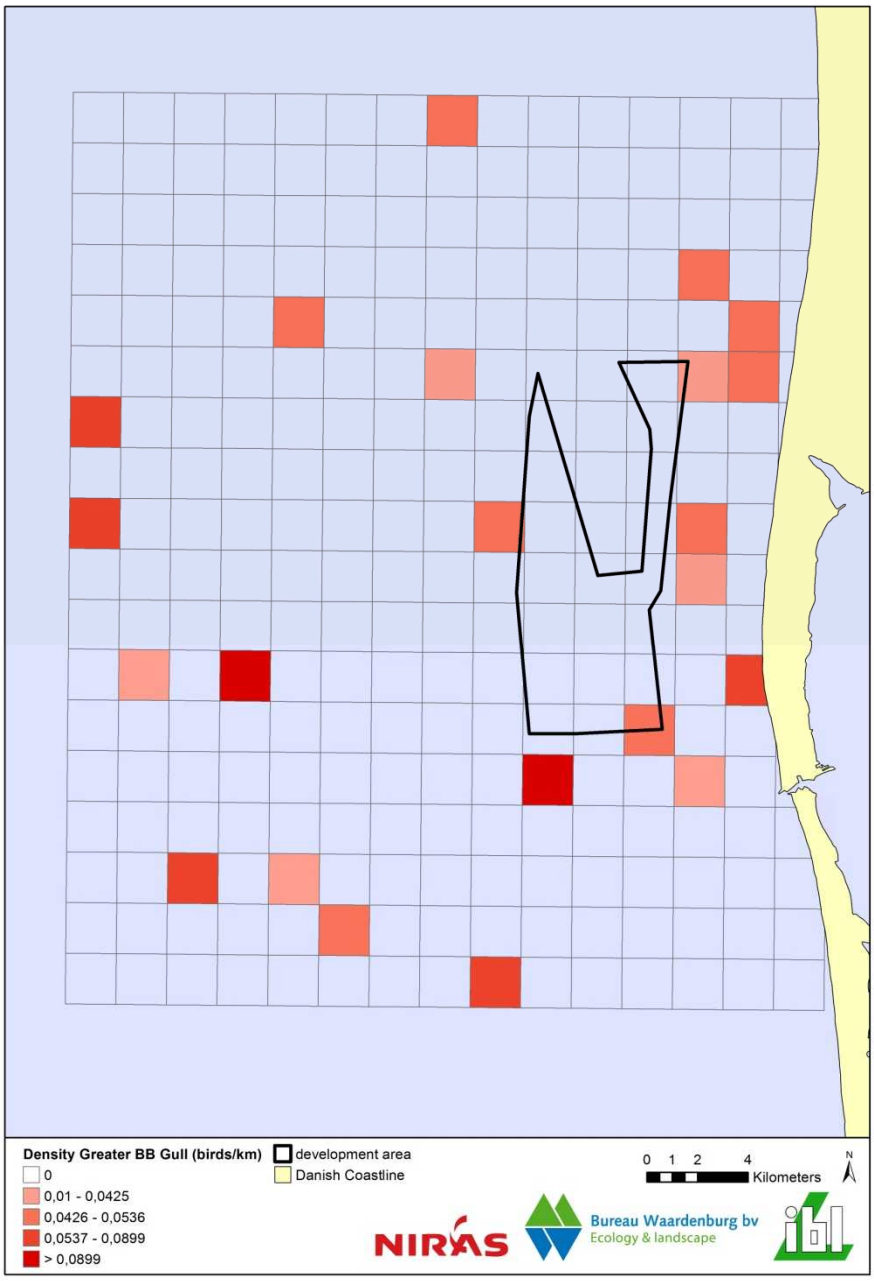


Figure 50: Relative density of Great Black-backed Gulls based on six surveys. Data represent the number of observed birds per kilometer of flown transect in each 2 x 2 km grid square

Figure 51 shows the distribution of Great Black-backed Gulls on each of the six surveys. In neither survey an area of concentration was present

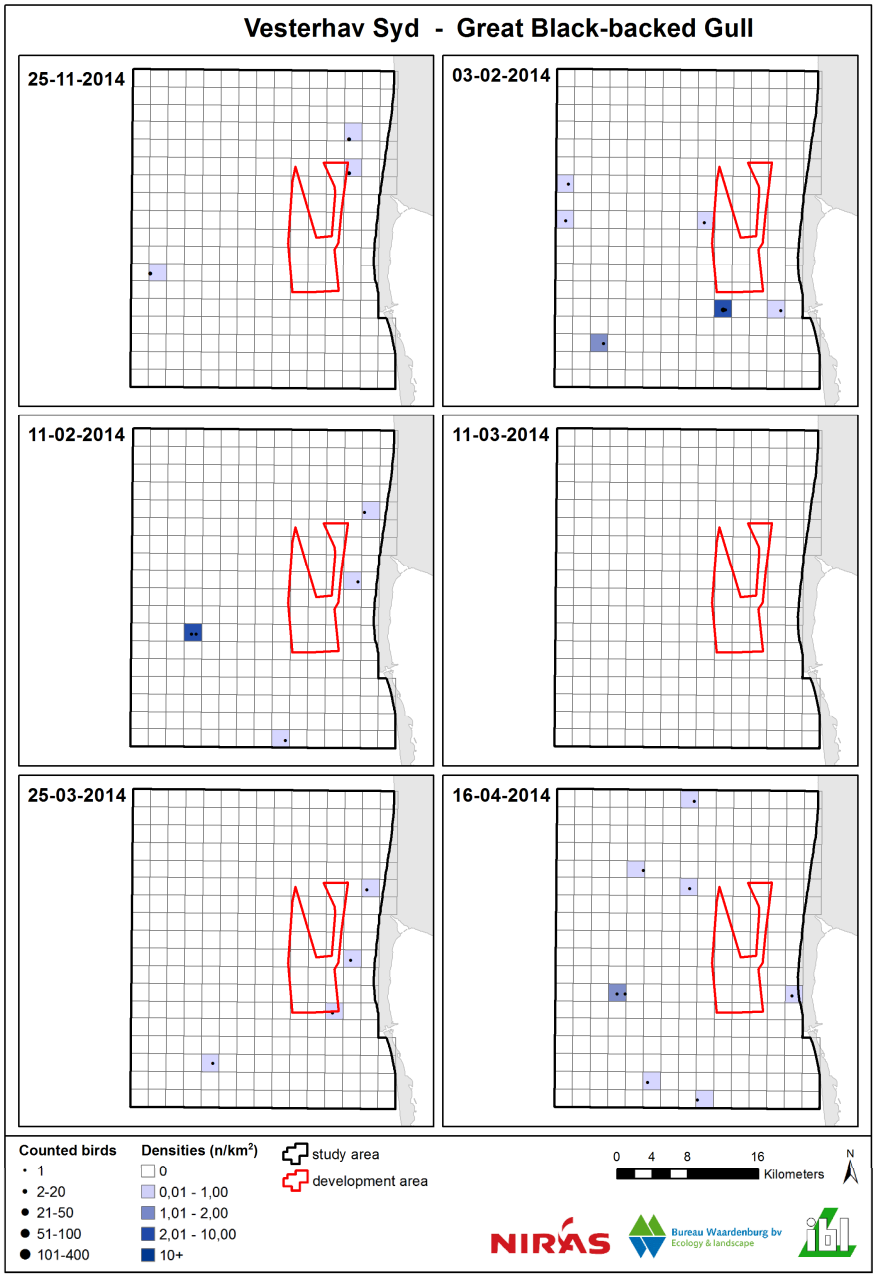


Figure 51: Counted numbers and density (n/km²) of Great Black-backed Gulls based on six surveys. Data represented for 2 x 2 km grid square

The sightings were scattered over water depths between 6 and 32 m deep and no clear pattern of selectivity was apparent (Figure 52).

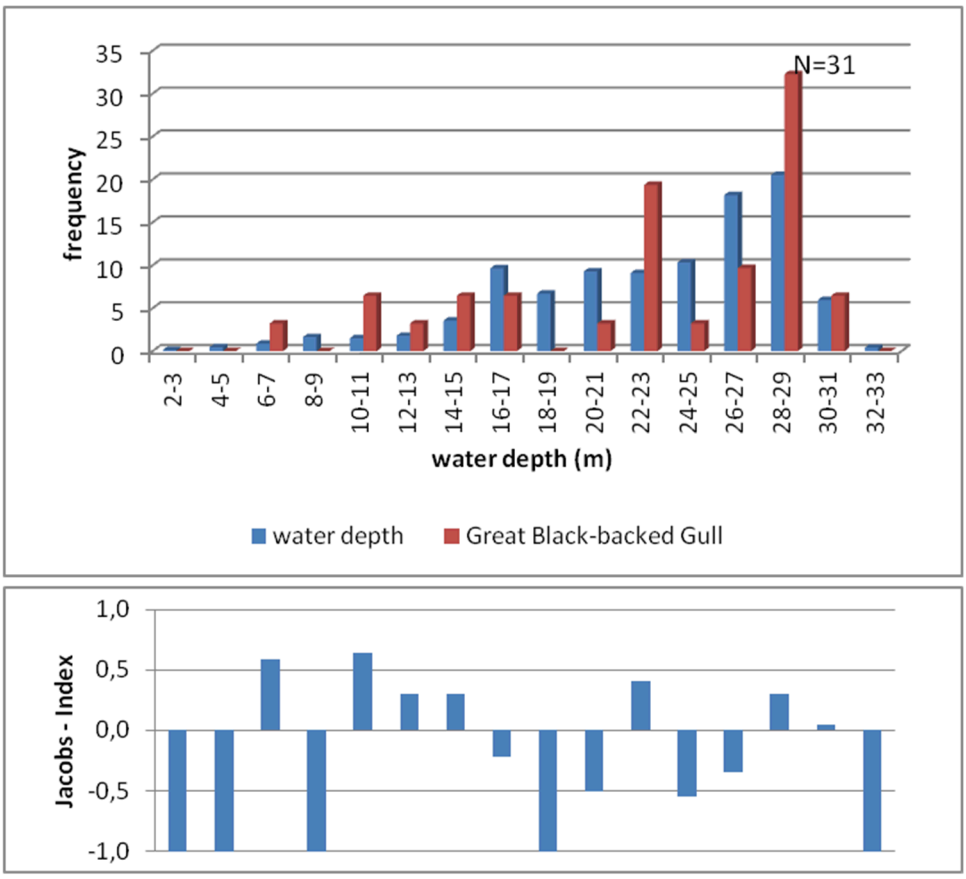


Figure 52: Frequency distribution of water depths and frequency distribution of the use of water depths by Great Black-backed Gulls (2m-depth intervals, top) as well as Jacobs-Index of selectivity for each water depth category (bottom)

5.11.3 *Abundance and distribution according to other studies*

Great Black-backed Gulls are observed in relatively few numbers in the Horns Rev study areas (Christensen et al. 2006). During Horns Rev 1 studies, high numbers were recorded in August/September and in April with a maximum density of nearly 1 bird/km² in September 1999 (Christensen et al. 2003). Gulls were mainly recorded in the eastern part of the study area. However, they were not as restricted to coastal areas as Herring Gulls. Studies in the German North Sea show a scattered distribution (Mendel et al. 2008).

A low number of Great Black-backed Gulls at the Vesterhav Syd site corresponds to the findings from Horns Rev area. However, the summer and autumn months were not covered in the present studies. According to Skov et at. (1995) report the highest densities of Great Black-backed Gulls from May to October.

5.12 Black-legged Kittiwake

5.12.1 Abundance in the Vesterhav Syd area

As 21% of all gull observations were not identified to species level and therefore not included in estimates of densities and numbers for species, the abundance value for the Black-legged Kittiwake has to be regarded as a minimum value.

The highest density of Black-legged Kittiwakes was recorded on 25th November 2013 with a density of 0.06 individuals/km² (population estimate: 58 birds, Table 22). In late March 2014, number of Black-legged Kittiwakes were similar to the November survey (50 birds) whereas in the other surveys population estimates ranged from 9 to 30 individuals (Table 22, Figure 53). Most birds were seen flying.

Black-legged Kittiwakes are widely distributed in the North Sea all year round. The period outside of the breeding season (wintering period) lasts from October to March according to Skov et al. (1995). Garthe et al. (2007) confined the wintering period to the months from November to February. Therefore, at least the first three surveys cover the wintering period. As fluctuation between these surveys is relatively low the data from surveys give reliable estimates on winter populations.

Table 22: Densities and population estimates of Black-legged Kittiwakes for each of the six surveys. Lower 95% confidence interval (LCI) and higher 95% confidence interval (HCI) are given

Date	Density (birds/km²)	Study area population estimate	LCI	HCI	Density of flying birds (birds/km²)
25.11.2013	0.06	58	35	97	0.05
03.02.2014	0.02	26	11	58	0.02
11.02.2014	0.03	30	12	76	0.03
11.03.2014	0.01	9	3	26	0.00
25.03.2014	0.05	50	22	113	0.02
16.04.2014	0.01	12	3	45	0.01

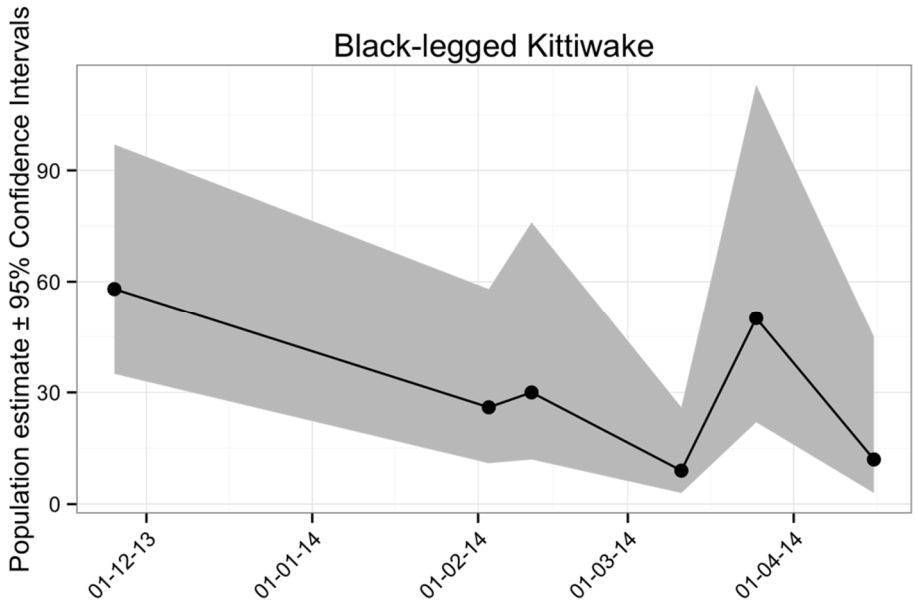


Figure 53: Population estimates (black line) and 95% confidence intervals (grey area) of Black-legged Kittiwakes during the six surveys

5.12.2 *Distribution in the Vesterhav Syd area*

Black-legged Kittiwakes showed low numbers in coastal waters and were more frequent in areas further offshore (Figure 54). The distribution pattern showed no areas of concentration and birds were scattered relatively regularly over the study area (with the described difference between offshore and coastal areas).

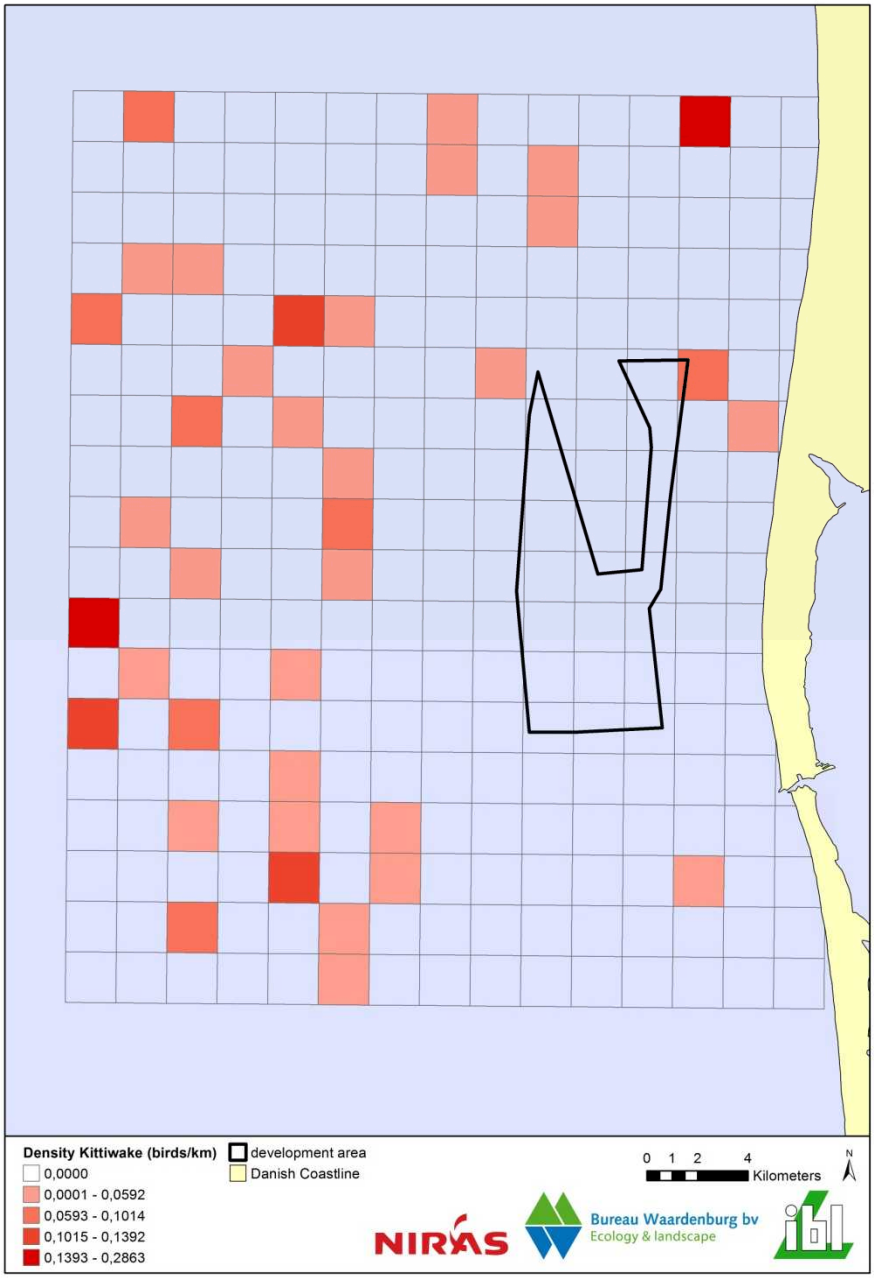


Figure 54: Relative density of Black-legged Kittiwakes based on six surveys. Data represent the number of observed birds per kilometer of flown transect in each 2 x 2 km grid square

During the single surveys Black-legged Kittiwake showed a patchy distribution with no indications of concentrations in any survey (Figure 55).

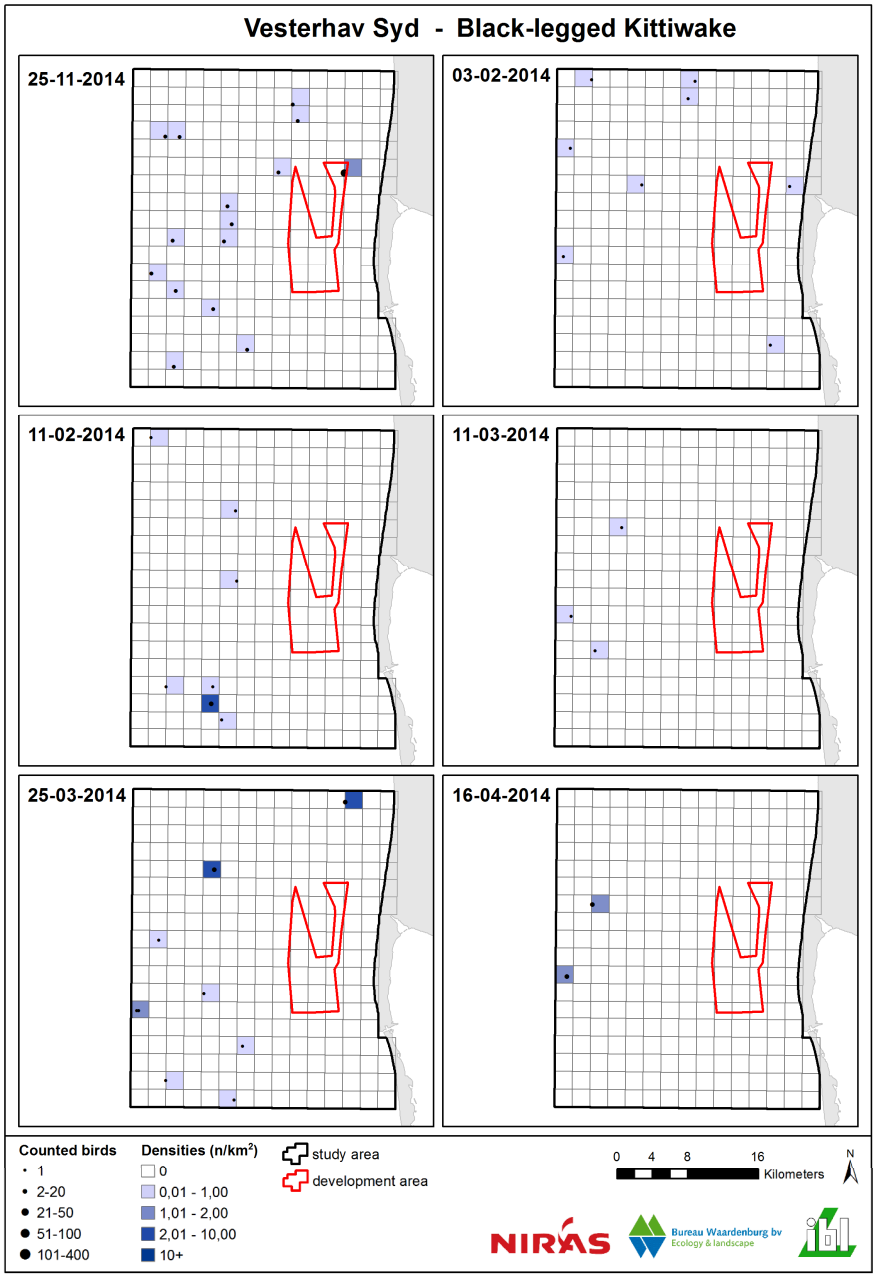


Figure 55: Counted numbers and density (n/km²) of Black-legged Kittiwakes based on six surveys. Data represented for 2 x 2 km grid square

Black-legged Kittiwakes were found mostly in water depths between 18 and 32 m (Figure 56). Areas of deep water (especially between 28 and 32 m) were

positively selected and shallower waters (especially from 2-16 m) avoided. A distribution map with observation point in relation to water depth is shown in Figure 74 in Appendix 16.4.

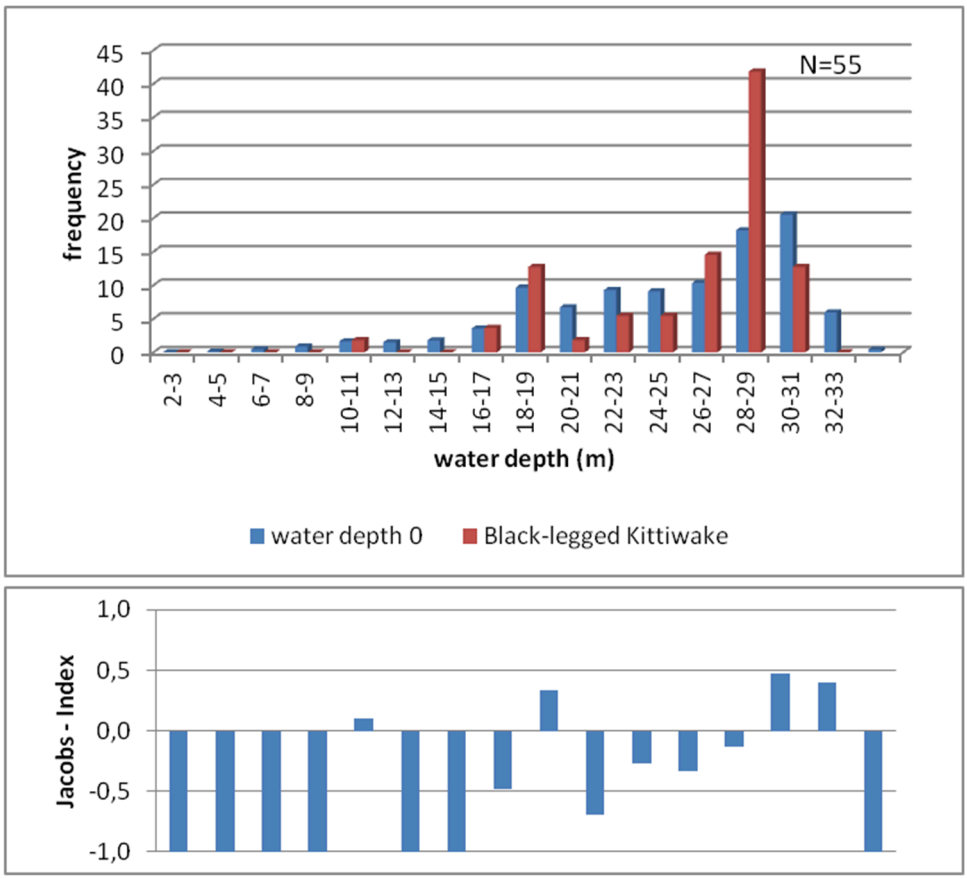


Figure 56: Frequency distribution of water depths and frequency distribution of the use of water depths by Black-legged Kittiwake (2m-depth intervals, top) as well as Jacobs-Index of selectivity for each water depth category (bottom)

5.12.3 *Abundance and distribution according to other studies*

During Horns Rev 3 surveys Kittiwakes were recorded during most days (HR3: Orbicon 2014a). High densities were recorded in January and November, both with approximately 0.15 ind./km². Higher densities were identified by Christensen (2003). Here, a maximum of 0.4 Ind/km² was reported in August 2000. The general pattern suggests a peak in the autumn months with fewer birds observed in winter. All three studies describe the spatial distribution consistently with Kittiwakes observed over the entire study area. Densities became even higher in areas further offshore (Christensen et al. 2003, 2006, HR3: Orbicon 2014a).

The maximum density values at Vesterhav Syd are below those recorded in Horns Rev studies, but densities in February and March are comparable (Horns Rev 3: 0.01 individuals/km² in February and 0.04 in March 2013). It has to be

noted, that the summer months are not covered and higher numbers of birds are likely to be present in late summer / autumn.

5.13 Common Guillemot / Razorbill

5.13.1 Abundance in the Vesterhav Syd area

Auks are treated as a combined group of Common Guillemots, Razorbills and unidentified auks. The numbers were highest during the first three surveys with maximum densities and population estimates on 11th February 2014 (0.75 individuals/km² and 771 individuals; Table 23, Figure 57). Nearly no auks were seen flying. Auks left the study area in March and only low densities and bird numbers were found during the last two surveys.

Table 23: Densities and population estimates of auks (sum of unidentified birds and identified Common guillemots and identified razorbills) for each of the six surveys. Lower 95% confidence interval (LCI) and higher 95% confidence interval (HCI) are given

Date	Density (birds/km²)	Study area population estimate	LCI	HCI	Density of flying birds (birds/km²)
25.11.2013	0.70	723	534	978	0.00
03.02.2014	0.41	425	255	708	0.00
11.02.2014	0.75	771	521	1,140	0.01
11.03.2014	0.29	298	215	411	0.00
25.03.2014	0.04	37	19	71	0.00
16.04.2014	0.05	49	20	121	0.00

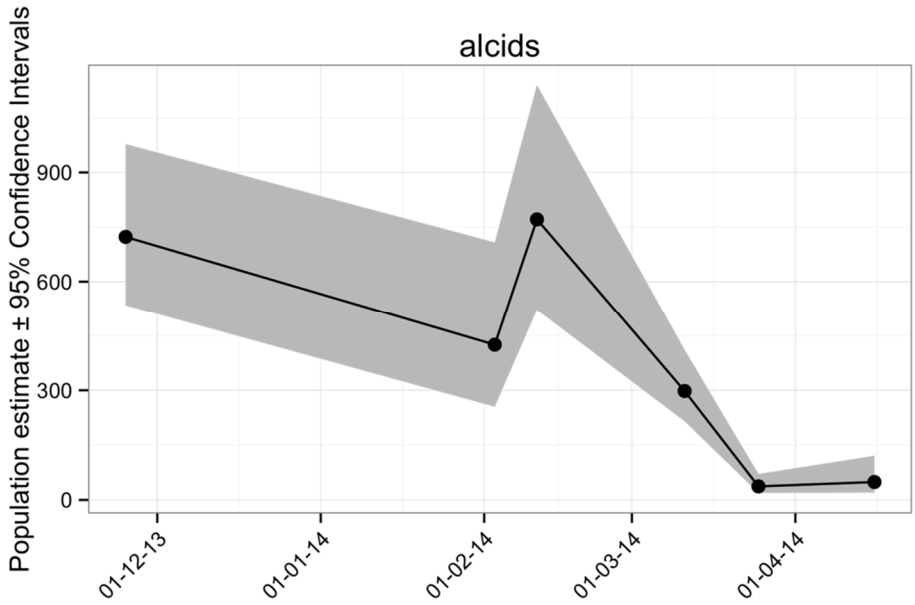


Figure 57: Population estimates (black line) and 95% confidence intervals (grey area) of auks during the six surveys

5.13.2 *Distribution in the Vesterhav Syd area*

Auks were recorded in low numbers close to the coastline (no records closer than 2 km) and concentrated in the western part of the study area (Figure 58). In the development area, auks were recorded only in four grid cells with low densities. Auks showed a negative selectivity index and the observed number of birds was significantly lower than the expected numbers for all distance classes (DA+0, DA+2, DA+4, Table 11).

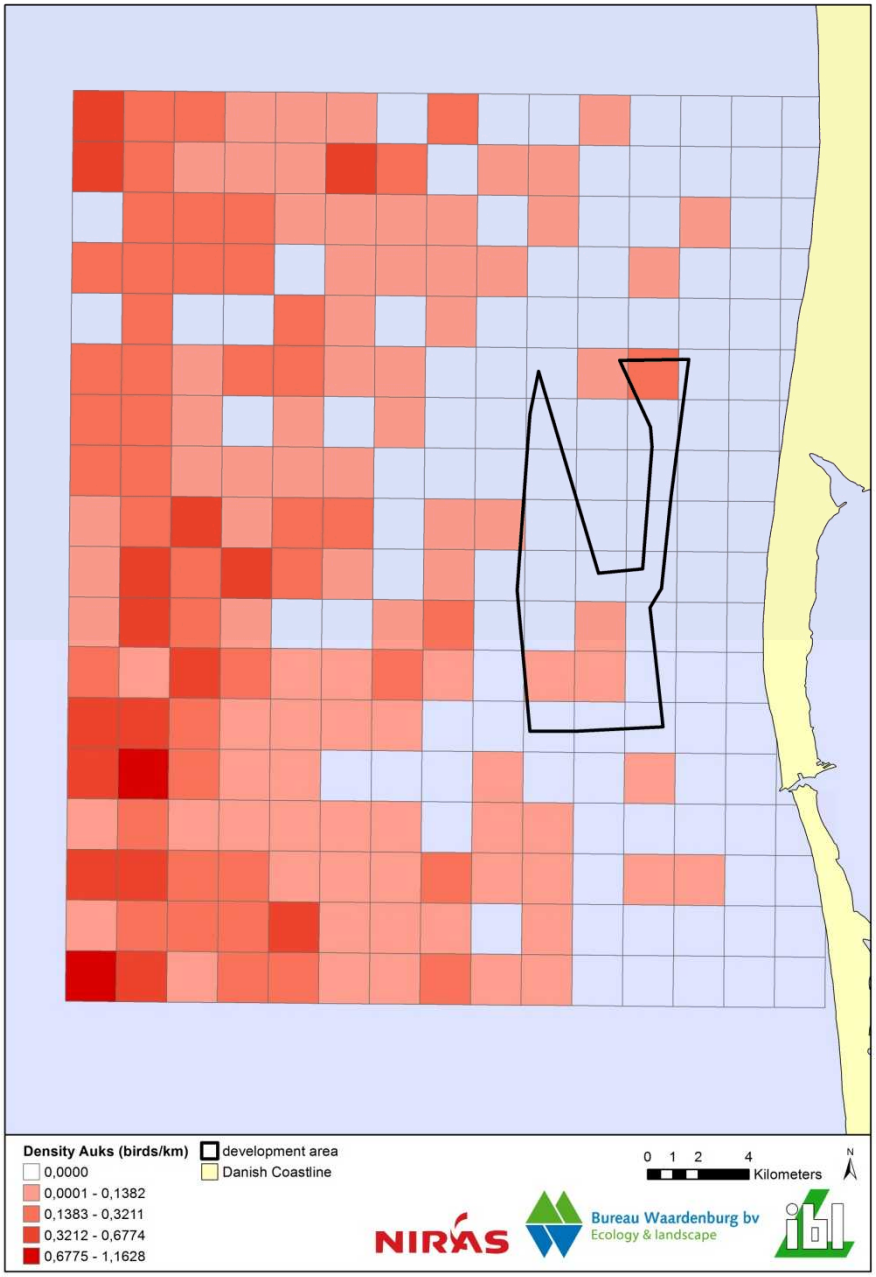


Figure 58: Relative density of auks based on six surveys. Data represent the number of observed birds per kilometer of flown transect in each 2 x 2 km grid square

Auks preferred the western part of the study area in all surveys, but the distribution was different (Figure 59). On 3rd February 2014 auks were concentrated in a very narrow area in the west (almost all birds within 6 km to the west), whereas during other surveys birds were more scattered in the western part of the study area.

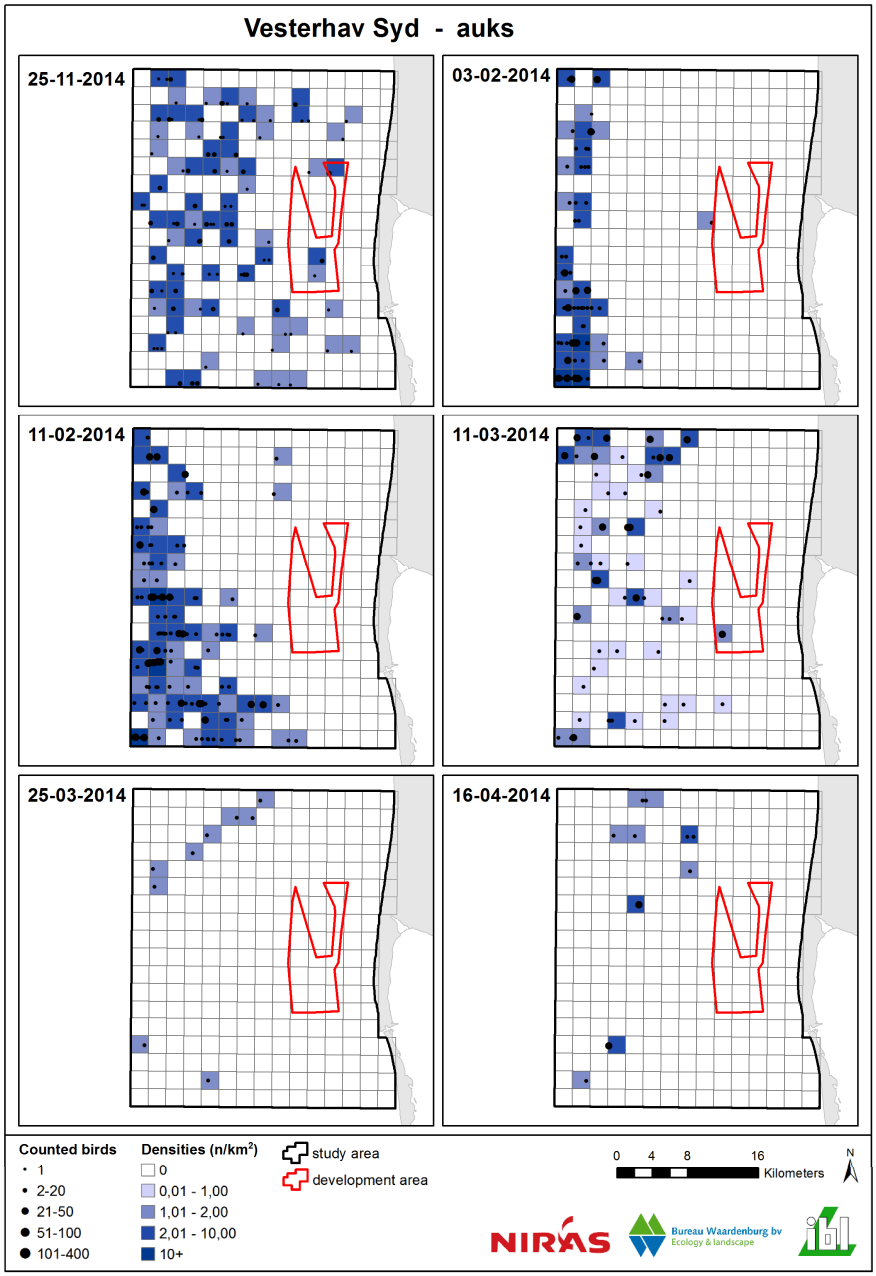


Figure 59: Counted numbers and density (n/km²) of auks based on six surveys. Data represented for 2 x 2 km grid square

The main water depths used by auks ranged from 22 to 32 m (Figure 60). Compared with the water depth available a strong avoidance of water depths up to 22 m were observed whereas a positive selection occurred for deep water from 26 m onwards.

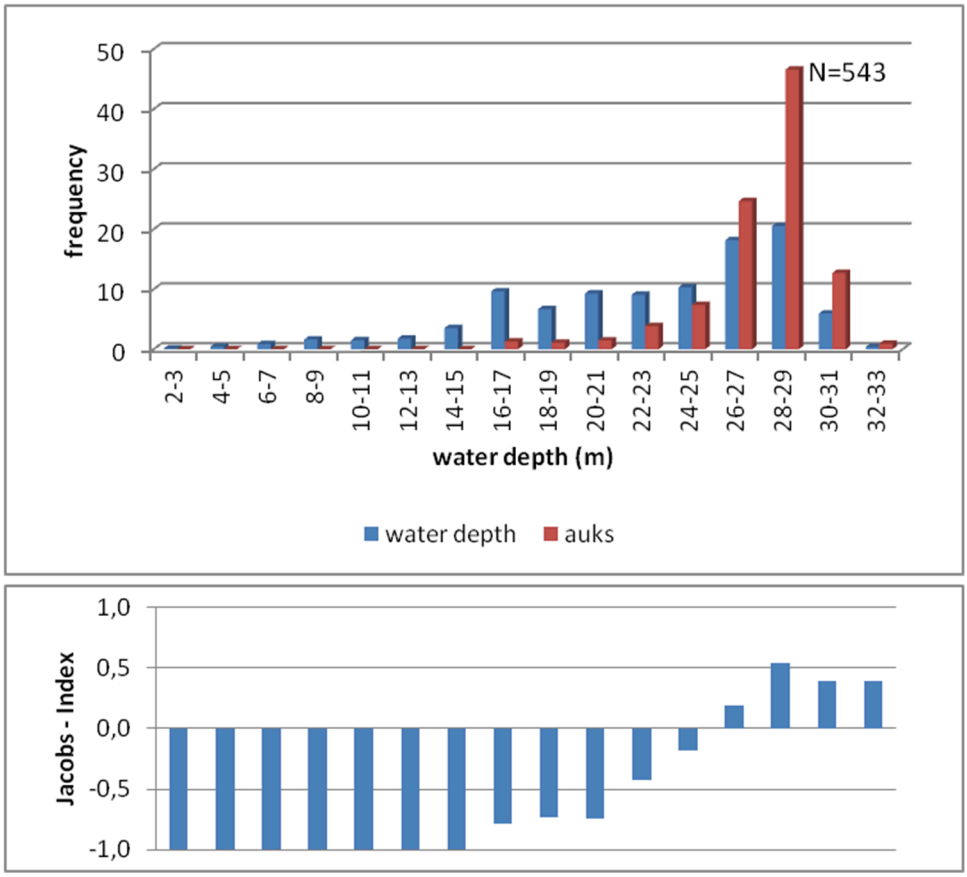


Figure 60: Frequency distribution of water depths and frequency distribution of the use of water depths by auks (2m-depth intervals, top) as well as Jacobs-Index of selectivity for each water depth category (bottom)

Figure 61 shows the observation points of auks in relation the water depths. Most observations were made within the depth category from 20 to 30 m.

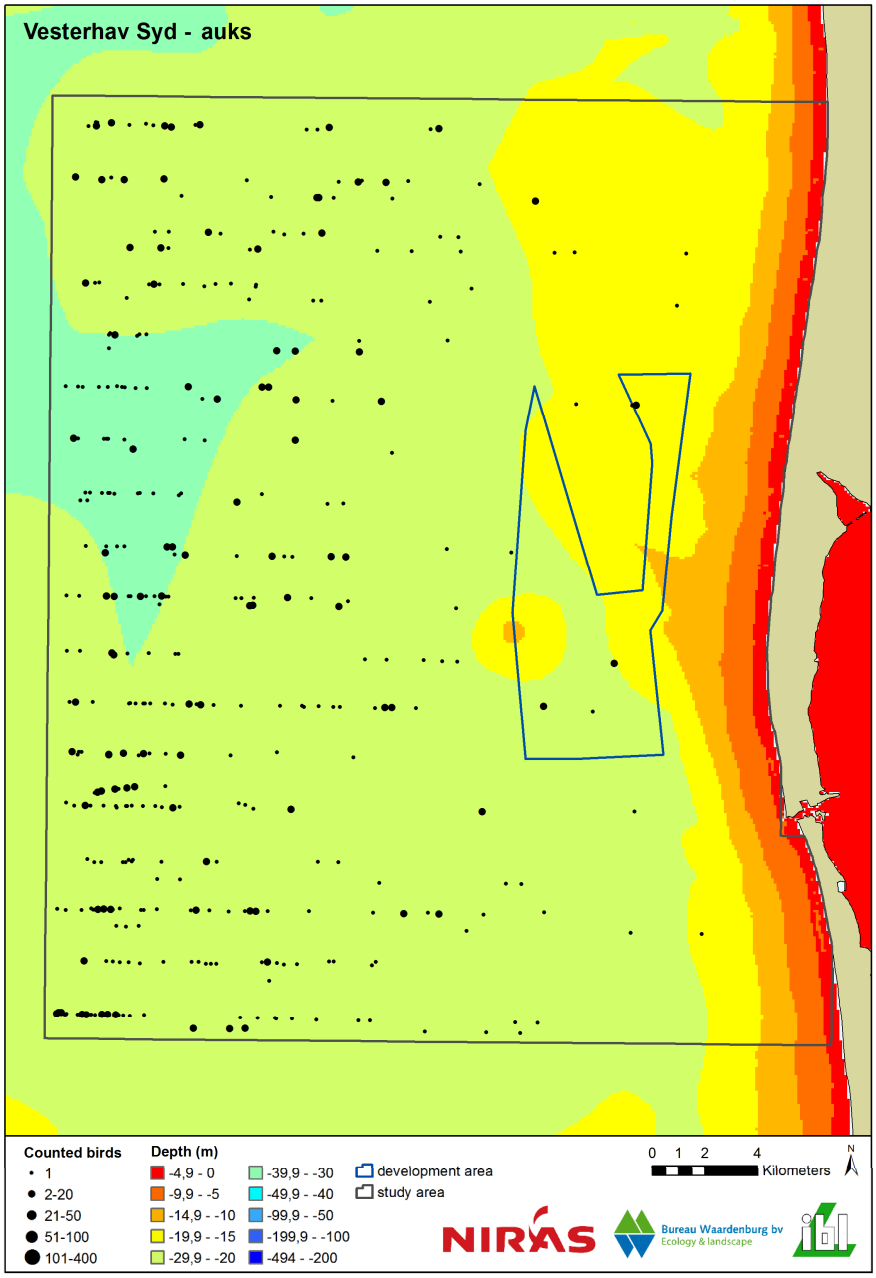


Figure 61: Distribution of counted auks as a sum of all six surveys in relation to water depth

5.13.3 *Abundance and distribution according to other studies*

Analysing data from a Danish monitoring program, Petersen & Nielsen (2011) mapped the occurrence of auks (Common Guillemot and Razorbills) for the Danish North Sea (Figure 62). As the general number of birds was relatively low, only results from spring surveys of the years 2008 and 2009 are presented. Due

to the coverage of a huge total area the transect spacing was rather high and also variable. Only 2-3 west-east transect lines match the Vesterhav Syd study area and only one short transect fragment of a north-south transect. Within the Vesterhav Syd study area no Auks were seen, including within the 30 km buffer zone.

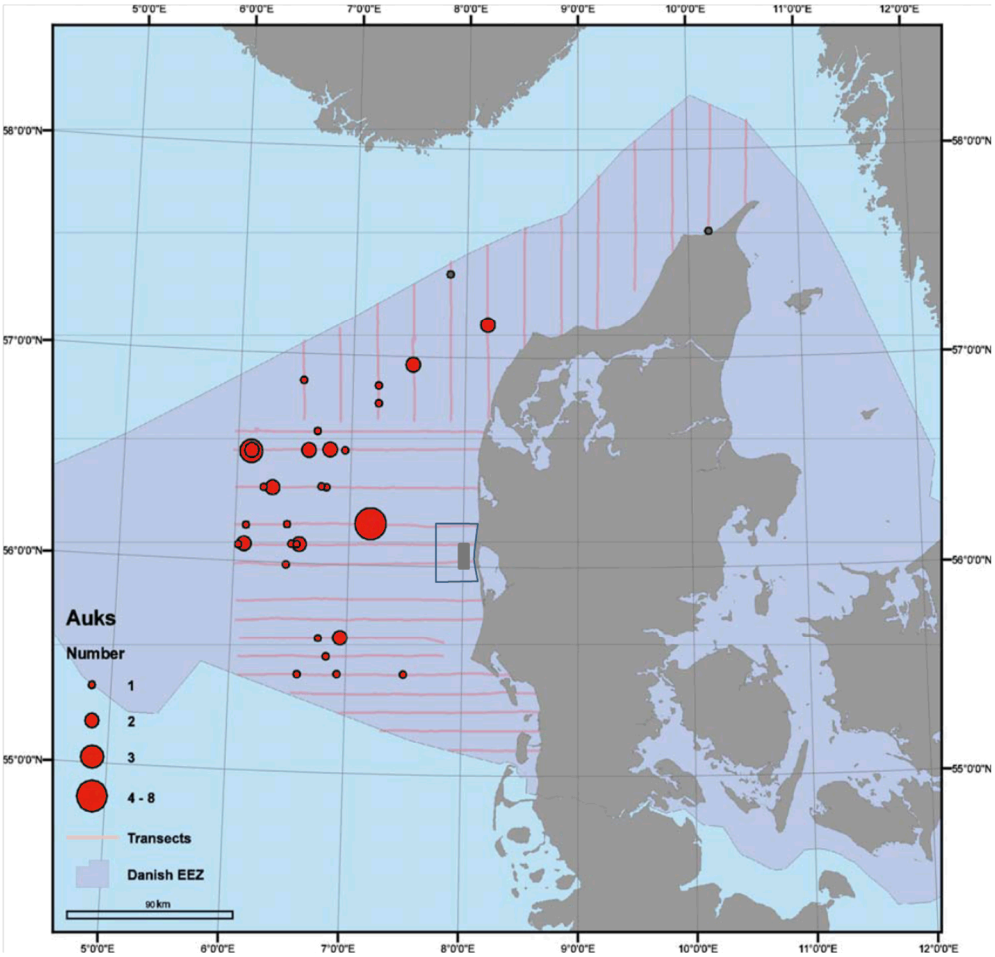


Figure 62: Distribution of auks (Guillemot/Razorbill) in spring (April 2008, 2009). Figure modified after Petersen and Nielsen (2011). Study area and development area for Vesterhav Syd project are indicated schematically (blue line around shaded area)

In Horns Rev 1 and 2 study areas Petersen et al. (2006a) counted 2,430 auks during 34 survey from 1999 to 2005. During studies for Horns Rev 3 project auks were generally recorded in low densities (<0.5 individuals/km^2, HR3: Orbicon 2014a). During a single flight in November 2013, 354 auks were recorded resulting in a density of 1.7 birds/km² (HR3: Orbicon 2014a). In Horns Rev 1 and 2 studies highest auk densities were also recorded in November. In November 1999 a maximum density of approximately 2.6 birds/km² was calculated in the Horns Rev 1 area. This study also showed a clear spatial distribution with the majority of birds recorded further offshore in the western parts of the study area

(Christensen et al. 2003). This finding was further supported by Petersen et al. (2006a) who found a clear preferences for areas with water depth greater than 20 m. However, the Horns Rev 2 study recorded birds in eastern areas. This distribution is mainly based on one single flight where the vast majority of auks was recorded (Christensen et al. 2006).

In the Vesterhav Syd area maximum densities of auks were below those found in the Horns Rev area. The winter and spring densities in Horns Rev 3 studies of 0.06 ind./km² in April 2013 to 0.37 ind./km² in January 2013 are within the same range compared to Vesterhav Syd study area.

6 METHODOLOGY OF IMPACT ASSESSMENT

6.1 Introduction

The construction and the operation of an offshore wind farm may cause different impacts on resting birds (see Section 6.3). Depending on the species-specific sensitivity (see Section 6.4) the following pressures may potentially cause negative impacts on birds:

- Habitat loss / habitat change;
- Displacement / disturbance;
- Collision mortality ; and
- Barriere effects.

A basic methodology for assessing potential impacts has been outlined by Energinet.dk and NIRAS (2013) and is applied in the following for resting birds. The impacts ”habitat loss / change” and ”disturbance / displacement” are evaluated using this methodology in Section 6.2. The impacts of ”collisions” are assessed using a different approach, the reasons and the approach are described in Section 6.2.5. Offshore wind farms can potentially also be regarded as a barrier for resting birds comparable to the situation in migrating birds. In migrating birds the additional energy expenditure due to flying around a wind farm may negatively affect energy balance of the total flyway. In resting birds a barrier may affect local movements within the resting area. As they move within their resting area energy loss is not regarded to be a significant negative factor. Further, a potential barrier effect has the same consequences and pressures like displacement: sensitive birds regard the wind farm as a barrier and avoid the area. Therefore, the barrier effect is not regarded as a significant pressure in resting birds.

Criteria using the methodology of Energienet.dk and NIRAS (2013) include:

- Degree of disturbance/impact;
- Importance;
- Likelihood of occurrence; and
- Persistence.

A combination of these criteria according to Table 80, Table 81 and Table 82 in the Appendix Section 16.7 leads to a given **Magnitude of impact** of the categories *“Major, Moderate, Minor or Negligible/neutral/no impact”*. A description of these categories with examples of dominating effects is given in Table 24. In

addition to these negative/neutral impacts positive impacts may also occur. They are mentioned separately in the text and do not follow the impact criteria described below.

Table 24: Explanation of magnitude of impact

Magnitude of impact	Explanation
Major impact	Impacts with a large extent and/or long-term effects, frequently occurring and with a high probability, and with the possibility of causing significant irreversible impacts.
Moderate impact	Impacts with either a relatively large extend or long-term effects (e.g. throughout the lifespan of the wind farm), occurs occasionally or with a relatively high probability and which may cause some irreversible but local effects on elements worthy of preservation (culture, nature etc.).
Minor impact	Impacts of some degree or complexity, a certain degree of persistence beside the short-term effects, and with some probability to occur, but which will very likely not cause irreversible effects.
Negligible / neutral/no impact	Small impacts of local interest, which are uncomplicated, persist for a short-term or are without long-term effects and without any reversible effects. Or No impacts compared to status quo.

Besides the description of impact criteria (Section 6.2) the relevant project pressures are described in Section 6.3 and a sensitivity analysis of species against pressures is performed in Section 6.4.

6.2 Impact criteria

The criteria used for impact assessment are described below. The evaluation follow either measurements according to the studies performed or are based on expert judgments according to the knowledge from previous studies on offshore wind farm projects.

If a bird species is not present in the development area and impact zone (or only with very few individuals) the ”Degree of disturbance” is rated as ”Negligible” as no impact is expected. Further, if no negative impact is assessed according to expert judgment, the ”Degree of disturbance” is also rated as ”Negligible” and the methodology is not used (the Magnitude of impact is then also rated as ”Negligible”). For example, if gulls use the wind farm area as usual they are not displaced and the Degree of disturbance is not ”Low” but ”Negligible”. In this case the methodology is not used and the Magnitude of impact is rated as ”Negligible”.

The methodology tables for impact assessment are on the first level separated by ”High” (Table 80), ”Medium” (Table 81) and ”Low” (Table 82) Degree of disturbance (Appendix Section 16.7). In the case of a ”Negligible” degree of disturbance the presented methodology is not used and the Magnitude of impact is assessed as ”Negligible”.

6.2.1 Degree of disturbance

Displacement

The probability of being displaced depends on the sensitivity of a species to disturbance. Hence, the judgment of the degree of disturbance in relation to displacement is mainly based on a sensitivity analysis (see Section 6.4). Birds which avoid areas of construction or offshore wind farms in operation are rated as ”High” whereas species entering a wind farm or even are attracted to wind farms or vessels (construction period) are rated as ”Low”. This rating is based on literature knowledge and expert judgment.

Besides judging the impact of displacement *per se* (that is: e.g. being displaced can be regarded as a ”high” degree of disturbance), the assessment of the impact also has to consider how many birds will be affected. For example, if the degree of disturbance in a bird species is rated as ”High” due to a high sensibility against disturbance, but only very few individuals are affected, the rating can be down-graded. The number of birds affected are those individuals found within a species specific buffer zone on the survey day with maximum number of individuals found within the impact zone (as a worst case assumption). As reference population 1% of the biogeographical population is considered. This 1% criteria is originally used to define whether an area is of international importance as it holds at least 1% of the biogeographical population[1]. The linkage to this system is arbitrary and follows the idea that an impact is expected to be significant when an international important part of the population is affected. Following a precautionary principle the limits for a significant impact is set to half of the 1% value. Following this idea, it is assumed that a high impact is present if ≥0.5% of the population is affected (very high: ≥ 1%).

Table 25 shows the combined rating of the degree of disturbance for displacement according to sensitivity and the number of affected birds.If the proportion of affected birds is less than 0.001 % the degree of displacement is rated as ”Negligible” irrespective of sensitivity of the species. This would be the case if less than 10 individuals of a population of 1.000.000 individuals would be affected by

[1] Ramsar Conventsion 1971: Ramsar citeria 1999 on waterbirds: criterion 6 –site is of international imporance if site regularly supports 1% oft he individuals in a population of a species or subspecies of waterbirds (http://www.ramsar.org/cda/en/ramsar-about-sites-criteria-for/main/ramsar/1-36-55%5E20740_4000_0__)

displacement. Further, if the rating of affected bird numbers is Low (≥0.001% and <0.05% of biogeographic reference population) but the value is close to Negligible (0.001% regarded as the lowest limit for a Low rating) the observations are controlled for their exact location. If the affected birds were outside of the development area the rating of Low is down-graded to Negligible. This is to prevent the prediction of an impact in species that occur in very low numbers close to the development area, but actually do not use the area where the wind farm is planned.

Table 25: Definition of the parameter "displacement" according to sensitivity and birds within the impact zone

	Sensitivity		
Rating of birds within impact zone in relation to biogeographical population	**High**	**Medium**	**Low**
Very High: >1% of biogeographical reference population	High	High	Low
High: ≥0.5% and <1% of biogeographic reference population	High	Medium	Low
Medium: ≥0.05% and <0.5% of biogeographic reference population	Medium	Medium	Low
Low: ≥0.001% and <0.05% of biogeographic reference population	Low	Low	Low
Negligible: <0.001% of biogeographic reference population	Negligible	Negligible	Negligible

Habitat loss / habitat change

Basically, the loss of habitat or change in habitat can be regarded as a severe impact as the access to previously used food sources is prevented. However, the actual species specific impact depends on the ability of birds to react on this situation. Therefore, the basis for the ranking of the impact of habitat loss and habitat change is the flexibility in food choice. If a species is specialised on a particular prey a loss of habitat has stronger implications than in species that are flexible in food choice and capable of exploiting alternative prey. Besides the ability to switch to alternative prey species it is also judged on whether there are suitable foraging areas nearby that can be used alternatively.

Similar to the judgments on disturbance the rating is modified by the number of birds effected. If, e.g. a species with low flexibility is affected (e.g. Common Scoter that depend on particular water depths or the occurrence of particular stationary prey species) but only few individuals are present in the impact zone the

”high” rating of habitat loss / change is downgraded. The judgment on the number of affected birds follows the method described for disturbance and the 0.5% of the biogeogrphical population is taken as limit for a high impact.

Table 26 shows the combined rating of the degree of disturbance for habitat loss / change according to the flexibility of birds in food choice and the number of affected birds. Birds with a high flexibility in food choice that do not depend on this site or even benefit from increased food availability (e.g. cormorants attracted by turbine structure as sitting places or gulls expecting extra food from vessels) the degree of disturbance is rated as ”Negligible” and by definition is not part of further impact assessment (in terms of negative impact; possible positive impacts will be discussed). If a very high proportion of the biogeographical population is affected a low impact in species with high flexibility in food choice is anticipated. A negligible impact is assessed if very low number of birds are affected or if the food resource of the species is unaffected or increasing.

The loss of habitat is described by the footprint of the wind farm (coverage with rocks, scour protection) and therefore, the spatial dimensions are also included in the judgment of habitat loss. Even though the spatial dimensions of installation activities are more restricted than the effect of an existing wind farm the birds of the total development area are taken as reference following a precautionary principle.

Table 26: Definition of the parameter “habitat loss / change” according to the flexibility in food choice and birds within the impact zone

	Flexibility in food choice		
No. birds affected by habitat loss	**Low**	**Medium**	**High**
Very High: ≥1% of biogeographical reference population	High	High	Low
High: ≥0.5% and <1% of biogeographic reference population	High	Medium	Negligible
Medium: ≥0.05% and <0.5% of biogeographic reference population	Medium	Medium	Negligible
Low: ≥0.001% and <0.05% of biogeographic reference population	Low	Low	Negligibe
Negligible: <0.001% of biogeographic reference population	Negligible	Negligible	Negligible

6.2.2 *Importance*

The central aspects for assessing the importance of an area for a species are the conservation status of the respective species and its abundance in the area in relation to the relevant biogeographical population.
This is applied for both pressures ”displacement” and ”habitat loss / change”.

The population size and corresponding 1% value of the relevant biogeographic reference population of a resting species were taken from Wetlands International (2014). For seabird species, which are not listed in Wetlands International, winter population estimates from BirdLife International (2004) were taken. For the Northern Gannet, for which only a European breeding population is given in BirdLife International (2004), the population size was estimated by multiplying the breeding population by three (BirdLife International 2014). The relevant biogeographic reference populations are given in Table 27 and the respective population sizes and protection status in Table 28.

Table 27: Explanation of relevant biogeographic reference populations

Species	Scientific name	Biogeographic reference population
Red-throated Diver	*Gavia stellata*	NW Europe
Northern Gannet	*Morus bassana*	derived from European population (breeding pairs *3)
Velvet Scoter	*Melanitta fusca*	W Sibiria, N Europe, NW Europe
Common Scoter	*Melanitta nigra*	W Sibiria, N Europe/W Europe, NW Africa
Common Eider	*Somateria mollissima*	Baltic, Wadden Sea
Common Gull	*Larus canus*	NW & Central Europe, Atlantic coast, Mediterranean
Herring Gull	*Larus argentatus*	N and NW Europe
Lesser Black-backed Gull	*Larus fuscus*	S Scandinavia, Netherlands, Ebro Delta Spain
Greater Black-backed Gull	*Larus marinus*	N & W Europe
Black-headed Gull	*Larus ridibundus*	W Europe, W Mediterranean, W Africa
Little Gull	*Hydrocoloeus minutus*	Central, E Europe, SW Europe, W Mediterranean
Black-legged Kittiwake	*Rissa tridactyla*	East Atlantic
Common Guillemot	*Uria aalge*	North Sea, Baltic Sea
Razorbill	*Alca torda*	North Sea, Baltic Sea

Table 28: Population sizes, 1% value and protections status (EU Directive, Annex I and EU SPEC category) of relevant species

Species	Population size	1% value	EU Directive; Annex I	EU SPEC Category
Red-throated Diver	150,000-450,000	2,600	listed	SPEC 3

Species	Population size	1% value	EU Directive; Annex I	EU SPEC Category
Northern Gannet	900,000-930,000	9,150	not listed	Non-Spec E
Velvet Scoter	450,000	4,500	not listed	SPEC 3
Black Scoter	550,000	5,500	not listed	Non-Spec
Common Eider	976,000	9,800	not listed	Non-Spec E
Common Gull	1,200,000-2,250,000	16,400	not listed	SPEC 2
Herring Gull	1,300,000-3,100,000	20,100	not listed	Non-Spec E
Lesser Black-backed Gull	325,000-440,000	3,800	not listed	Non-Spec E
Greater black-backed Gull	330,000-540,000	4,200	not listed	Non-Spec E
Black-headed Gull	3,400,000-4,800,000	42,100	not listed	Non-Spec E
Little Gull	72,000-174,000	1,100	listed	SPEC 3
Black-legged Kittiwake	6,600,000	66,000	not listed	Non-Spec
Common Guilemot	>4,300,000	43,000	not listed	Non-Spec
Razorbill	>500,000	5,000	not listed	Non-Spec E

Explanations to SPEC: see text below

The abundance of a species at the project site is classified as ”*very high, high, medium, low”* according to the following criteria:

- **Very high**: ≥1% of the biogeographical reference population, or ≥20.000 individuals of a waterbird species (for populations >2 million birds);
- **High**: ≥0.5% and <1% of biogeographic reference population ;
- **Medium**: ≥0.1% and < 0.5% of biogeographic population; and
- **Low**: <0.1% of biogeographic population

Estimated population size in the study area as derived from project-specific aerial surveys (see Section 0) are used for assessment against the relevant biogeographical population.

Two indices are used as criteria for the conservation status: the listing in Annex I of the EU Birds Directive and the SPEC status (Species of European Concern) according to BirdLife International (2004). None of the recorded species are

listed as threatened (critical endangered, endangered, vulnerable) in the Danish Red Data Book (DMU 2014). The rating is as follows:

- **Very high** when the species is listed in the Annex I or holds the SPEC-status 1 or 2 (1: European species with global conservation concern, 2: European species whose global population is concentrated in Europe, unfavourable conservation status);
- **High** when SPEC-status is 3 (global population not conentrated in Europe, but unfavourable conservation status in Europe);
- **Medium** when global population is concentrated in Europe with favourable conservation status (Non-SPEC-E); and
- **Low** when global population is not concentrated in Europe, and have a favourable conservation status in Europe (Non-SPEC).

A combination of the criteria according to Table 29 results in an assessment of the importance of the area for resting birds. The resultant categories are ”*International*”, ”*National/regional*”, ”*Local*” and ”*Not important*”.

Table 29: Scheme for determination of importance of Vesterhav Nord area to bird species

	Conservation status			
Abundance	**Very high**	**High**	**Medium**	**Low**
Very high	International	International	International	National/ regional
High	International	National/ regional	Local	Local
Medium	National/ regional	National/ regional	Local	Local
Low	Local	Local	Not important	Not important

6.2.3 *Likelihood of occurrence*

The likelihood of occurrence describes the probability that the impacts (displacement, habitat loss / change) will occur.

If a species is present in the impact zone (development area including species specific buffer zone) the likelihood of an impact occurring is considered to be high. This “high” impact is modified by the behaviour of the bird; similar to the decisions for the degree of disturbance, birds with low disturbance levels (e.g. for gulls or cormorants; behaviour rated as Neutral/Attraction) will not be displaced and the likelihood of occurrence of displacement is Low. A further modification of the judgement is given by the regional use of the area. If birds are concentrated

in the impact zone the likelihood of occurrence is rated as High. The values are derived from selectivity indices and the relationship of bird numbers in the total study area to birds within the impact zone. In species showing a strong avoidance of wind farms a Low rating of selectivity (indicated by negative selectivity indices) is assessed only if the difference in observed and predicted number of birds is significant and is retained when a buffer zone of 2km is included.

Table 30 shows the combined rating of the likelihood of occurrence for displacement and habitat change according to the behaviour of birds and the site selectivity and occurrence in the impact zone in relation to study area. If a species shows a negative selection the local use of the area is limited and the likelihood of occurrence is rated as ”Low” also in birds showing avoidance behaviour.

During the period of installation and decommissioning also the spatial distribution of the species is considered as installation work is limited to a particular site. If a species shows a positive selection of the development area but the spatial distribution is characterised by highly preferred restricted areas then the rating is down-graded as the likelihood of an effect is reduced. The limited spatial extend of the impact during installation and decommissioning also results in a down-grading compared to the period of operation.

Duing the period of operation a habituation of birds to the wind farm may occur on a long time scale (see Section 6.4.2). If this can be expected the likelihood of occurrence of an effect is down-graded as the likelihood of habitat loss and displacement decreases. A down-grade due to habituation is only performed if likelihood is assessed to be high according to the selectivity in a first assessment. If selectivity indicates a medium or low the likelihood of occurrence this rating is not down-graded following a precautionary principle.

Table 30: Definition of the parameter “Likelihood of occurrence” of displacement according to sensitivity and the relative use of the impact zone in relation to study area

	Behaviour		
Selectivity; birds within impact zone in relation to study area	**Strong avoidance**	**Moderate avoidandce**	**Neutral/Attraction**
High: positive selectivity of area; higher number than expected	High	High	Low
Medium: relative bird numbers similar to total study area; no selectivity	High	Medium	Low
Low: negative selectivity of area (limited use); lower number than expected	Low	Low	Low

6.2.4 *Persistance*

The persistence of the impact gives a temporal scale of how long the pressure is present. There are three categories defined:

- **Permanent**: impact lasts for more than 5 years;
- **Temporary**: impact lasts for a period of 1 to 5 years; and
- **Short-term**: impact lasts for a period of less than one year

6.2.5 *Assessment method in collisions*

The assessment of collisions is not based on the NIRAS guidance as the applicabitlity of impact criteria is limited in case of collisions. For example, the degree of disturbance would always be high, as a collision means the death of a bird. If other criteria are also rated as high (e.g. international importance), major impacts could result from this assessment method even when few individuals would collide per year and actually no severe impact can be expected. Therefore, the assessment of collisions is based directly on the results of collision modeling. The assessment is completed by expert judgment taking into account the number of colliding birds in relation to reference populations. The magnitude of impact of collisions can only be judged if the number of collisions is compared to a reference population. For this purpose the following approach is used.

The rating of collisions is based on effects of additional mortality on the population level. The concept of the Potential Biological Removal (PBR) is based on the question at what impact (number of victims, increased mortality) is an effect on the population unacceptable large. According to Dillingham & Fletscher (2008) PBR is defined as:

$PBR=0.5*R_{max}*N_{min}*fr$,

Where R_{max}=annual recruitment, N_{min}=minimum population size (conservative estimate) and fr=recovery factor.

The recovery factor is reflecting the population trend: in a decreasing population additional mortality has much higher effects than in increasing populations and a removal of a much lower number of birds would cause adverse impacts. The recovery factor is defined as 0.1=decreasing population, 0.5=stable population, 1=increasing population.

The removal can also be expressed in terms of percentage of population. In order to gain information about the relationship between removal in terms of number of birds and % of population, data analysed by Poot et al. (2011) are presented for relevant species (Table 31).

Table 31: PBR (Potential Biological Removal) in number of individuals and in % of population for different population trends (rf); data from Poot et al. (2011)

	Min. pop. size	number of removal			% population removal			European trend
		rf=0.1	rf=0.5	rf=1	rf=0.1	rf=0.5	rf=1	overall status
Red-throated Diver	55,900	700	3,400	6,900	1.3	6.1	12.3	stable
Northern Gannet	167,300	1,000	5,200	10,400	0.6	3.1	6.2	large increase
Common Scoter	640,000	6,600	33,000	66,000	1.0	5.2	10.3	stable
Great Black-backed Gull	130,900	1,000	4,900	9,800	0.8	3.7	7.5	large increase
Herring Gull	50,000	200	1,200	2,400	0.4	2,4	4,8	moderate increase
Lesser Black-backed Gull	89,900	600	2,800	5,600	0.7	3.1	6.2	large increase
Little Gull	28,200	300	1,600	3,200	1.1	5.7	11.3	moderate increase
Common Gull	472,800	4,100	20,600	41,200	0.9	4.4	8.7	unknown
Black-legged Kittiwake	281,600	1,300	6,700	13,500	0.5	2.4	4.8	decrease
Sandwich Tern	16,700	100	600	1,300	0.6	3.6	7.8	small decline
Common Tern	17,000	100	700	1,400	0.6	4.1	8.2	stable
Common Guillemot	504,200	2,700	13,700	27,400	0.5	2.7	5.4	large increase
Razorbill	110,800	600	2,900	5,800	0.5	2.6	5.2	unknown

Explanation: rf – population trend: 0.1= decreasing, 0.5=stable, 1=increasing
population trends: BirdLife International (2004)

For most species the overall European trend is stable or increasing (BirdLife International 2004) suggesting the use of an rf-value of 0.5 or 1. Taking 0.5 as rf-value, the removal rate would be > 2% of population in all species. Using a precautionary approach and defining rf=0.1 as given factor, a value of 0.5% of the population can be applied as lower limit. If additional mortality exceeds 0.5% of the reference population a negative impact can be expected.

For the impact assessment of collision the following levels are defined:

- **Major**: mortality due to collisions ≥0.5% of the biogeographical reference population;

- **Moderate**: ≥0.1% and < 0.5% of biogeographic population;
- **Minor**: ≥0.01% and < 0.1% of biogeographic population; and
- **Negligible/No impact**: < 0.01% of biogeographic population.

A modification is possible according to expert judgment based on the conservation status of the species.

6.3 Project pressures and impacts on resting birds

The following section describes relevant project pressures causing impacts on resting birds. The description is based on available documentation from existing wind farm projects, especially from comparisons of pre- and post-installation data in terms of impacts during operation. The effects during the period of decommissioning are comparable to the effects during installation and therefore described together in the following section.

6.3.1 Impacts during installation/decommissioning

The installation activities are anticipated to take place over a period of 1-2 years. The following potential pressures are considered:

- Displacement;
- Habitat loss / change; and
- Collisions.

Disturbance / displacement

The disturbance impacts are mainly caused by vessel traffic; in addition to the vessels required for installation of the turbines, guard vessels, traffic control and material transportation carriers from harbours will also be present within the development area and the surrounding. Transportation of staff and material to installation vessels by helicopter is also likely to be commonplace and flight activity may cause disturbance to resting birds. Visual disturbance, noise emissions during pile driving, vibrations and light emissions are also considered. Throughout the installation period the number of turbines increases. Although they are not yet in operation (i.e. rotor blades are still) they are man-made, artificial structures with the potential for disturbance effects on sensitive species.

Compared to large scale offshore wind farms in operation, the disturbance effects of installation activities generally take place over a smaller spatial scale. The magnitude of disturbance depends on the presence of birds during the peri-

od of installation. As the number of birds at resting sites shows strong seasonal fluctuations the timing of installation activities is essential with respect to disturbance of birds. Within the Vesterhav Syd site, species most sensitive for disturbance (divers, scoters and auks) are most numerous during the winter months and in spring (from November to April). Therefore, disturbance and habitat displacement is most significant during the winter and spring period.

In addition to the defined population of affected birds, species specific behaviour is important. Birds may either be attracted to vessels as they expect a food source (e.g. gulls following fishing vessels) or they show a negative response and flush from approaching vessels. Thereby, species show different flushing distances according to their sensitivity to disturbance. Especially during the period of moult when birds are not able to fly, the sensitivity of waterbirds against vessel is expected to be particularly high. A species specific sensitivity analysis is presented in Section 6.4.

Habitat loss / change

The installation activities include work on the seabed. The preparation of seabed, sediment removal and deposition and cable laying activities will effect food availability for resting birds by destroying local prey items (e.g. loss of habitat). Increased water turbidity and sedimentation may cause effects surrounding the installation site causing a change in habitat. During decommissioning cables will probably be covered by rock-dumping (see Section 3.5).

Collisions

Resting birds may potentially collide with installation vessels. However, as the probability of such an incident is extremely low, the impact of collision during the period of installation is regarded as Negligible and not further considered for impact assessment.

6.3.2 Impacts during operation

Disturbance / displacement

Wind farms are man-made vertical structures which may impact bird species through disturbance and displacement. Compared to installation, the effect during operation occurs over a larger geographical and temporal scale. Besides the simple presence of a turbine, the movement of rotor blades, the emission of noise and light contribute to the disturbance effects on birds. Similar to the situation during installation, species-specific differences in sensitivity to wind farms in operation are considered (described in Section 6.4). In addition to the wind farm

structures, vessel and helicopter traffic for the maintenance of the wind farm may cause disturbance to resting birds.

Habitat loss / change

Habitat loss for resting birds may take place as a result of the presence of foundations and scour protection around the foundation covering the seabed (habitat loss). Further, indirect effects by changes in habitat and food availability has the potential to affect birds. If the area cannot be used by sensitive species due to displacement a changed food situation may negatively effect birds. Besides these negative impacts, there is also potential for positive impacts to occur. For example, foundations and scour protection provide hard substrate and potential new habitat for benthic communities which may attract birds. Reduced fishing activities in the wind farm area may positively affect fish stock and thus, birds preying on fish.

Collision

During the resting period birds may fluctuate between sites within the entire resting area or change sites between day and night. This behaviour depends on site-specific situations and therefore occurs in varying intensities. During these flights birds may collide with wind turbines causing mortality.

6.4 Sensitivity analysis

Different bird species (or groups of species) react in different ways to the described project pressures. This species-specific sensitivity is essential for the assessment of impacts on resting birds. Therefore, the following sensitivity analysis is a major step in order to determine the “degree of disturbance” in the process of impact assessment (see Section 0).

If a species shows a strong negative response to a given pressure (e.g. high flushing distance against vessels during installation or avoidance distance against wind farm) it is ranked to be of higher sensitivity compared to a species with less intense response. The ranking is based on information from literature or is subject to expert judgment.

Effects of vessels (causing disturbance mainly during installation/decommissioning) and wind farms in operation are supposed to be comparable when species specific reactions are considered (e.g. divers avoid the vicinity of both vessels and offshore wind farms). Therefore, the sensitivity analysis is performed as a general analysis for both periods.

6.4.1 *Habitat loss / change*

Habitat loss implies that a particular area is destroyed or not accessible preventing birds from using it for foraging. Therefore, all species are sensitive to loss of habitat, but the impact of habitat loss is usually very small scale (scour protection, location of vessels).

The most important issues with respect to habitat loss / change are indirect impacts resulting from changes in food resources. A reduced availability of benthic communities and fish may have a negative impact on waterbirds. There are several examples of food reductions caused by human activities with strongly negative effects on seabirds. Overfishing of mussels and cockles in the Wadden Sea in the early 1990s led to a mass starvation of Common eider (Camphuysen et al. 2002) and intensive commercial fisheries caused starvation and reduced fitness in seabirds (Tasker 2000). Whereas these are long-term and large scaled impacts (overfishing), seabirds are generally known to have a certain degree of plasticity in prey selection allowing them to exploit species that are most abundant. For example, Common Scoters forage on a wide range of bivalves and are able to exploit new food resources when environmental conditions change (Leonhard & Skov 2012).

The foundations of turbines provide new hard substrate creating new benthic communities and attracting fish. The profit for most seabirds may be low, as most diving species who could have access to this new food resource show a high avoidance of wind farm areas. However, recent studies show that Common Scoter are seen within the wind farm Horns Rev 2 and also Common Eider have been reported to forage on artificial reefs at the basis of offshore wind turbines (Lindeboom et al. 2011). Cormorants are supposed to benefit from this habitat change as they show no avoidance of wind farms. They are reported to occur inside of wind farms exploiting the additional food resource and using structures above sea level for resting (Petersen et al. 2006a, Lindeboom et al. 2011).

6.4.2 *Disturbance*

The response of waterbirds to vessel traffic is different between species. Some species may be attracted by the vessels (expecting extra food) others avoid vessels and flush away at a certain distance. Studies on the response of waterbirds to shipping showed highest response values for divers and Common/Velvet Scoter (both 1-2 km), whereas the flushing distance of auks (Razorbill, Common Guillemot, Black Guillemot) was estimated at maximum 500 m (Bellebaum et al. 2006, Schwemmer et al. 2011). The behaviour may show a high degree of variation depending on e.g. status of moult (high sensitivity during moult), flock size (high sensitivity in large flocks, Schwemmer et al. 2011) and hunting pressure (high fleeing distances in hunted species (e.g. Laursen et al. 2005). In order to

account for species-specific effects Furness et al. (2013) developed a ranking on how strongly birds are effected by disturbances. This ranking is based on bird's reaction to ships and helicopters and their habitat flexibility and was also developed in order to be transferred to offshore wind farms. Divers achieved the highest index value. Other species with high values are Common and Velvet Scoter, Common Eider, Common Guillemot and Razorbill. Lower values obtained all gull species and the Northern Gannet.

Gulls and terns are often associated with vessels and their sensitivities to disturbance are often regarded as low (Garthe & Hüppop 2004, Mendel et al. 2008, Furness et al. 2013). Therefore, during the period of installation of the wind farm the sensitivity of these species is assessed to be low. This assessment also includes all gull species recorded in the Vesterhav Nord study area: Little Gull (Petersen et al. 2006 in Horns Rev 1), Herring Gull (Petersen et al. 2006 in Nysted, Horns Rev 1, Gill et al. 2008 in Kentish Flats), Great Black-backed Gull (Gill et al. 2008 in Kentish Flats) and Kittiwake (PMSS 2007 in North Hoyle). Whereas in British wind farms both Sandwich and Common terns showed no avoidance (PMSS 2007, Gill et al. 2008), Petersen et al. (2006a) found indications of moderate avoidance in Horns Rev 1.

For the period of operation there are species specific data on disturbance available from existing wind farms. In the following sections, the available information on relevant species from different studies is presented.

Divers

Divers are ranked as species with the highest sensitivity index in the context of disturbance effects from wind farms (index value: 32, Furness et al. 2013). In the Horns Rev 1 and Nysted wind farms divers showed a complete displacement and no birds were found inside of the wind farm (Petersen et al. 2006a). In Horns Rev 1 avoidance effects occurred up to 2 km around the wind farm, whereas in Nysted the nearest distance was 1.6 km. In a recent analysis on avoidance behaviour at Horns Rev 2 wind farm Petersen et al. (2014a) found reductions in diver numbers up to a distance of 5-6 km. The total numbers of divers in the study area remained constant and the spatial distribution shifted mainly to the west side of the wind farm. In the British wind farms Thanet and Kentish Flats, the avoidance of divers was not complete and indications of habituation were found (Percival 2009, 2013). At Thanet, diver numbers were reduced by 73% and by 80% at Kentish Flats (60% reduction in a buffer zone from 0 to 500 m and 20% reduction at 500 to 1,000 m distance around the wind farm). These British studies cover a time period of up to ten years (Kentish flats) and may indicate that over a long time span a habituation of divers to wind farms may occur. Data from Egmont van Zee wind farm in the Netherlands also found divers to be present inside of the wind farm (Leopold et al. 2011). In five of eight surveys there

was no significant difference in diver densities comparing inside and outside the wind farm.

The species determination of divers during aerial surveys is difficult and birds are usually classified as “unidentified divers”. During the surveys in the Vesterhav Syd study area 18% of all divers were identified as Red-throated Divers. Based on the results from the ship surveys in 1999 at Horns Rev 1, 78% of the identified divers were Red-throated and 22% Black-throated Divers (Christensen et al. 2006). Hence, it can be assumed that the majority of divers in Vesterhav Syd area were also Red-throated Divers.

Common Scoter/Velvet Scoter

Common Scoter is a species with a high sensitivity against wind farms (according to sensitivity index rank 24; Furness et al. 2013). Comparing densities in the Horns Rev 1 wind farm before and after installation an avoidance of the wind farm was documented (Petersen et al. 2006a). However, recent surveys in Horns Rev 2 wind farm found Common Scoters inside of the wind farm indicating a habituation of part of the present birds to the new situation (Petersen & Fox 2007). The (partial) avoidance effects on Common Scoter in Horns Rev 2 wind farm lasted up to a distance of up to 2-3 km (Skov et al. 2012, Petersen et al. 2014a). Compared to the pre-installation period high density areas shifted in areas of greater water depths which could additionally result in higher energy demand during foraging (Petersen et al. 2014b). In the British wind farm North Hoyle also indications of habituation was found in Common Scoters (PMSS 2007). Data on Velvet Scoters are less abundant but as behaviour against shipping is similar between Common and Velvet Scoter the sensitivity of Velvet Scoter is assessed to be similar with regard to wind farms.

Northern Gannet

Northern Gannets are ranked as insensitive with respect to wind farms (Furness et al. 2013). This is mainly a result of Northern Gannets following fishing vessels for extra food. In fact, studies on wind farms report either partial or complete avoidance (Petersen et al. 2006a, Krijgsveld et al. 2011, Leopold et al. 2012) or indications of no avoidance (PMSS 2007). In the first German wind farm “Alpha ventus” Northern Gannets avoided the wind farm area (Aumüller et al. 2013).

Auks

With a vulnerability index value of 14 Common Guillemots and Razorbills lie below the threshold value of 15 which is allocated to species in focus for concern with regard to displacement (Black Guillemot: ranking 16; Furness et al. 2013). In the Horns Rev wind farms selectivity indices suggested Razorbills and Common Guillemots to avoid the wind farm area, but results were not significant. Also in the Egmont van Zee wind farms results were not clear with some surveys showing avoidance in others not (two of 11 surveys significant avoidance; Leopold et

al. 2011). Overall, in most studies there were partial avoidance or indications of avoidance, but not as expressed as in divers or scoters.

Gulls and terns

Present studies indicate no avoidance behaviour of gulls and terns with respect to wind farms. This was observed in the wind farms Horns Rev 1 and Nysted (Petersen et al. 2006a) as well as in British wind farms Kentish Flats and North Hoyle (PMSS 2007, Gill et al. 2008). Only the species group of Arctic/Common Tern showed indications of moderate avoidance (Petersen et al. 2006a).

Cormorants

Cormorants have been reported to be attracted by wind farms (Leopold et al. 2012) or showed at least no avoidance behaviour (Petersen et al. 2006a, Leopold et al. 2012). Cormorants benefit from offshore wind farms as the can use overwater structures for resting and take advantage of probably increasing fish stock due to reduced fishing activity or the influence of additional hard substrate habitats on turbine foundation.

Summarising the results on disturbance, a pattern can be derived indicating species with offshore habitats showing stronger reactions to wind farms than species with more coastal habitats.

6.4.3 Collision

Resting birds may collide with wind turbines when fluctuating between resting sites. The risk of collision depends on a variety of factors including the behaviour of the bird (especially flight altitude), turbine characteristics (e.g. diameter of rotor blade) and environmental conditions (e.g. wind speed, direction and visibility). The collision sensitivity of a bird species depends on the probability of encountering a turbine and is thus closely linked to bird's avoidance behaviour. Collision risk is low in species with high avoidance behaviour. Further, these species (mainly divers, scoters, auks) usually fly at very low altitude, often below rotor swept area (Cook et al. 2012, Furness et al. 2013, Johnston et al. 2014). Gulls, terns and cormorants enter wind farm areas and also frequently use altitudes that overlap with rotor heights. Therefore, these groups of birds show a higher risk of collision. Northern Gannets also show an overlap of flight altitude with rotor swept area (Johnston et al. 2014), but they are known to show avoidance against wind farms (see Section 6.4.2). Apart from these basic assumptions, the occurrence of birds within wind farm and flight altitude may be strongly influenced by weather conditions. Poor visibility may let sensitive species come close to wind farms and tailwind increases flight altitude (Krüger & Garthe 2001).

The probability of collisions of birds with vessels (relevant during installation) can be regarded as low and is not further considered in impact assessment of resting birds.

6.4.4 Conclusions from sensitivity analyses for impact assessment

According to the sensitivity analysis of resting birds a negative impact with respect to displacement is expected mainly in those species that are sensitive to disturbance (divers, Common Scoters and auks). With respect to collisions gulls are most sensitive as they enter the wind farm and frequently use flight altitudes overlapping with the risk area of rotor blades.

7 IMPACT ASSESSMENT DURING INSTALLATION

7.1 Habitat loss / change

7.1.1 Degree of disturbance

Installation activities cause a habitat loss as the potential feeding area is covered by vessels or parts of turbines in construction. Whereas habitat loss is spatially restricted to the site of construction (footprint of working activities) the indirect effects of habitat change may influence the availability of prey species stronger and at a larger spatial scale.

Effects of installation on the feeding habitat during construction arise from suspension of material due to construction activities and from sediment spill deposition. Seabed preparation will for installation of foundations will result in a minor increase in sediment concentrations of less than 5mg/l in most parts of the OWF with short periods with concentrations up to 10mg/l (COWI A/S 2014). Outside the offshore wind farm less than 2mg/l is predicted at all times. Jetting of cables is expected to cause larger sediment spill volumes and effect wider areas than excavation at foundations. The natural variations in sediment concentrations (e.g. caused by large waves) are of the same order of magnitude or larger than the concentrations of spilled sediment during dredging or jetting operations. The deposition of sediment will be highest in the cable corridors (max. 2 kg/m²) and up to 200g/m² in the OWF and its near surrounding. The predicted sedimentation values are very small and will be expected to result in local seabed accretion in the order of only a few millimetres.

In birds foraging on a large variety of prey species or covering large areas during feeding without being bound to particular sited there is no impact of installation activity expected and the degree of disturbance is rated as Negligible. **Gulls** and **Northern Gannets** are allocated to this group (high flexibility index in habitat use, Furness et al. 2013). A rating to a Low degree of disturbance due to a very high proportion of birds using the area (by definition >1%, Table 26) is not valid as proportions of all gull species and Northern Gannets within the impact zone of the development area are far below a proportion of 1% of the biogeographical population (Table 32). Even including not identified gulls would not cause percentages close to the threshold value of 1%.

Table 32: Maximum number of Northern Gannets and gulls in the impact zone of 500m as numbers and percentage of biogeographical population.

Species	Max. number in 500m impact zone	Birds within 500 m impact zone in % of biogeographical population
Northern Gannets	6	0.001
Little Gull	0	0.000
Common Gull	74	0.005
Lesser Black-backed Gull	8	0.002
Herring Gull	40	0.002
Great Black-backed Gull	3	0.001
Black-legged Kittiwake	7	<0.001

For these species the impact assessment method is not further used (as defined in Section 0) and the magnitude of impact is rated as **Negligible**.

Those species with possible impacts have to be divided into birds preying on fish (piscivorous birds such as divers, auks) and those preying on benthos organisms (e.g. benthivorous seaducks).

For the fish communities minor impacts are predicted for noise emission during installation of turbines and for suspension and sedimentation during the period of cable laying (NIRAS 2015b). Increased suspension is expected to be of minor duration and lies within the normal range of variation. Sedimentation during cable laying is expected to be of a magnitude of 1-2 mm/m² close to cable corridors and up to 0.2mm/m² within the development area. Fish species with benthic egg laying (such as herring or sand eel which are supposed to belong to main prey species for auks and divers) are supposed not to use the dynamic area between wind farm and coastline. It is concluded that expected sedimentation is low in general and impacts on fish communities negligible. Therefore, only minor changes in food availability in birds preying on fish is expected due to installation activities. Further, the distribution of piscivorous species is generally flexible according to hydrographic and tidal conditions and not bound to locally restricted sites. Increased water turbidity due to installation activities could negatively affect fishing ability of divers and auks. However, both divers and auks are common in tidal areas with partially high water turbidity and the impact of fishing ability is regarded to be low.

Divers are thought to show a low flexibility in habitat use (Furness et al. 2013). The spatial distribution of divers depends to a high degree on hydrographic current (Skov & Prins 2001) and on the occurrence of fish prey species and is there-

fore less confined to particular sites compared to e.g. Common Socter (depend on sessile benthos organisms). This is also reflected by the survey data: whereas in divers there was a high variability in the spatial distribution (Figure 14) Common Scoter were found as very similar sites in any survey (Figure 25). Therefore, a differentiation in the flexibility in food choice between divers and scoters is justified and the flexibility in divers is rated as Medium. As outlined in Section 8.2.1 on displacement during operation, 0.071% of the biogeographical populations will be affected by habitat change (rated as Medium). Divers were present in the area of the cable corridors but at none of the two corridors (see Figure 2) concentrations of divers were found (Figure 13). As only 2 km between the impact zone and landfall are left (and therefore, most divers are considered in the assessment) and diver densities were low in this area, the contribution of cable corridors to the number of affected birds is assessed to be low.

A medium flexibility in food choice in combination with a medium number of affected birds leads to a **Medium** degree of disturbance for habitat loss / change. As habitat change affects a larger area than habitat loss (only direct footprint of activities of vessels) effects of habitat change are rated higher than habitat loss and presented as impact for the combined parameter habitat loss / change.

Auks are assessed to show a medium to low flexibility in habitat use (Furness et al. 2013). Similar to divers, the spatial distribution depends to a high degree on the occurrence of fish prey species and is therefore less confined to particular sites compared to e.g. Common Scoter (depend on sessile benthos organisms). The flexibility in food choice is therefore rated as Medium. As outlined in Section 8.2.1 on displacement during operation 0.006% of the biogeographical populations will be affected by habitat change (rated as Low). Auks were not found between the development area and the coastline (Figure 58) and therefore, the installation activities related to the cable laying along the two cable corridors do not affect auks.

A medium flexibility in food choice in combination with a low number of affected birds leads to a **Low** degree of disturbance for habitat loss / change.

In the benthivorous species **Common Scoter** the habitat loss and the change in habitat due to installation activities can potentially negatively affect food availability. The very strong selectivity of water depths presumably due to the availability of suitable food resources in this area confirms the suggestion that Common Scoter are ranked to show a low fexibility in habitat use (Furness et al. 2013). The fexibility in food choice is therefore rated as low. Common Scoter showed only low densities in the area of the cable corridors (mainly along the northern corridor; Figure 24; see Figure 2 for position of cable corridors). The calculated

number of affected birds is based on a 2 km impact zone around the turbines and only about 2 km between impact zone and landfall are left. As the densities of Common Scoter were low in this area and the additional area to be considered for cable corridor is small, the contribution of cable corridor to the number of affected birds is assessed to be low.

A medium number of birds affected (0.123% of biogeographical population) and low felxibility in food choice results in a **Medium** degree of disturbance.

Furness et al. (2013) assess the **Velvet Scoter** to be more flexible in habitat use compared to Common Scoter. Velvet Scoter are regarded to utilise a greater variety of prey species as they tend to forage closer to coastlines than Common Scoter (often rocky and stony substrates with diverse food; Fox 2003). The flexibility in food choice is therefore rated as Medium. Velvet Scoter were not found in the area of cable corridors (Figure 30).

The number of birds affected represents 0.013% of biogeographical population (see Section 8.2.1) and is rated as Low. A combination of a Medium flexibility in food choice and a Low number of affected birds results in a **Low** degree of disturbance for habitat loss / habitat change in the Velvet Scoter.

7.1.2 Importance

The criteria ”Importance” is judged on the same basis for the period of installation and operation. As the period of operation is supposed to cause higher and longer lasting effects the assessment of Importance is described in detail in Section 8.2.2. In the following only the results of this assessment are presented for the relevant species.

In divers, Common Scoter, Velvet Scoter and auks degrees of disturbances higher than negligible were found. The Importance of the area for these species are presented in the following:

Divers:	**National/regional**
Common Scoter:	**Local**
Velvet Scoter:	**Local**
Auks:	**Local**

7.1.3 *Likelihood of occurrence*

The criteria ”Likelihood of occurrence” is judged on the same basis for the period of installation and operation. As the period of operation is supposed to cause higher and longer lasting effects the assessment of Importance is described in detail in Section 8.2.3. Effects of habituation are not considered during the installation period due to the short duration of the impact. However, a down-grading for the period of installation is performed due to the smaller spatial extend of the effect compared to the period of operation. Referred to the number of birds within the impact zone not all individuals are affected (birds outside of the installation site) and the likelihood of occurrence of habitat loss is therefore down-graded. Following a precautionary principle the down-grading is only performed if first assessment was High. The results of this assessment are presented for the relevant species.

Divers:	**Medium** (habituation not considered for installation period, but down-grading from High due to limited spatial scale during installation)
Common Scoter:	**Medium** (habituation not considered, but down-grading from High due to limited spatial scale during installation)
Velvet Scoter:	**Medium** (habituation not considered, but down-grading from High due to limited spatial scale during installation)
Auks:	**Low**

7.1.4 *Persistence*

The total installation period starts with trenching and installation of cables and end with the installation of last turbine. This procedure is expected to last for period of approximately 1.5 years (Energinet.dk 2015). The habitat loss / habitat change affects the particular area of installation activities. The remaining regions of the development area are still available for resting birds. The site of construction moves with ongoing time of installation within the development area and an installation site is occupied by vessels or construction device for less than one year. Therefore, the persistence of habitat loss / habitat change is rated as **Short-term** (0-1 year). For example, Common Scoter that concentrate in the north eastern part of the development area will not be affected by habitat loss during construction activities in the south western part of the development area in a distance of more than 10 km.

In Table 33 the results of the impact assessment habitat loss / habitat change is summarised. **Minor** impacts are expected for **divers**. In all species the magnitude of impact is rated as **Negligible / neutral / no impact**.

Table 33: Impact assessment on “habitat loss/change” during the period of installation

Parameter; Species	Degree of disturbance *	Importance	Likelihood of occurrence	Persistence	Magnitude of impact
Divers	Medium	National/regional	Medium	Short-term	Minor
Northern Gannet	Negligible	Not rated	Not rated	Not rated	Negligible/neutral/no impact
Common Scoter	Medium	Local	Medium	Short-term	Negligible/neutral/no impact
Velvet Scoter	Low	Local	Medium	Short-term	Negligible/neutral/no impact
Auks	Low	Local	Low	Short-term	Negligible/neutral/no impact
Gulls	Negligible	Not rated	Not rated	Not rated	Negligible/neutral/no impact

* If Degree of disturbance is Negligible further criteria are not rated as Magnitude of impact is always Negligible

7.2 Displacement

Installation activities associated with the installation of Vesterhav Syd offshore wind farm and the deployment of subsea cables are related to the presence of vessels (installation vessels, dredger, guard vessels) as well as to helicopter flights. With regard to birds which are sensitive to this kind of disturbance, these activities will result in displacement from the installation sites. Although the installation activities are restricted to a smaller area within the site (e.g. pile driving, mounting of rotor blades, laying the subsea cable etc.), the installation overall will have a total development footprint of approximately 60 km². By definition, the worst case scenario of impacts during installation is based on the same reference area as that during operation (wind farm development area and species specific buffer zones). As the parameters ”degree of disturbance”, ”importance” and ”likelihood” are derived from bird numbers in relation to the development

area and study area, the rating of the impact ”displacement” is the same for the periods of installation and operation.

Displacement effects are expected to be higher during operation than during installation due to the larger extent of the footprint of disturbance from an operational wind farm than from local installation activities. Presumably, this assumption is also true taking into account a possible habituation to some degree in particular species. Therefore, the explanations of ratings of the parameter ”degree of disturbance” and ”importance” are placed in the section on the impact assessment on resting birds during operation (Section 8.2). The likelihood of occurrence is modified for different reasons (operation: habituation, installation: spatial extend) and listed in the following.

7.2.1 *Degree of disturbance*

The explanation of the degree of disturbance for displacement is presented in Section 8.2.1. The ratings are as follows:

Divers:	**Medium**
Northern Gannet:	**Low**
Common Scoter:	**Medium**
Velvet Scoter:	**Low**
Auks:	**Low**
Gulls:	**Negligible**

7.2.2 *Importance*

In divers, Northern Gannet, scoters and auks degrees of disturbances higher than negligible were found. The Importance of the area for these species are presented in the following (for explanations see Section: 8.2.2):

Divers:	**National/regional**
Northern Gannet:	**Not important**
Common Scoter:	**Local**
Velvet Scoter:	**Local**
Auks:	**Local**

7.2.3 *Likelihood of occurrence*

The down-grading in the likelihood of occurrence due to habituation in the period of operation is not applied for the period of installation, but a down-grading is performed due to the small scale of disturbance in comparison with operation period. A down-grading is only performed if first rating of the likelihood of occurrence was High.

The rating of the likelihood of occurrence is as follows:

Divers:	**Medium** (habituation not considered, but down-grading from High due to limited spatial scale during installation)
Northern Gannet:	**Medium**
Common Scoter:	**Medium** (habituation not considered, but down-grading from High due to limited spatial scale during installation)
Velvet Scoter:	**Medium** (habituation not considered, but down-grading due to limited spatial scale during installation)
Auks:	**Low**

7.2.4 *Persistence*

The temporal extend of displacement during construction is the same as described for habitat loss / habitat change in Section 7.1.4. As installation sites move with ongoing time of installation within the development area and an installation site is occupied by vessels or construction device for less than one year displacement from a particular site is also supposed to last for less than one year. Therefore, the persistence of displacement is rated as **Short-term** (0-1 year).

In Table 34 the results of the impact assessment for displacement during installation is summarised for different species. In **divers** the magnitude of impact is rated as **Minor.** In all other species following the combination of the rating of categories the magnitude of impact is rated as **Negligible/neutral/no impact**.

Table 34: Impact assessment on the pressure “displacement” during the period of installation

Parameter; Species	Degree of disturbance*	Importance	Likelihood of occurrence*	Persistence	Magnitude of impact
Divers	Medium	National/regional	Medium	Short term	Minor
Northern Gannet	Low	Not important	Medium	Short term	Negligible/neutral/no impact
Common Scoter	Medium	Local	Medium	Short term	Negligible/neutral/no impact
Velvet Scoter	Low	Local	Medium	Short term	Negligible/neutral/no impact
Auks	Low	Local	Low	Short term	Negligible/neutral/no impact
Gulls	Negligible	Not rated	Not rated	Not rated	Negligible/neutral/no impact

* If Degree of disturbance is Negligible further criteria are not rated as Magnitude of impact is always Negligible

7.3 Collisions

During the period of installation vessels or installation cranes are potential collision hazards to flying birds. However, the probability of collisions with construction vessels can be regarded as very low or negligible. Bad weather conditions with low visibility could increase the risk of collisions, but most parts of construction activities depend on favourable weather conditions minimizing the likelihood of collisions. The impacts of construction vessels are limited to a small area during a limited time period and the number of collisions is assessed to be low. Therefore, detailed assessment of the impact of collisions with vessels is not performed and the Magnitude of impact is rated as **Negligible/Neutral/No impact**.

7.4 Total impacts

A **Minor** magnitude of impact was assessed for divers in the period of installation for both habitat loss / habitat change and displacement. In other species the impacts during installation are predicted to be **Negligible**.

Table 35: Summary of impact on resting birds during installation

Parame-ter Species	Degree of disturb-ance*	Importance	Likelihood of occurrence	Persis-tence	Magnitude of impact
Habitat loss / change					
Divers	Medium	Nation-al/regional	Medium	Short-term	Minor
Northern Gannet	Negligible	Not rated	Not rated	Not rated	Negligi-ble/neutral/no impact
Common Scoter	Medium	Local	Medium	Short-term	Negligi-ble/neutral/no impact
Velvet Scoter	Low	Local	Medium	Short-term	Negligi-ble/neutral/no impact
Auks	Low	Local	Low	Short-term	Negligi-ble/neutral/no impact
Gulls	Negligible	Not rated	Not rated	Not rated	Negligi-ble/neutral/no impact
Displace-place-ment					
Divers	Medium	Nation-al/regional	Medium	Short term	Minor
Northern Gannet	Low	Not important	Medium	Short term	Negligi-ble/neutral/no impact
Common	Medium	Local	Medium	Short	Negligi-ble/neutral/no

Parame-ter Species	Degree of disturb-ance*	Importance	Likelihood of occurrence	Persis-tence	Magnitude of impact
Scoter				term	impact
Velvet Scoter	Low	Local	Medium	Short term	Negligi-ble/neutral/no impact
Auks	Low	Local	Low	Short term	Negligi-ble/neutral/no impact
Gulls	Negligible	Not rated	Not rated	Not rated	Negligi-ble/neutral/no impact
Collisions					
All species	Different system for assessment used				Negligi-ble/neutral/no impact

*If Degree of disturbance is Negligible further criteria are not rated as Magnitude of impact is always Negligible

8 IMPACT ASSESSMENT DURING OPERATION

8.1 Habitat loss / change

8.1.1 Degree of disturbance

Divers and auks

For **divers** and **auks** the reduction in seabed area is regarded to be not relevant in terms of habitat loss due to the low area covered. The footprints of the turbines and scour protection are not anticipated to affect the availability of fish. For the assessment of habitat change, it is anticipated that divers and auks have a medium flexibility in food choice (see Section 7.1.1 for further explanations).

For divers, a medium number of affected birds (between 0.05 and 0.5% of biogeographical population, see Section 8.2.1) and a medium flexibility in food choice result in a **Medium** degree of disturbance.

In auks, a low number of affected birds (between 0.05 and 0.001% of biogeographical population) and a medium flexibility in food choice results in a **Low** degree of disturbance.

Common Scoter, Velvet Scoter

During operation, a loss in habitat for benthivorous species such as Common Scoter and Velvet Scoter is likely to occur due to foundations with scour protection covering the seabed around the turbine. The benthos fauna therefore cannot be exploited e.g. by mussel feeding sea ducks. In addition, a possible reduction in biomass of mussels in the wind farm due to reduction in flow velocity over the seabed (caused by the presence of foundations) could have impacts on birds. Assuming monopiles with scour protection to be the option with the highest coverage of seabed (99,000 in 66 turbines with 3 MW; lower areas in other foundations, Table 3), the maximum coverage would be 0.16% (3 MW) of the development area (0.099 km² coverage of about 60 km², respectively). As Common Scoter used only the north eastern part of the development area, the scour protection of only 16 turbines would affect the feeding area of this species, corresponding to 0.04% of the development area. Judging the impact of habitat loss and habitat change Common Scoter have to be regarded as a species with a low flexibility in habitat use and Velvet Scoter as species with medium flexibility (Furness et al. 2013) As the areas covered by scour protection cannot be used further and birds rely on particular water depths with suitable food species the flexibility in food choice as a criteria for assessing the habitat loss /habitat change is rated as low for the Common Scoter. Velvet Scoter feed on a higher variety of species and show less expressed prey selection than Common Scoter (Fox 2003) and are therefore rated as Medium in flexibility in food choice.

The rating of the degree of disturbance is presented in the following:

Common Scoter: A medium number of birds affected (0.123% of biogeographical population; see Section 8.2.1 on displacement for detailed calculations) combined with a low flexibility in food choice results in a **Medium** degree of disturbance.

Velvet Scoter: A low number of birds affected (0.013% of biogeographical population) combined with a medium flexibility in food choice results in a **Low** degree of disturbance.

Gulls and Northern Gannet

For species that continue to use the wind farm area as feeding place (e.g. gulls) or in species with large foraging areas (e.g. Northern Gannet) the flexibility in habitat use is ranked high (Furness et al. 2013). As the number of affected birds is below 1% of the biogeographical population in Northern Gannets and all gull species (see Table 32 in Section 7.1.1) the effects of habitat loss / change are regarded to be **Negligible.**

Artificial reef effects caused by foundations and scour protection lead to changes in benthos biodiversity and biomass in the vicinity of turbines as well as fish abundance (e.g. for species related to reefs, reduced fishing activities in and around wind farms, etc.). In contrast to negative effects (habitat loss as benthos fauna is destroyed) artificial reefs may have a **positive effect** increasing the food conditions for benthivorous and piscivorous species. As outlined in the sensitivity analysis (Section 6.4) Common Scoter showed habituation to the Horns Rev 3 wind farm and birds were seen very close to the turbines. Additionally, divers were seen in British wind farms indicating the use of the area for foraging (see Section 6.4). However, it has to be considered that even if birds may habituate to the wind farm, densities of sensitive birds will most probably always be lower than in the situation before construction. Therefore, increasing food conditions are supposed not to have an overall positive effect on the populations.

8.1.2 Importance

The criteria ”Importance” for habitat loss / change is equal to the assessment of displacement as presented in Section 8.2.2. The results of this assessment are presented for the relevant species where the degree of disturbance is at least Low.

In divers, scoters and auks degrees of disturbances higher than negligible were found. The Importance of the area for these species are presented in the following:

Divers:	**National/regional**
Common Scoter:	**Local**
Velvet Scoter:	**Local**
Auks:	**Local**

8.1.3 Likelihood of occurrence

The criteria ”Likelihood of occurrence” for habitat loss / change is equal to the assessment of displacement as presented in Section 8.2.3. If habituation is expected the degree of habitat loss / change is not total but the habitat can be used by those birds which still feed within the wind farm. This assumption leads to a down-grading of the initial assessment. The results of this assessment are presented for the relevant species.

Divers:	**Medium** (habituation expected; down-grading from High)
Common Scoter:	**Medium** (habituation expected; down-grading from High)
Velvet Scoter:	**Medium** (high probability of habituation; selectivity mainly based on use of buffer zones, see Section 8.2.3)
Auks:	**Low**

8.1.4 Persistence

The lifetime of the wind farm is expected to be around 25-30 years. Accordingly, the operation period will be longer than 5 years and the persistence of the pressure disturbance is rated as **Permanent**.

In Table 33 the results of the impact assessment of the pressure habitat loss / change during operation is summarised for different species. In **divers** and **Common Scoter**, the habitat loss / change is supposed to have a **Moderate** magnitude of impact. In **Velvet Scoter** and **auks** a **Minor** impact is predicted.

Positive impacts can result from artificial reef effects in those species that habituate to the wind farm.

Table 36: Impact assessment on habitat loss / change during the period of operation

Parameter; Species	Degree of disturbance *	Importance	Likelihood of occurrence	Persistence	Magnitude of impact
Divers	Medium	National / regional	Medium	Permanent	Moderate
Northern Gannets	Negligible	Not rated	Not rated	Not rated	Negligible/neutral/no impact
Common Scoter	Medium	Local	Medium	Permanent	Moderate
Velvet Scoter	Low	Local	Medium	Permanent	Minor
Auks	Low	Local	Low	Permanent	Minor
Gulls	Negligible	Not rated	Not rated	Not rated	Negligible/neutral/no impact
Note:	**Artificial reef effects** may positively affect the habitat use of benthivorous (higher benthos diversity and biomass on scour protection) and piscivorous species (new species dependent on reef structures, reduced fishing activities in and around wind farms). This effects only refer to those birds that habituate to the wind turbines and use that area for feeding				

*If Degree of disturbance is Negligible further criteria are not rated as Magnitude of impact is always Negligible

8.2 Displacement

8.2.1 Degree of disturbance

The degree of disturbance is derived from a combination of the sensitivity of a bird species and the number of birds affected by displacement in defined impact zones. For determination of the degree of disturbance the number of displaced birds is calculated as a percentage of the biogeographical population (see Section 6.2.1). The impact zone includes the development area and a species specific buffer zone around the development area.

Recorded disturbance distances of birds from vessels and offshore wind farms vary depending on the site and time in operation (see analyses on sensitivity, Section 6.4). In divers and Common Scoter bird numbers within a buffer zone of 2 km are commonly used as a measure of disturbance distance (e.g. Horns Rev 1 and 2; Christensen et al. 2003, Petersen et al. 2006a), but recent studies have indicated some levels of habituation and buffer zones of only 500 m around the wind farm have been suggested (HR3: Orbicon 2014a). On the other hand, studies on pre- and post-installation distribution of divers in the wind farm Horns Rev 2 documented significant negative effects on diver densities up to a distance of 5 to 6 km (Petersen et al. 2014a). In this report, a disturbance distance of 2 km for divers and Common Scoters is used as a conservative approach following the precautionary principle. For auks, 500 m as an impact zone around an offshore wind farm is realistic (HR3: Orbicon 2014a) due to their lower sensitivity (see Section 6.4). The same distance of 500 m is used for Northern Gannet (for avoidance behaviour, but not as expressed as in divers or scoters). For an overall view, the number of birds within the critical distances of 2 km and 500 m are presented as basis for impact assessment.

A further consideration is the degree of displacement. Whereas in some sensitive species 100% of resting birds can be regarded to be affected by displacement within the impact zone, recent studies showed that displacement is not always complete and some individuals still remain within the wind farm area. However, as there is high variation among studies for the purpose of this assessment 100% disturbance is assumed. This approach can be regarded as highly precautionary and recent guidance suggests 30-70% may be more appropriate (Natural England 2014).

As a further worst case assumption the impact assessment is based on the survey date with most birds of the respective species present in the impact zone (turbine area including species-specific buffer zone).

For species not sensitive to disturbance (e.g. gulls, cormorants; Garthe & Hüppop 2004, Furness et al. 2013) the sensitivity is rated as ”Negligible” and an impact assessment of disturbance is not presented. Nevertheless, the estimated populations in the defined area are presented in the Appendix (Section 16.6.). In the following section, the degree of disturbance is assessed for the following species: divers, Common Scoters, Velvet Scoter, Northern Gannet and auks.

Divers were most abundant in the study area during the survey on 11th March 2014 (959 individuals in the study area and 182 within the impact zone of 2km, Table 12). The highest number of divers within the wind farm area including a 2 km impact zone were present on 25th November 2013 with 186 individuals (93 within 500 m around turbines and 533 in total study area, Table 37). As a percentage of the biogeographical population, 0.071% would have been displaced from the impact zone (development area +2 km; 0.036% from development area +500 m; rated as Medium). This percentage is on a low level within the defined

values for a medium impact (≥0.05% and <0.5% of biogeographic reference population). Therefore, even is more birds have to be added due to diving birds that have been missed, this rating would persists. The sensitivity of divers is rated as high and the proportion of affected population is rated as Medium resulting in a **Medium** degree of disturbance for divers (see Table 25).

Table 37: Number of divers within a buffer zone of 2 km and 500 m around the development area during the six surveys. Given are population estimates and lower 95% confidence interval (LCI) / higher 95% confidence interval (HCI)

	Birds within 2 km			**Birds within 500 m**		
Survey	**Pop. estimate**	**LCI**	**HCI**	**Pop. estimate**	**LCI**	**HCI**
25.11.2013	186	132	261	93	66	131
03.02.2014	15	9	24	4	2	6
11.02.2014	23	17	30	0	0	0
11.03.2014	182	123	269	40	27	59
25.03.2014	28	18	45	9	6	15
16.04.2014	4	2	8	0	0	0

Northern Gannets are determined by some studies to be of relatively low concern in the context of disturbance (Furness et al. 2013), whereas other studies have reported avoidance behaviour towards offshore wind farms (see Section on sensitivity analyses 6.4.2). For the impact assessment the sensitivity is therefore rated as Medium. The survey on 16th April 2014 found most Northern Gannets occurred around the development area, most of them outside of the boundary (Table 68). Most birds within the development area occurred on 25th March 2014 (21 individuals within 2km and 6 individuals within 500m individuals, a total of 35 individuals in total on that day). The percentage of the biogeographical population was 0.002%. A Medium sensitivity and a Low proportion of affected population yields to a **Low** degree of disturbance of Northern Gannets. This value has to be considered as a minimum values as densities of Northern Gannets area supposed to be higher in months not covered by surveys.

Common Scoter numbers were highest during the survey on 11th March 2014 (1,996 individuals in the study area, Table 15), corresponding to the date with most birds seen within the impact zone 2 km around the wind farm (674 individuals, 334 within 500 m, Table 38). The birds within the impact zone of 2 km made up 0.123% of the biogeographical reference population (rating: Medium). As Common Scoter are regarded to be highly sensitive the degree of disturbance is rated as **Medium.**

Table 38: Number of Common Scoter within a buffer zone of 2 km and 500 m around the development area during the six surveys. Given are population estimates and lower 95% confidence interval (LCI) / higher 95% confidence interval (HCI)

	Birds within 2 km			Birds within 500 m		
Survey	**Pop. estimate**	**LCI**	**HCI**	**Pop. estimate**	**LCI**	**HCI**
25.11.2013	316	166	602	84	44	159
03.02.2014	144	71	292	50	25	100
11.02.2014	674	335	1,358	334	166	673
11.03.2014	587	234	1,476	31	12	79
25.03.2014	92	27	311	43	13	146
16.04.2014	93	38	229	6	2	14

Velvet Scoter numbers were highest during the survey on 11th March 2014 (118 individuals in the study area, Table 16), corresponding to the date with most birds seen within the impact zone 2 km around the wind farm (60 individuals, Table 39). The birds within the impact zone of 2 km made up 0.013% of the bio-geographical reference population (rating: Low). As Velvet Scoter are regarded to be highly sensitive the degree of disturbance is rated as **Low**.

Table 39: Number of Velvet Scoter within a buffer zone of 2 km and 500 m around the development area during the six surveys. Given are population estimates and lower 95% confidence interval (LCI) / higher 95% confidence interval (HCI)

	Birds within 2 km			Birds within 500 m		
Survey	**Pop. estimate**	**LCI**	**HCI**	**Pop. estimate**	**LCI**	**HCI**
25.11.2013	0	0	0	0	0	0
03.02.2014	0	0	0	0	0	0
11.02.2014	7	2	22	5	2	14
11.03.2014	60	17	207	0	0	0
25.03.2014	2	0	48	0	0	0
16.04.2014	2	0	12	0	0	0

Auks were most frequent during the survey on 11th February 2014 (771 individuals in the investigation area, Table 23), but birds were strongly concentrated in the western part of the study area and no bird was found within the wind farm area including an impact zone of 500 m (Table 40, Figure 59). On 25th November 2013 a similar number of auks were present in the study area (723 individuals) and distribution was more scattered including birds being close to the development area (Figure 59). On this day 28 individual were present within the impact zone of 500 m around the wind farm. The population of Razorbills (smaller popu-

lation of Razorbills taken as a precautionary principle) indicates that 0.006% of the population would be affected by displacement (rating: Low). The sensitivity of auks is regarded as less to that of divers or Common Scoter and this criteria is therefore rated as Medium. Following the definitions in Table 25 degree of disturbance for auks is rated as **Low**.

Table 40: Number of auks within a buffer zone of 2 km and 500 m around the development area during the six surveys. Given are population estimates and lower 95% confidence interval (LCI) / higher 95% confidence interval (HCI)

	Birds within 2 km			**Birds within 500 m**		
Survey	**Pop. estimate**	**LCI**	**HCI**	**Pop. estimate**	**LCI**	**HCI**
25.11.2013	37	27	50	28	20	37
03.02.2014	4	3	7	4	3	7
11.02.2014	0	0	0	0	0	0
11.03.2014	7	5	10	0	0	0
25.03.2014	0	0	0	0	0	0
16.04.2014	0	0	0	0	0	0

8.2.2 *Importance*

The importance of the area for a species is judged according to its conservation status in combination with the occurrence in the study site in relation to the respective biogeographical population. The population on the day with maximum numbers recorded is taken as worst case scenario.

Red-throated Divers are listed in Annex I of the EU Directive and holds the category SPEC 3 (global population not concentrated in Europe, but unfavourable conservation status in Europe) leading to a conservation status of the category Very high. On 11th April 2014 959 divers were present in the study area corresponding to 0.369% of the biogeographical population of 260,000 individuals. Therefore, the abundance is rated as Medium. According to the guidance of determination of importance the combination of a very high conservation status and medium abundance leads to an importance category **National/regional**. As correction factors for diving birds (as a normal behaviour) is not considered the number of birds in the area may be higher. However, as respective factors are not published and still underlie high uncertainties the correction is not applied to the number of birds present. An upgrading to High abundance (≥ 0.5% of biogrographical population) and hence International importance would require that an additional 341 divers were present in the study area. This would be the case if at least 27% of all divers in the area were diving at any time and therefore remained unrecorded.

Northern Gannets are not listed in Annex I of the EU Directive and holds no SPEC category (Non-SPEC-E) leading to a conservation status of the category Medium. The maximum abundance in the area (16th April 2014: 57 individuals) was 0.006% of the biogeographical population. Even if considered that Northern Gannets are probably more common in other months not covered by surveys the importance of the area for this species is rated as **Not important**.

Common Scoter are not listed in Annex I of the EU Directive and holds no SPEC category (Non-SPEC) leading to a conservation status of the category Low. On 11th February 2014 1,996 Common Scoter were present in the study area corresponding to 0.363% of the biogeographical population of 550,000 individuals. Therefore, the abundance is rated as Medium. According to the scheme of determination of importance the combination of a low conservation status and medium abundance leads to an importance category **Local**.

Velvet Scoter are not listed in Annex I of the EU Directive and is listed as SPEC 3 species (global population not concentrated in Europe, but unfavourable conservation status in Europe). The conservation status of Velvet Scoter is therefore rated as High. On 11th March 2014 118 Velvet Scoters were present in the study area corresponding to 0.026% of the biogeographical population of 450,000 individuals. Therefore, the abundance is rated as Low. According to the scheme of determination of importance the combination of a low conservation status and medium abundance leads to an importance category **Local**.

Both **Common Guillemot** and **Razorbill** (combined as auks) are not listed in Annex I of the EU Directive. Razorbill are ranked as ”Non-SPEC-E” indicating that global population is concentrated in Europe with favourable conservation status (rated as Medium), whereas in Common Guillemot global population is not concentrated in Europe, and they have a favourable conservation status in Europe (Non-SPEC). Conservation status of Common Guillemot is therefore rated as Low. On 11th February 2014 771 auks were present in the study area corresponding to 0.154% of the biogeographical population of 500,000 individuals (referred to the smaller population of Razorbill, precautionary principle). Therefore, the abundance is rated as Medium. According to the scheme of determination this combination leads to an importance category of **Local**.

8.2.3 Likelihood of occurrence

The parameter likelihood of occurrence is at first derived from the estimation the behaviour of birds. If a bird uses the area in the same way than before or are attracted there is low likelihood that that birds will be displaced. A likelihood of displacement is given in species showing negative reactions against wind farms. The likelihood of occurrence is modified by the **regional use of the area** derived from selectivity indices and a comparison of observed and expected individuals (based on the day of most individuals in the impact zone). It is further judged,

whether a positive selection is caused by the characteristics of the development area or by a general preference of the coastal area. The likelihood of occurrence can be down-graded if habituation over time can be expected. In this case habituated birds are not affected by displacement.

If the degree of disturbance is rated as Negligible (Section 8.2.1) a further assessment of the likelihood of occurrence in this species is not performed. This is that case for gulls.

An assessment is made for divers, Northern Gannets Common Scoter, Velvet Scoter and auks, all known to show displacement behaviour.

Divers were most abundant during the survey on 11th March 2014 (959 individuals in the investigation area, Table 12), and this date was taken as the basis for assessing the likelihood of occurrence of displacement. Assuming an impact zone of 2 km around the Vesterhav Syd boundary 182 divers were affected by displacement (40 divers within the impact zone of 500 m). Using the population in the study area, 18.7% of all birds would have been displaced from the impact zone (development area +2 km; 4.1% from development area +500 m). Regarding the impact zone of 2 km divers showed a neutral selectivity index and and the number of birds found corresponds to the number expected (Table 11). Due to the general avoidance behaviour of divers and the neutral selectivity index the likelihood of occurrence of displacement for divers is rated as High in a first assessment. Several studies indicate that divers show habituation to wind farms in operation (see Section 6.4.2) and the likelihood of occurrence of displacement decreases over a longer time span. Therefore, the high rating of the likelihood of occurrence of displacement is down-graded to **Medium**.

Northern Gannet were most abundant during the survey on 16th April 2014 (57 individuals in the study area, Table 14), and this date was taken as the basis for assessing the likelihood of occurrence of displacement. Assuming an impact zone of 500 m around the Vesterhav Syd boundary six Northern Gannet were affected by displacement (Table 68 in Appendix 16.6). Using the population in the study area, 0.001% of all birds would have been displaced from the impact zone (development area +2 km: 0.002%; 22 individuals).Northern Gannet showed no selection for the development area (Table 11). Due to a moderate avoidance behaviour of Northern Gannets and the fact that there was no selectivity for the development area the likelihood of occurrence of displacement for divers is rated as **Medium**.

Common Scoter were most abundant during the survey on 11th February 2014 (1,996 individuals in the study area, Table 15), and this date was taken as the

basis for assessing the likelihood of occurrence of displacement. Assuming an impact zone of 2 km around the Vesterhav Syd boundary 674 Common Scoter were affected by displacement (334 Common Scoter within the impact zone of 500 m). Using the population in the study area, 33.8% of all birds would have been displaced from the impact zone (development area +2 km; 16.7% from development area +500 m). Common Scoter showed a positive selectivity index and more birds were found than expected (Table 11). Due to the general avoidance behaviour of Common Scoters and positive selectivity index the likelihood of occurrence of displacement for divers is rated as High in a first assessment. It has been reported that Common Scoter show habituation to wind farms in operation (see Section 6.4.2) and the likelihood of occurrence of displacement decreases over a longer time span. Therefore, the high rating of the likelihood of occurrence of displacement is down-graded to **Medium**.

Velvet Scoter were most abundant during the survey on 11th March 2014 (118 individuals in the study area, Table 16), and this date was taken as the basis for assessing the likelihood of occurrence of displacement. Assuming an impact zone of 2 km around the Vesterhav Syd boundary 60 Velvet Scoter were affected by displacement (no birds occurred the impact zone of 500 m). Using the population in the study area, 51% of all birds would have been displaced from the impact zone (development area +2 km). Velvet Scoter showed a positive selectivity index for the development area (DA +2 km) and more birds were found than expected within the buffer zone of 2 km (Table 11). Due to the general avoidance behaviour of Velvet Scoter and the positive selectivity the likelihood of occurrence of displacement for Velvet Scoter is rated as High in a first rating. Velvet Scoter most probably behave similar to Common Scoter with respect to avoidance reaction to offshore wind farms. Therefore, also in the Velvet Scoter habituation can be expected. Further, there was a negative selectivity of the development area as such indicating that the positive selectivity for the areas including the zones of 2 and 4km around the development area are mainly caused by birds within the buffer zones. Besides the assumption of a similar behaviour as in Common Scoter habituation is likely to occur also because of the high presence in the buffer zone (moderate avoidance after habituation). Due to these reasons the first assessment of a High likelihood of occurrence is down-graded to **Medium**.

Auks were most abundant during the survey on 11th February 2014 (771 individuals in the study area, Table 23), but birds were strongly concentrated in the very western part of the study area with no birds occurring in the development area (Figure 59). On 25th November 2013 the number of auks in the study area was also high (723 individuals) and distribution was more scattered with birds also occurring in and around the development area (Figure 59). This day was used

for the impact assessment in terms of likelihood of occurrence. Within the impact zone of 500m (defined for auks) 28 individuals were found, corresponding to 3.8% of the regional population of 723 individuals. Applied to the total data set, auks showed negative selectivity indices and the number of observed birds was significantly lower than expected (Table 11). The significant difference was found for all distance classes (DA+0, DA+2 and DA+4). Due to the moderate avoidance behaviour of auks, the low proportion of regional population affected caused by a negative selectivity of the development area the likelihood of occurrence of displacement for auks is rated as **Low**.

8.2.4 Persistence

The lifetime of the wind farm is expected to be around 25-30 years. Accordingly, the operation period will be longer than 5 years and the persistence of the pressure disturbance is rated as **Permanent**.

In Table 34 the results of the impact assessment of the pressure displacement during the period of operation is summarised for different species. For **divers** and **Common Scoter** the magnitude of impact is rated as **Moderate** mainly due to the high sensitivity, bird numbers and the conservation status. In **Velvet Scoter** and **auks** a **Minor** impact is predicted. For gulls and Northern Gannet no impact is predicted with respect to displacement.

Table 41: Impact assessment on displacement during the period of operation

Parame-ter; Species	Degree of disturbance *	Importance	Likelihood of occurrence	Persis-tence	Magnitude of impact
Divers	Medium	Nation-al/regional	Medium	Perma-nent	Moderate
Northern Gannet	Low	Not important	Medium	Perma-nent	Negligi-ble/neutral/no impact
Common Scoter	Medium	Local	Medium	Perma-nent	Moderate
Velvet Scoter	Low	Local	Medium	Perma-nent	Minor
Auks	Low	Local	Low	Perma-nent	Minor
Gulls	Negligible	Not rated	Not rated	Not rated	Negligi-ble/neutral/no impact

*If Degree of disturbance is Negligible further criteria are not rated as Magnitude of impact is always Negligible

For the interpretation of the predicted impacts the consequences of the worst case assumptions are discussed in the following:

Divers

The spatial distribution of divers showed a high fluctuation among surveys with some days holding very few divers in the development area (e.g. on 16th April 2014, 3rd February 2014, Table 37, Figure 14). Besides seasonal variation in bird numbers, spatial fluctuations of divers may occur due to small scale changes in the spatial distribution of fish stock and hydrographic fronts (Skov & Prins 2001). This spatial fluctuation in bird distribution shows that the anticipated worst case scenario (choosing day of highest number in the development area) is not a common situation and that in other time periods less divers can be expected to be affected by displacement. With respect to the total number of divers affected it has to be considered that this figure may be underestimated because of those birds not counted during surveys due to their normal diving behaviour (Section 4.3).

Common Scoter / Velvet Scoter

For Common Scoter and Velvet Scoter the worst case scenario of a wind farm layout with 66 turbines including the area in the north east is applied (Section 4.5). Birds concentrated in the shallow waters in the north eastern part of the development area and the moderate impacts are most probably caused by birds in this area (number of birds outside this area within the development area was very low in any survey, see Figure 24 for Common Scoter and Figure 30 in Velvet Scoter). Therefore, it can be assumed that a moderate impact is found only in this limited part of the development area whereas in the majority of the development area the impact is supposed to be lower.

8.3 Collision

8.3.1 Predicted collision risk

Divers

For each survey the monthly rate of collisions of divers was calculated for each avoidance rate ranging from 95% to 99.5% (Table 42). Based on the survey with highest number on 25th March 2014 and an avoidance rate of 98% 0.38 birds per month are predicted to collide. Referring to the total number of collisions during the resting season from October to May (Skov et al. 1995), 1.56 birds can be expected to collide per year. Detailed calculations of seasonal collisions is divers presented in Table 8.

Table 42: Estimated collisions of divers (individuals per month) calculated on the basis of each survey divided by different avoidance rates

	Avoidance rate			
Date	**95%**	**98%**	**99%**	**99.5%**
25.11.2013	0.33	0.13	0.07	0.03
03.02.2014	0.49	0.20	0.10	0.05
11.02.2014	0.07	0.03	0.01	0.01
11.03.2014	0.36	0.14	0.07	0.04
25.03.2014	0.95	0.38	0.19	0.09
16.04.2014	0.02	0.01	0.00	0.00

Northern Gannet

As Northern Gannet were usually seen flying the calculated collision risk in relation to the total number of birds seen is higher when compared to other species e.g. with divers (who are usually seen swimming). Based on the survey with highest recorded bird numbers a monthly collision risk of 1.48 birds can be expected (calculates assuming 98% avoidance, Table 43). Gannets range widely during the breeding season and in late summer and autumn they show a wide

distribution over the North Sea (Skov et al. 1995). Only from November to February are concentrations present further south (Channel) and close to the Uk's east coast. Assuming 98% avoidance rate a maximum yearly collision of 5.6 birds has been calculated.

The surveys cover the period of November to April and Northern Gannets are most likely to use the area also in summer months. Therefore collision risks may be higher than calculated on the basis of the present surveys. As a result, this value has to be regarded as a minimum value.

Table 43: Estimated collisions of Northern Gannets (individuals per month) calculated on the basis of each survey divided by different avoidance rates

	Avoidance rate			
Date	**95%**	**98%**	**99%**	**99,5%**
25.11.2013	0.00	0.00	0.00	0.00
03.02.2014	0.00	0.00	0.00	0.00
11.02.2014	0.00	0.00	0.00	0.00
11.03.2014	0.25	0.10	0.05	0.03
25.03.2014	3.70	1.48	0.74	0.37
16.04.2014	0.28	0.11	0.06	0.03

Common Scoter

Collision risks were calculated based on the data of each survey (Table 44). Assuming an avoidance rate of 98% the highest number of colliding birds would be 7.41 individuals per month using estimates from for the survey on 11th February 2014.

If Common Scoter utilise the area during the wintering months from October to May (Skov et al. 1995) this would result in 31 collisions (98% avoidance).

Table 44: Estimated collisions of Common Scoter (individuals per month) calculated on the basis of each survey divided by different avoidance rates

	Avoidance rate			
Date	**95%**	**98%**	**99%**	**99,50%**
25.11.2013	10.02	4.01	2.00	1.00
03.02.2014	2.98	1.19	0.60	0.30
11.02.2014	18.52	7.41	3.70	1.85
11.03.2014	14.10	5.64	2.82	1.41
25.03.2014	6.17	2.47	1.23	0.62
16.04.2014	3.70	1.48	0.74	0.37

Velvet Scoter

Collision risk was calculated based on the data of each survey (Table 45). Assuming an avoidance rate of 98% the highest number of colliding birds would be 0.50 individuals per month for the survey on 25th March 2014.

If Velvet Scoters use the area for a similar time span as Common Scoter this stay would result in 2.5 collisions (98% avoidance). The time period for which birds are present is not clear as according to Skov et al. (1995) the area is of no importance for Velvet Scoter. The assumption of a parallel use to Common Scoter is therefore conservative.

Table 45: Estimated collisions of Velvet Scoter (individuals per month) calculated on the basis of each survey divided by different avoidance rates

	Avoidance rate			
Date	**95%**	**98%**	**99%**	**99,50%**
25.11.2013	0.00	0.00	0.00	0.00
03.02.2014	0.00	0.00	0.00	0.00
11.02.2014	0.00	0.00	0.00	0.00
11.03.2014	1.20	0.48	0.24	0.12
25.03.2014	1.26	0.50	0.25	0.13
16.04.2014	0.05	0.02	0.01	0.01

Little Gull

Collisions of Little Gull were only predicted for the survey on 11th February 2014. On other surveys, the density of flying birds was low and anticipated collisions were below 0.01 and therefore not presented. The monthly collision estimate was 0.08 collisions when taking 98% avoidance into account (Table 46). Assuming a presence of six months in the area (migration/wintering) collisions are anticipated to be 0.25 colliding birds (98% avoidance). The maximum collision rate of the group of “small gull” was 12.39 collisions with 98% avoidance (Table 65 in Appendix 16.5). However, most of these gulls are allocated to Common Gulls, which are between “large” and “small” in size and in this analyses allocated to the group of “small gulls”. Therefore, Little Gulls may be part of this species group, but the number is supposed to be low and an effect of collision rate is assumed to be low. Further, the interpretation of collision modeling in groups of gulls is limited as described in the Section 4.3 on data analyses.

Table 46: Estimated collisions of Little Gulls (individuals per month) calculated on the basis of each survey divided by different avoidance rates

	Avoidance rate			
Date	**95%**	**98%**	**99%**	**99,5%**
25.11.2013	0.00	0.00	0.00	0.00
03.02.2014	0.00	0.00	0.00	0.00
11.02.2014	0.41	0.16	0.08	0.04
11.03.2014	0.00	0.00	0.00	0.00
25.03.2014	0.00	0.00	0.00	0.00
16.04.2014	0.00	0.00	0.00	0.00

Common Gull

Common Gulls were mostly seen flying and flight altitude overlap with rotor swept area to a larger extent than is observed in other species e.g. in scoters and divers (Cook et al. 2012). Therefore, the calculated collision risks are high in some surveys with a maximum value of 23 birds per month on 25th March 2014 (avoidance rate 98%, Table 47). If Common Gulls use the study area all year (Skov et al. 1995) a yearly sum of 208 birds may collide. This has to be regarded as a minimum value as Common Gulls most probably contributed to the category of unidentified “Small gulls” listed in Table 10.

Table 47: Estimated collisions of Common Gulls (individuals per month) calculated on the basis of each survey divided by different avoidance rates

	Avoidance rate			
Date	**95%**	**98%**	**99%**	**99,5%**
25.11.2013	27.66	11.06	5.53	2.77
03.02.2014	3.90	1.56	0.78	0.39
11.02.2014	16.26	6.51	3.25	1.63
11.03.2014	48.94	19.58	9.79	4.89
25.03.2014	57.16	22.86	11.43	5.72
16.04.2014	5.45	2.18	1.09	0.54

Lesser Black-backed Gull

The estimated number of monthly collisions was highest on 25th March 2014. Assuming an avoidance rate of 98% and based on this survey with highest collision rate 2.59 birds per month are predicted to collide (Table 48). Assuming that Lesser Black-backed Gulls spend eight months in the area (March to October; Skov et al. 1995) 14.4 birds could collide within a year (98% avoidance, for calculation method see example in Table 8). As the summer and autumn months are not covered by surveys the collision numbers have to be regarded as a minimum values. Further, Lesser Black-backed Gulls contribute to the category of

unidentified gulls (“Gull spec.” and “Great Gull” in Table 10) and the number of collisions may increase from these birds.

Table 48: Estimated collision collisions of Lesser Black-backed Gulls (individuals per month) calculated on the basis of each survey divided by different avoidance rates

	Avoidance rate			
Date	**95%**	**98%**	**99%**	**99,5%**
25.11.2013	0.00	0.00	0.00	0.00
03.02.2014	0.00	0.00	0.00	0.00
11.02.2014	0.00	0.00	0.00	0.00
11.03.2014	3.43	1.37	0.69	0.34
25.03.2014	6.48	2.59	1.30	0.65
16.04.2014	1.27	0.51	0.25	0.13

Herring Gull

The highest rates of collisions are calculated for the survey on 25th November 2014 with 15 collisions per month (98% avoidance rate; Table 49). Collision rates during the March surveys were slightly lower. Collision risks for Herring Gull in February 2014 are estimated to be low. Assuming a presence in the Vesterhav Syd area all year, an annual sum of 156 collisions can be expected (98% avoidance). Herring Gulls contribute to the category of unidentified gulls (“Gull spec.” and “Great Gull” in Table 10) and the annual sum of collisions has to be regarded as minimum value.

Table 49: Estimated collisions of Herring Gulls (individuals per month) calculated on the basis of each survey divided by different avoidance rates

	Avoidance rate			
Date	**95%**	**98%**	**99%**	**99,5%**
25.11.2013	37.61	15.04	7.52	3.76
03.02.2014	1.33	0.53	0.27	0.13
11.02.2014	1.97	0.79	0.39	0.20
11.03.2014	27.37	10.95	5.47	2.74
25.03.2014	34.10	13.64	6.82	3.41
16.04.2014	19.26	7.70	3.85	1.93

Great Black-backed Gull

The highest collision risk was calculated for the survey on 3rd February 2014 with 3.16 collisions (avoidance rate 98%, Table 50). Based on an all year round presence a collision risk of 19.4 birds per year is calculated (98% avoidance). As the summer and autumn months are not covered by surveys the collision numbers have to be regarded as minimum value as bird numbers may be higher in summer months.

Table 50: Estimated collisions of Great Black-backed Gulls (individuals per month) calculated on the basis of each survey divided by different avoidance rates

	Avoidance rate			
Date	**95%**	**98%**	**99%**	**99,50%**
25.11.2013	2.42	0.97	0.48	0.24
03.02.2014	7.91	3.16	1.58	0.79
11.02.2014	1.56	0.62	0.31	0.16
11.03.2014	0.00	0.00	0.00	0.00
25.03.2014	4.28	1.71	0.86	0.43
16.04.2014	1.34	0.54	0.27	0.13

Black-legged Kittiwake

The highest collision rate is calculated for the survey on 25th November 2013. Assuming an avoidance rate of 98 % 0.61 birds would collide (Table 51). If Black-legged Kittiwakes use the area all year annual collisions can total 5.6 birds (98% avoidance rate). As the summer and autumn months are not covered by surveys the collision numbers have to be regarded as minimum values.

Table 51: Estimated collisions of Black-legged Kittiwakes (individuals per month) calculated on the basis of each survey divided by different avoidance rates

	Avoidance rate			
Date	**95%**	**98%**	**99%**	**99,5%**
25.11.2013	1.53	0.61	0.31	0.15
03.02.2014	0.41	0.16	0.08	0.04
11.02.2014	0.00	0.00	0.00	0.00
11.03.2014	0.00	0.00	0.00	0.00
25.03.2014	0.00	0.00	0.00	0.00
16.04.2014	0.00	0.00	0.00	0.00

Common Guillemot / Razorbill

Auks are rarely seen flying and if so, the flight altitude is very low (estimated % in blade height: 1%; Furness et al. 2013). Therefore, regardless of any abundance of auks within the Vesterhav Syd site, the probability of collision is regarded as low. Only on 11th February 2014 flying auks were seen in very low densities of

≥0.01 birds/km² (Table 23) and the calculated number of collisions is below 0.01 individuals for all avoidance rates (Table 52).

Table 52: Estimated collisions of auks (individuals per month) calculated on the basis of each survey divided by different avoidance rates

	Avoidance rate			
Date	**95%**	**98%**	**99%**	**99,50%**
25.11.2013	0.00	0.00	0.00	0.00
03.02.2014	0.00	0.00	0.00	0.00
11.02.2014	0.00	0.00	0.00	0.00
11.03.2014	0.00	0.00	0.00	0.00
25.03.2014	0.00	0.00	0.00	0.00
16.04.2014	0.00	0.00	0.00	0.00

8.3.2 Impact assessment of collisions during operation

During the period of operation birds may collide with wind turbines causing mortality. The probability of collisions is very different between species. In the following the collision risk of relevant species occurring in the Vesterhav Syd development area will be discussed based on a sensitivity analysis according to literature knowledge followed by a site specific analysis of collision rates and the assessment of possible effects on the population level. This assessment is linked to the framework of Potential Biological Removal (PBR) indicating a level of unacceptable additional mortality (see Section 6.2.5).

Divers

The flight altitude is one important parameter for the assessment of collision risk. In particular, the proportion of birds flying within the altitude of rotor swept area is important. Estimations of overlap of flight altitude with rotor swept area in divers range from 1 % (Red-throated Diver, 7% in Black-throated Diver; Johnston et al. 2014) to 5% (Furness et al. 2013) indicating a low proportion of birds flying at risk height. Flight altitudes vary with wind conditions (Krüger & Garthe 2001) and at Horns Rev 3 divers were seen flying at altitudes of up to 100 m (HR3: Orbicon 2014a). Divers fly fast and show a limited flight agility making them vulnerable if a risky situation should occur (Furness et al. 2013). However, due to the avoidance behaviour to date no risky situation have been observed in divers flying near offshore wind farms. Long term observations of collisions at lighthouses in Denmark document only 12 collisions of Red-throated Divers (and 2 Black-throated Divers) in a period of 54 years (0.2 birds per year; Hansen 1954). Depending on the variation of model input parameter collision rates at Horns Rev 2 and 3 were assessed to be between 0 and 15 collisions in Red- and Black-throated divers (HR3: Orbicon 2014b).

Assuming an avoidance rate of 98% in the Vesterhav Syd study area a monthly collision rate between 0.01 and 0.38 individuals was calculated (Table 42). For a total resting period collisions of 1.56 individuals are predicted.

Divers are characterised by a high conservation status as they are listed in Annex I of the EU Directive and holds the category SPEC 3 (unfavourable conservation status in Europe, global population not concentrated in Europe). This high conservation status has to be taken into account for impact assessment.

A high impact is expected when the additional mortality has negative effects on the population. For the assessment of impacts of additional mortality the Potential Biological Removal (PBR) is often used. This proportion of population is related to the population size and the population trend as outlined in the methods section (Section 6.2.5). The overall European population of Red-throated Diver (as the most frequent species compared to Black-throated diver) trend is assessed to be stable for the period from 1990-2002 (BirdLife International 2004). The most relevant population of Black-throated Divers is in Sweden where a long term increase of population is indicated (levelled off during past 10-15 years before 2013). In Red-throated Divers an increase in population in north Sweden is also observed whereas indications of declines were found in southern Sweden (Eriksson 2013). The stable or mostly increasing population suggests a use of a recovery factor of 0.5 for a stable population. In this case a removal of 6.1% of the population would lead to a negative impact. On a precautionary basis (and as parts of populations decline) the recovery factor for a decreasing population is used for assessment (rf=0.1) leading to a maximum removal of 1.3% of the population. The calculated 1.56 collisions per year makes up 0.0006% of the north west European population of 260,000 individuals of smaller population of Red-throated Divers (Wetlands International 2014) and is below a defined threshold of 0.01% for a Low impact (Section 6.2.5). Even if the high conservation status of divers is taken into account the Magnitude of impact of collisions on divers is assessed to be **Negligible/Neutral/No impact**.

Northern Gannet

Northern Gannet belong to those species with a relatively high overlap of flight altitude with the zone of rotor blades ranging from 7 to 16% (Cook et al. 2012, Furness et al. 2013, Johnston et al. 2014). Birds show partial or complete avoidance of offshore wind farms, reducing the probability of collisions.

In the Vesterhav Syd offshore wind farm a yearly collision of 5.6 Northern Gannets is predicted. Compared to the abundance of birds in the area during the periods of survey this value is relatively high due to the high percentage of overlap with rotor blade zone used for collision modelling. Referred to the reference population 0.0006% of birds are supposed to collide. In decreasing populations

of Northern Gannet an additional removal of 0.6% of the population (PBR) is supposed to cause negative impacts on the population. This is highly precautionary as Gannet populations in Europe are increasing (BirdLife International 2014), suggesting that an impact would be expected when 6.2% of the population is removed (Table 31). As 0.0006% of the reference population is predicted to collide the Magnitude of impact is rated as **Negligible/Neutral/No impact** (<0.01% as defined in Section 6.2.5). As Northern Gannets show a low conservation status the rating is not modified.

It has to be considered that the seasonal period of highest anticipated number of Northern Gannets was not covered by the surveys and the number of collisions is therefore to be regarded as minimum values. An up-grade to a Minor impact would require a further yearly 86 collisions. In the Horns Rev3 study three collisions of Northern Gannets per year are predicted including the summer and autumn period (HR3: Orbicon 2014b). Therefore, additional 86 collisions in the Vesterhav Syd area are highly unlikely.

Common Scoter

The flight altitude of Common Scoter is reported to be very low and estimations range from 0.1% to 3% (Cook et al. 2012, Furness et al. 2013, Johnston et al. 2014). At Horns Rev 3 all seaducks (mostly Common Scoter) were seen below 50 m. Therefore, they mainly fly below the rotor swept area. Nevertheless, collisions with static structures such as turbine pylons would be possible. Common Scoter are known to show strong avoidance behaviour and collisions are predicted to be rare. However, some studies have reported that habituation can occur to some degree and Common Scoter were seen within wind farms (HR3: Orbicon 2014a) making respective flight activities a potentially risky behaviour. Obstacles are visible during the daytime and collisions are expected to be linked to darkness or bad weather conditions. Even at night wind turbines are recognised as obstacles but with less probability (Dirksen et al. 1998, Christensen et al. 2004). In migrating Common Eider an adjustment of flight directions along arrays of offshore wind turbines has been observed supporting the assumption of obstacle recognition during night (Christensen et al. 2004, Kahlert et al. 2004). Collisions with vertical structures over a long period of time was analyised by Hansen (1954) recoding 2.4 collisions of Common Scoter per year (Common Eider: 1.6). Assuming an avoidance rate of 98% collision numbers of Common Scoter at Horns were estimated to be between 5 (Horns Rev 3) and 178 individuals (Horns Rev 2; HR3: Orbicon 2014b). In comparison with the Vesterhav Syd study area it has to be considered that densities of Common Scoter used for collision modelling in the Horns Rev studies were between 12.2 (Horns Rev 3) and 274 individuals per km² (Horns Rev 2) indicating high concentrations of this species.

The overall European population of Common Scoter is assessed to be stable for the period from 1990-2002 (BirdLife International 2004). The stable population suggests a use of a recovery factor of 0.5 for a stable population. In this case a removal of 5.1% of the population would lead to a negative impact. On a precautionary basis the recovery factor for a decreasing population is used for assessment (rf=0.1) leading to a maximum removal of 1.0% of the population (Table 31). The calculated 31 collisions per year make up 0.005% of the reference population of 550,000 individuals and according to the definition in Section 6.2.5) the Magnitude of impact of collisions on Common Scoter is assessed to be **Negligible/Neutral/No impact**.

Velvet Scoter

Similar to the Common Scoter the flight altitude of Velvet Scoters is supposed to be very low. At Horns Rev 3 all seaducks (including Velvet Scoter) were seen below 50 m. Velvet Scoter are known to show avoidance behaviour and collisions are predicted to be rare. Hansen (1954) calculated 0.2 collisions of Velvet Scoter per year with lighthouses considering a period of 54 years. Assuming an avoidance rate of 98% collision only one collision is predicted in Velvet Scoter in the Horns Rev 3 area (HR3: Orbicon 2014b).

The population of Velvet Scoters is assessed to be declining (BirdLife International 2004) suggesting the use of 0.1 for the recovery factor in the context of calculations on Potential Biological Removal. The calculated 2.5 collisions per year as a worst case correspond to 0.0005% of the reference population of 450,000 individuals. and the Magnitude of impact of collisions on Velvet Scoter is assessed to be **Negligible/Neutral/No impact** (<0.01% of reference population).

Gulls

Of all birds detected in offshore wind farms, gulls are the most frequently observed group using the potential risk zone of the rotor swept area. The proportion of birds flying at rotor swept area are estimated to be highest in large gulls (Herring Gull, Lesser Black-backed Gull and Great Black-backed Gull) with an overlap of flight altitude with rotor swept between 20 and 35% (Cook et al. 2012, Furness et al. 2013, Johnston et al. 2014). Common Gulls also fly to a high proportion at risk altitude (estimations between 13 and 23%) whereas in Little Gulls less than 10% are expected to fly a risk height.

In addition to this behaviour (flying at a risky altitude) gulls are known to show low avoidance behaviour towards offshore wind farms and are frequently seen within wind farms. Increased abundance of gulls within wind farms could also result from restricted fishing activities within wind farms presumably causing increasing fish stock as food for gulls. Further, gulls are known to follow fishing

vessels and even though vessels will not go into wind farms the movements of birds between fishing vessels around wind farms may increase the chance of collisions. Therefore, regular collisions are expected in gulls and Furness et al. (2013) classify gulls as the seabird group with the highest sensitivity towards wind farms, especially for the three large gull species Herring Gull, Great Black-backed Gull and Lesser Black-backed Gull.

For the Horns Rev wind farms collisions of 149 (Horns Rev 3) to 378 (Horns Rev 1) large gulls (Herring Gull, Lesser Black-backed Gull and Great Black-backed Gull) are predicted using a model scenario of 98% avoidance behaviour (HR3: Orbicon 2014b). In small gulls (Common Gull, Black-headed Gull and Little Gull) the number of collisions at Horns Rev varied from 10 (Horns Rev 2) to 34 (Horns Rev 3) when an avoidance rate of 98% is applied.

The sum of collisions in large gulls in the Vesterhav Syd area was 189 individuals per year (sum of respective species in Table 53). A separate collision modelling of ”large gulls” (identified and un-identified species allocated to ”large gulls”) is not presented due to the reasons given in the methods Section 4.3. Including further collisions from not identified gull species (21% not identified to species level) the collisions are within a same range compared to the Horns Rev projects.

In small gulls a sum of 214 collisions per year are expected. Also in this group collisions of not identified gulls have to be added (a part of the 21 % of gulls not identified to species level). This relatively high value is mainly caused by the Common Gull with expected yearly collisions of 208 individuals (Table 53). Following a precautionary principle in the judgment of collisions the month with maximum collisions is used as a basis for survey months not covered. Therefore, this value may indicate an overestimation of anticipated collision, on the other hand presumably a high proportion of not identified gulls will be represented by Common Gulls. 21% of gulls were not identified to species level. The number of anticipated collisions of Common Gull in the Horns Rev areas is estimated to be 18 individuals at Horns Rev 3 and fewer at Horns Rev 1 and 2 wind farms (HR3: Orbicon 2014b).

Table 53: Number of collisions per year in gull species

Species	Collisions per year/ season	Biogeographical population*	Collisions in % of population	Conservation status
Herring Gull	156	2,010,000	0.008	Non-SPEC E
Lesser black-backed Gull	14	380,000	0.003	Non-SPEC E
Great black-backed Gull	19	420,000	0.005	Non-SPEC E
Common Gull	208	1,640,000	0.013	SPEC 2
Black-legged Kittiwake	6	6,600,000	<0.001	Non-SPEC
Little Gull	0.25	110,000	<0.001	SPEC 3, listed Annex

* see Table 27 and Table 28 for explanations

To assess the magnitude of collision arising from Vesterhav Syd offshore wind farm it has to be considered whether the additional mortality may negatively affect the population. As described above, a combination of Potential Biological Removal (PBR) and population size is used for this purpose (see Section 6.2.5) and as a precautionary principle the lowest recovery factor is used as a reference. A low impact of collisions on the population is anticipated if the proportion of colliding birds reaches 0.01% of the population. This proportion is achieved in the Common Gull (Table 53). In the Herring Gull the collisions are marginal below this threshold and including collisions from not identified gulls (where Herring Gulls presumably participate to a great extend) the threshold of 0.01 % may also be reached in this species A further aspect in the assessment of the conservation status of a species. The Common Gull has a relatively high conservation status as it is rated as SPEC 2 (European species whose global population is concentrated in Europe, unfavourable conservation status). The Little Gull is a SPEC 3 species (global population not concentrated in Europe, but unfavourable conservation status in Europe) and is also listed in the Annex I of the EU Bird Directive. For the Lesser Black-backed Gull it has to be considered that surveys did not cover months where most birds are anticipated to be present in the area and the number of collisions have to be regarded as minimum values.

According to the preceding explanations the Magnitude of impact in gulls is rated as follows:

Herring Gull: predicted collisions make up 0.008% of the biogeographical population. Further collisions of Herring Gulls may arise from unidentified gulls that contribute to the group of “large gulls”. Therefore, there is a high probability that the 0.01% threshold is exceeded. Calculated from derived Potential Biological

Removal the impact of collisions related to the Vesterhav Syd offshore wind farm is rated as **Minor**.

Lesser Black-backed Gull: predicted collisions represent 0.004% of the biogeographical population (14 individuals from 380,000). Calculated from derived Potential Biological Removal the impact of collisions related the Vesterhav Syd offshore wind farm is rated as ”Negligible/Neutral/No impact”. As the temporal season of abundance of Lesser Black-backed Gulls is not totally covered there is a possibility that the number of collisions may be strongly underestimated using the data of the surveys performed. Additional yearly collisions of 25 individuals would lead to a population proportion of more than 0.01% which is defined to represent a Minor impact (39 individuals from 380,000). From a comparison of bird densities with the Horns Rev 3 area (about 30 km south) it can be expected that densities in the Vesterhav Syd area will be much higher in summer, e.g. maximum densities in Horns Rev 3 study was 1.2 birds/km² in July (HR3: Orbicon 2014a) compared to 0.04 in late March in the Vesterhav Syd study area. For the Horns Rev 3 area a yearly collisions of 115 individuals is expected. Taking the number of turbines into account (133 turbines with 3MW in worst case scenario in Horns Rev 3 wind farm and 66 turbines with 3MW in worst case scenario in Vesterhav Syd wind farm) collisions of about 60 birds in Vesterhav Syd wind farm would be realistic. At least, there is a high probability that more than 25 (and less than 370 - would be Moderate with 0.1% of population) birds will collide. Therefore the magnitude of impact is rated as **Minor**.

Great Black-backed Gull: predicted collisions make up 0.005% of the biogeographical population. Calculated from derived Potential Biological Removal the impact of collisions related to the Vesterhav Syd offshore wind farm is rated as **Negligible/Neutral/No impact**. From comparison with the Horns Rev 3 wind farm it can be expected that the numbers of Great Black-backed Gulls in period not covered with surveys is not higher than in the period of surveys (HR3: Orbicon 2014a).

Common Gull: predicted collisions make up 0.013% of the biogeographical population. Calculated from derived Potential Biological Removal the impact of collisions related the Vesterhav Syd offshore wind farm is rated as Low. The surveys covered the period of highest abundance in the area and an underestimation of population and collisions is not expected. As Common Gulls have a high conservation status (SPEC 2) the magnitude of impact is rated as **Minor**.

Little Gull: predicted collisions correspond to less than 0.001% of the biogeographical population. Calculated from derived Potential Biological Removal the impact of collisions related the Vesterhav Syd offshore wind farm is rated as **Negligible/Neutral/No impact**. Little Gulls have a high conservation status (SPEC 3 and Annex I in EU directive), but due to the very low number of expected collisions (0.25 per season) the rating of the magnitude of impact is not modified.

Black-legged Kittiwake: the predicted collisions make up less than 0.001% of the biogeographical population. Judged from derived Potential Biological Removal the impact of collisions related the Vesterhav Syd offshore wind farm is rated as **Negligible/Neutral/No impact**. As Black-legged Kittiwakes have a low conservation status this rating is not further modified.

Auks

Auks belong to those seabird species with very low flight altitudes. There is only a very low overlap of flight altitude with the risk zone of the rotor blades. The percentage of overlap is supposed to be 1% and less (Cook et al. 2012, Furness et al. 2013, Johnston et al. 2014). Auks are reported to avoid offshore wind farms (see Section 6.4) further limiting the probability of collisions of auks with offshore wind farms. In Horns Rev 2 and 3 collision modelling predicted zero collisions when an avoidance of 98% is applied (HR3: Orbicon 2014b).

The collision modelling is based on the densities of flying birds which is very low and auks are mostly seen swimming (2 % total flying in all surveys were seen flying). As no collision is predicted the Magnitude of impact of collisions on auks is regarded as **Negligible/Neutral/No impact**.

Table 54 summarises the results of the assessment of collisions during the period fo operation. **Minor** impacts are prediced for Herring Gulls, Common Gulls and Lesser Black-backed Gulls.

Table 54: Impact assessment of collisions during the period of operation

Parameter Species	Magnitude of impact
Divers	Negligible/ neutral/no impact
Northern Gannet	Negligible/ neutral/no impact
Common scoter	Negligible/ neutral/no impact
Herring Gull	Minor
Lesser Black-backed Gull	Minor
Greater Black-backed Gull	Negligible/ neutral/no impact
Common Gull	Minor
Little Gull	Negligible/ neutral/no impact
Kittiwake	Negligible/ neutral/no impact
Auks	Negligible/ neutral/no impact

8.4 Total impact

Table 55 gives a summary of impact assessment of resting birds during operation separated by different project pressures. Regarding habitat loss / change **Moderate** impacts are predicted for divers and Common Scoter, whereas impacts on Velvet Scoter and auks are assessed to be **Minor**. Artificial reef structures may have positive impacts on benthivorous and piscivorous species (restricted to those species and parts of population that shows habituation).

The magnitude of impact of displacement is rated as **Moderate** in divers and Common Scoter and as **Minor** in Velvet Scoter and auks. In Northern Gannets and gulls displacement is assessed to have a **Negligible** impact. The magnitude of impact of collisions with wind turbines during the period of operation is rated **Minor** in Herring Gulls, Lesser Black-backed Gulls and Common Gulls. In all other species collisions are assessed to have **Negligible** impacts.

Table 55: Summary of impacts on resting birds during operation

Parameter **Species**	**Degree of disturbance ***	**Importance**	**Likelihood of occurrence**	**Persistence**	**Magnitude of impact**
Habitat loss / change					
Divers	Medium	National / regional	Medium	Permanent	Moderate
Northern Gannets	Negligible	Not rated	Not rated	Not rated	Negligible/neutral/no impact
Common Scoter	Medium	Local	Medium	Permanent	Moderate
Velvet Scoter	Low	Local	Medium	Permanent	Minor
Auks	Low	Local	Low	Permanent	Minor
Gulls	Negligible	Not rated	Not rated	Not rated	Negligible/neutral/no impact
Note:	**Artificial reef effects** may positively affect the habitat use of benthivorous (higher benthos diversity and biomass on scour protection) and piscivorous species (new species dependent on reef structures, reduced fishing activities in and around wind farms). This effects only refer to those birds that habituate to the wind turbines and use that area for feeding				

Parameter Species	Degree of disturb-ance *	Importance	Likelihood of occurrence	Persis-tence	Magnitude of impact
Displace-ment					
Divers	Medium	Nation-al/regional	Medium	Perma-nent	Moderate
Northern Gannet	Low	Not important	Medium	Perma-nent	Negligi-ble/neutral/no impact
Common Scoter	Medium	Local	Medium	Perma-nent	Moderate
Velvet Sco-ter	Low	Local	Medium	Perma-nent	Minor
Auks	Low	Local	Low	Perma-nent	Minor
Gulls	Negligible	Not rated	Not rated	Not rated	Negligi-ble/neutral/no impact
Collision	Different system of impact assessment used				
Divers					Negligible/ neu-tral/no impact
Northern Gannet					Negligible/ neu-tral/no impact
Common scoter					Negligible/ neu-tral/no impact
Herring Gull					Minor
Lesser Black-backed Gull					Minor
Greater Black-backed Gull					Negligible/ neu-tral/no impact
Common Gull					Minor
Little Gull					Negligible/ neu-tral/no impact
Kittiwake					Negligible/ neu-tral/no impact
Auks					Negligible/ neu-tral/no impact

*If Degree of disturbance is Negligible further criteria are not rated as Magnitude of impact is always Negligible

9 IMPACT ASSESSMENT DURING DECOMMISSIONING

The decommissioning of the wind farm is planned after a period of operation of approximately 25 to 30 years in order to minimise both the short and long term effects on the environment. Based on current available technology, it is anticipated that the following level of decommissioning on the wind farm will be performed:

- Wind turbines – to be removed completely;
- Structures and substructures – to be removed to the natural seabed level or to be partly left in situ;
- Cables – to be either removed (in the event they have become unburied) or to be left safely in situ, buried to below the natural seabed level or protected by rock-dump; and
- Scour protection – to be left in situ.

Impacts on resting birds during decommissioning are comparable to those assessed for the installation phase. The greatest impact is caused by increased vessel traffic in relation to disturbance, whereas habitat loss is also considered in terms of activities associated with the removal of turbines, cables and other infrastructure.

9.1 Habitat loss / change

9.1.1 Degree of disturbance

The scour protection will be left in situ and the related loss of habitat described in relation to operation is persistent (Section 8.1). If cables are removed the resultant impact (sedimentation and increase in water turbidity) will be comparable to those assessed for installation (Section 7.1). Studies on sedimentation at Vesterhav Syd conclude that the decommissioning phase is generally considered to incur similar or less changes in environmental parameters (COWI A/S 2014).

Due to expected small scale of sediment plumes and short duration of the spills (COWI A/S 2014) the effect on mussels and other prey organisms for wintering waterbirds is anticipated to be very small. If cables are left in the seabed, the extent to which rock-dumping will be necessary is not yet clear. Normally, they are still buried below the natural seabed and only if the cable protrudes from the seabed e.g. due to shifts in sediment, would rock dumping will be necessary for protection. This would lead to a further reduction in available seabed with potential prey items for benthivorous species, but also would mean positive effects due

to an increase in hard bottom substrate. New benthos species could settle and positive effects on fish communities would be expected.

Similar to the situation during installation the degree of disturbance in habitat loss / change in **gulls** and **Northern Gannets** is regarded as **Negligible** (see Section 7.1.1 for further explanations) and other criteria are not further assessed.

In piscivorous **divers** and **auks** the situation during decommissioning is comparable to the installation phase and the degree of disturbance is also rated as **Medium** in divers and **Low** in auks (Section 7.1.1). The increase in artificial reef structures caused by scour protection and rock dumping may positively affect piscivorous species as fish communities may be positively affected. However, the effects of artificial reefs are assessed to be minor (NIRAS 2015b).

For **Common Scoter** and **Velvet Scoter** the activities during decommissioning will negatively affect food availability. In areas of vessel activities Common Scoter are prevented to forage and if rock dumping will be necessary seabed with prey will be covered and the area is lost as feeding areas. As outlined in Section 7.1.1 Common Scoter show a low flexibility in habitat use and their flexibility in food choice is therefore rated as low. The expected degree of turbidity and sedimentation caused by decommissioning is expected to be within the natural range in this part of the North Sea and impact from these parameter are regarded as natural background variation (COWI A/S 2014).

The rating is presented in the following:

Common Scoter: Medium number of birds affected (0.123% of biogeographical population; see Section 8.2.1 on displacement for detailed calculations) and low felxibility in food choice results in a **Medium** degree of disturbance.

Velvet Scoter: Low number of birds affected (0.013% of biogeographical population; see Section 8.2.1 on displacement for detailed calculations) and Medium flexibility in food choice results in a **Low** degree of disturbance.

9.1.2 Importance

The criteria ”Importance” is judged on the same basis for the period of decommissioning and operation. As the period of operation is supposed to cause higher and longer lasting effects the assessment of Importance is described in detail in Section 8.2.2. The results of this assessment are presented for the relevant species.

In divers, Common Scoter, Velvet Scoter and auks degree of disturbance has been assessed as higher than negligible. The Importance of the area for these species is listed in the following:

Divers:	**National/regional**
Common Scoter:	**Local**
Velvet Scoter:	**Local**
Auks:	**Local**

9.1.3 Likelihood of occurrence

The criteria ”Likelihood of occurrence” is judged on the same basis for the period of decommissioning and operation. As the period of operation is supposed to cause higher and longer lasting effects the assessment of Importance is described in detail in Section 8.2.3. Effects of habituation are not considered during decommissioning period but a down-grading for the period of decommissioning is performed due to the smaller spatial extend of the effect compared to the period of operation. The results of this assessment are presented for the relevant species.

Divers:	**Medium** (habituation not considered, but down-grading from High due to limited spatial scale during decommissioning)
Common Scoter:	**Medium** (habituation not considered, but down-grading from High due to limited spatial scale during decommissioning)
Velvet Scoter:	**Medium** (habituation not considered, but down-grading from High due to limited spatial scale during decommissioning)
Auks:	**Low**

9.1.4 Persistence

The habitat loss / change due to decommissioning activities is limited to the time period of work at a particular site. The total time period of decommissioning cannot yet be defined and is anticipated to be similar to the time needed for installation. Decommissioning work will progress with time and it can be anticipated that work on particular sites last for less than one year. After leaving a working area the site is again available for birds. Therefore, the persistence of habitat loss / habitat change during the period of decommissioning is rated as **Short-term**.

In Table 56 the results of the impact assessment on habitat loss / habitat change for the period of decommissioning is summarised. Only in **divers** a **Minor** Magnitude of impact is expected. In all other species the impact is assessed to be **Negligible**. Positive impacts may result from artificial reefs built by hard substrate covering cables after rock dumping.

Table 56: Impact assessment on "habitat loss/change" during the period of decommissioning

Parameter; Species	**Degree of disturbance ***	**Importance**	**Likelihood of occurrence**	**Persistence**	**Magnitude of impact**
Divers	Medium	National/regional	Medium	Short-term	Minor
Northern Gannet	Negligible	Not rated	Not rated	Not rated	Negligible/neutral/no impact
Common Scoter	Medium	Local	Medium	Short-term y	Negligible/neutral/no impact
Velvet Scoter	Low	Local	Medium	Short-term	Negligible/neutral/no impact
Auks	Low	Local	Low	Short-term y	Negligible/neutral/no impact
Gulls	Negligible	Not rated	Not rated	Not rated	Negligible/neutral/no impact
Note	**Artificial reef effects (rock-dumping on subsea cables are further artificial reefs besides fundaments and scour protection)** may positively affect the habitat use of benthivorous (higher benthos diversity and biomass on scour protection, settling of new species as food for seaducks) and piscivorous species (new species dependent on reef structures, reduced fishing activities in and around wind farms)				

*If Degree of disturbance is Negligible further criteria are not rated as Magnitude of impact is always Negligible

9.2 Displacement

The disturbance of birds during decommissioning is expected to be comparable to the situation of installation. Also during decommissioning disturbance is predominantly caused by vessels. As the extent of work will be comparable to the

situation during installation, the effect of displacement during decommissioning is considered to be of the same magnitude as during installation (see Section 7.2).

In Table 57 the results of the impact assessment for displacement during decommissioning is summarised for different species. In **divers** a **Minor** impact of displacement is predicted. In all other species the combination of the rating of categories the magnitude of impact is rated as **Negligible/neutral/no impact.**

Table 57: Impact assessment on the pressure "displacement" during the period of decommissioning

Parameter; Species	Degree of disturbance*	Importance	Likelihood of occurrence*	Persistence	Magnitude of impact
Divers	Medium	National/regional	Medium	Short term	Minor
Northern Gannet	Low	Not important	Medium	Short term	Negligible/neutral/no impact
Common Scoter	Medium	Local	Medium	Short term	Negligible/neutral/no impact
Velvet Scoter	Low	Local	Medium	Short term	Negligible/neutral/no impact
Auks	Low	Local	Low	Short term	Negligible/neutral/no impact
Gulls	Negligible	Not rated	Not rated	Not rated	Negligible/neutral/no impact

*If Degree of disturbance is Negligible further criteria are not rated as Magnitude of impact is always Negligible

9.3 Collisions

Referred to collisions the situation during decommissioning is comparable to the situation during installation. The Magnitude of impact of collisions during the period of decommissioning is assessed to be **Negligible/Neutral/No impact**. For further explanations see Section 7.3 on installation.

9.4 Total impact

Habitat loss / change as well as displacement is assessed to cause a **Minor** impact in divers during decommissioning. In other species impacts are assessed to be negligible. Additional artificial reefs build by rock-dumping to protect the cables (in case that they are left in the seabed and rock dumping will be necessary) will increase the positive effect of benthos and fish communities at the expense of a reduction in the softbottom infauna (Table 58).

Table 58: Summary of impact on resting birds during decommissioning

Parameter; Species	**Degree of disturbance ***	**Importance**	**Likelihood of occurrence**	**Persistence**	**Magnitude of impact**
Habitat loss / change					
Divers	Medium	National/regional	Medium	Short-term	Minor
Northern Gannet	Negligible	Not rated	Not rated	Not rated	Negligible/neutral/no impact
Common Scoter	Medium	Local	Medium	Short-term y	Negligible/neutral/no impact
Velvet Scoter	Low	Local	Medium	Short-term	Negligible/neutral/no impact
Auks	Low	Local	Low	Short-term y	Negligible/neutral/no impact
Gulls	Negligible	Not rated	Not rated	Not rated	Negligible/neutral/no impact
NOTE	**Artificial reef effects (rock-dumping on subsea cables are further artificial reefs besides fundaments and scour protection)** may positively affect the habitat use of benthivorous (higher benthos diversity and biomass on scour protection, settling of new species as food for seaducks) and piscivorous species (new species dependent on reef structures, reduced fishing activities in and around wind farms)				

Parame-ter; Species	Degree of disturbance *	Importance	Likelihood of occurrence	Persis-tence	Magnitude of impact
Displace-place-ment					
Divers	Medium	Nation-al/regional	Medium	Short term	Minor
Northern Gannet	Low	Not im-portant	Medium	Short term	Negligi-ble/neutral/no impact
Common Scoter	Medium	Local	Medium	Short term	Negligi-ble/neutral/no impact
Velvet Scoter	Low	Local	Medium	Short term	Negligi-ble/neutral/no impact
Auks	Low	Local	Low	Short term	Negligi-ble/neutral/no impact
Gulls	Negligible	Not rated	Not rated	Not rated	Negligi-ble/neutral/no impact

*If Degree of disturbance is Negligible further criteria are not rated as Magnitude of impact is always Negligible

10 CUMULATIVE IMPACT ASSESSMENT

When several wind farm projects are present in the same environment at the same time there is the potential for cumulative effects to arise. Possible cumulative effects will be addressed in the following sections.

10.1 Projects considered for cumulative impacts

For resting birds there are no relevant existing offshore wind farms in the direct vicinity of the planned Vesterhav Syd offshore wind farm. The wind farms in the Horns Rev zone are located about 30 km south of Vesterhav Syd. Wind farms Horns Rev 1 and Horns Rev 2 are located further south than Horns Rev 3. Horns Rev 1 has been operational since 2002. Common Scoter have displayed some habituation to these wind farms whereas avoidance behaviour is still observed in diver species (Petersen et al. 2006a). However, studies at British wind farms (in operation for a longer period) have found that avoidance is not complete and indications of habituation were found also in divers (Percival 2009, 2013). Therefore, the two existing wind farms Horns Rev 1 and 2 are not considered within this cumulative assessment for displacement because after a longer period of operation greater levels of habituation can be expected. For the cumulative effects of collisions both wind farms Horns Rev1 and Horns Rev 2 are considered as habituation cannot be applied and collisions can be expected. Both wind farms are located in rather close distance to the Vesterhav Syd project justifying an inclusion in the cumulative assessment. Horns Rev 3 is not yet built and the effects of this wind farm will most probably overlap in time with the wind farm Vesterhav Syd. Accordingly, a cumulative effect is considered.

For the assessment of cumulative effects on resting birds the following wind farms are considered (see Figure 63 for locations).

- Vesterhav Nord is located about 42 km North of Vesterhav Syd and is planned to be built at the same time as Vesterhav Syd. The size of the wind farm and location with respect to coastline is similar to Vesterhav Syd project. The exact wind farm layout and the number and size of turbines is not yet determined.

- Nissum Bredning / Fjordgrundene Havmøller: planned wind farm south east of Thyborøn inland in the Nissum Bredning fjord about 7 km east of Vesterhav Nord. It is planned with 14 turbines (6 MW) in two rows. The turbines are not yet built and currently no time scale is available.

- Horns Rev 1 is located about 60 km south of the planned wind farm Vesterhav Syd and about 14-20 km south west of Blåvands Huk. The wind farm was completed in late 2002. It has a capacity of 160 MW and is composed of 80 turbines erected in a grid pattern of 10 rows oriented north-south (21 km²).

- Horns Rev 2 is located about 50 km south west of the planned wind farm Vesterhav Syd south of Horns Rev 3. The wind farm was built from May 2008 to September 2009. It has a capacity of 209 MW and consists of 91 turbines covering an area of 33 km².

- Horns Rev 3 is located about 40 km south west of Vesterhav Syd north-west of the westenmost point of Denmark, Blåvands Huk and is planned to be built in the near future. It will have a capacity of 400 MW over an area of 145 km². Size and number of turbines is not yet determined with range between 40 turbines (10 MW) and 136 turbines (3 MW).

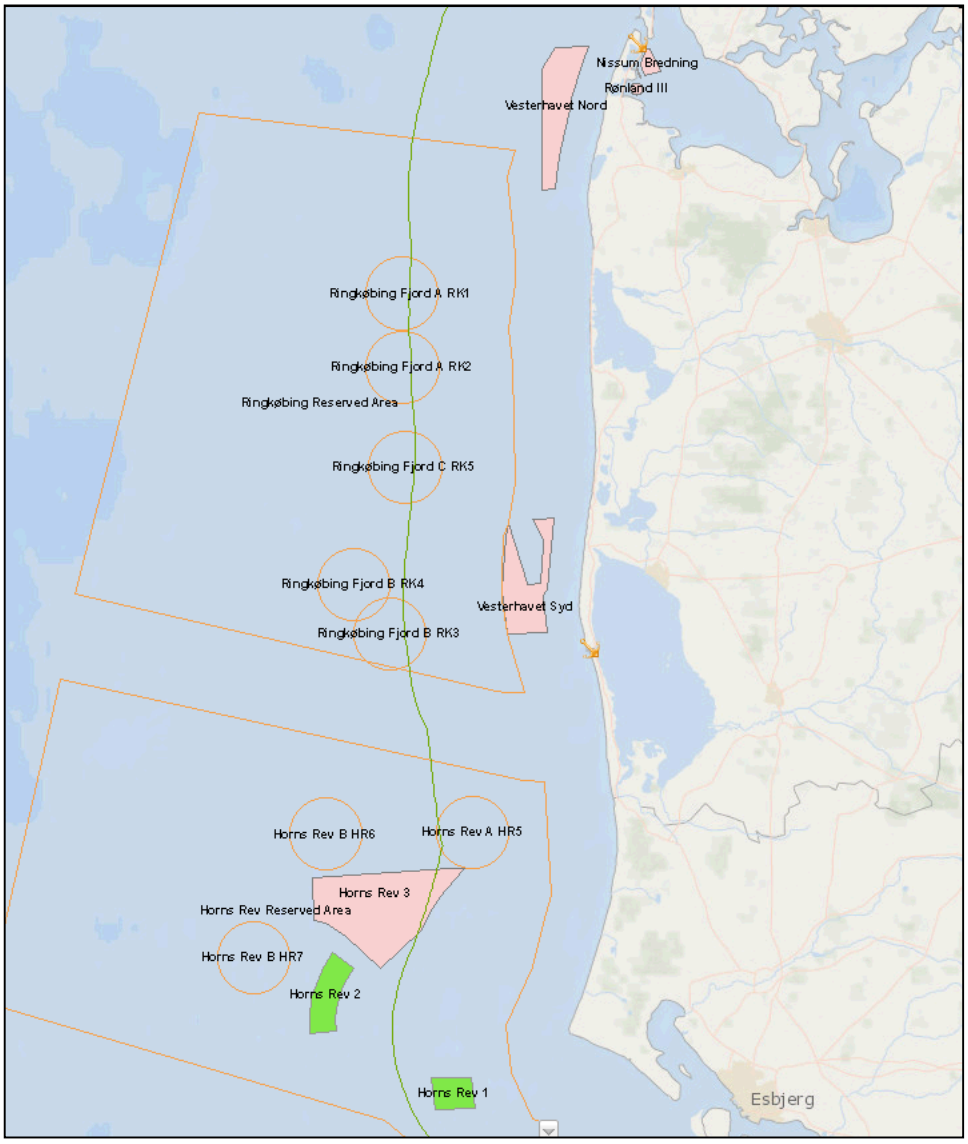


Figure 63: Wind farms considered for cumulative effects: Horns Rev 1, Horns Rev 2, Horns Rev 3, Vesterhav Syd, Vesterhav Syd and Nissum Bredning (source: http://www.4coffshore.com/offshorewind/)

10.2 Cumulative impact assessment

Cumulative impacts are assessed for those species in which at least a minor effect was predicted. As there is no timetable available regarding the installation and decommissioning of all wind farms considered the cumulative assessment will be restricted to the period of operation.

In divers and Common Scoter moderate impacts are assessed for the period of operation for both habitat loss / change and disturbance (in divers minor effects also during installation and decommissioning). Minor effects are predicted for displacement and habitat change in auks and Velvet Scoter during operation. For collisions minor impacts are predicted in Common Gulls, Herring Gulls and Lesser Black-backed Gulls. For these species a cumulative impact assessment is performed. As divers, Common Scoter, Velvet Scoter and auks are regarded to be sensitive against disturbance the effect of habitat loss / habitat change is superposed by the effect of disturbance: a bird that is disturbed from an area also loses this habitat for feeding. Therefore, the assessment of cumulative effect is performed on displacement only in these species (as it also covers habitat loss in these species).

10.2.1 Divers

The cumulative impact assessment in Horns Rev 3 project include Horns Rev 1 and Horns Rev 2 wind farms and also the wind farm projects Vesterhav Syd and Vesterhav Nord. Based on the impact assessment for Horns Rev 3 no significant cumulative impacts on divers are predicted (HR3: Orbicon 2014a). In Horns Rev 3 wind farm it is assessed that up to 165 divers would be displaced. In contrast to Vesterhav Nord (2 km buffer zone and 100% displacement as a worst case following a precautionary principle) the calculations in Horns Rev 3 project are based on a buffer zone of 500 m and a displacement rate of 85%. For Vesterhav Syd offshore wind farm it is predicted that 186 divers will be displaced (as a worst case assumption: population in spring, 2 km displacement for all birds) corresponding to 0.052% of the biogeographical population. In Vesterhav Nord the highest number of divers present within the 2 km impact zone was 136 individuals on 25th November 2013 (NIRAS 2015c). Summing up the predicted number of displaced divers of all projects considered approximately 0.18% of Red-throated Diver population would be affected by displacement (rating **Medium** for the degree of disturbance according to Table 25). It is considered that displacement of birds does not directly result in mortality, but in a redistribution of bird populations. If a deterioration in feeding conditions is associated with this redistribution, increased mortality or reduced reproduction could be a potential consequence. However, in contrast to benthivorous species, divers are not bound to

particular areas with suitable water depths but rely more on dynamic processes like water fronts (Skov & Prins 2001). Therefore, it can be assumed that the displacement will have no significant effects in terms of reduction in diver population. Divers are not supposed to fly inland during the resting period and the wind farm Nissum Bredning is therefore not considered in divers.

Topping and Petersen (2011) assessed the cumulative impacts on the Red-throated Diver on the population level using a modelling approach. For different levels of wind farm developments they predicted only small impacts on the overall population. A decrease in flyway population by 0.1% is predicted in scenario 2 covering the wind farms shown in Figure 64 which is below the level of relevance on population level.

Figure 64: Considered wind farms in scenario 2 for modeling approach of cumulative impacts on Red-throated Diver according to Topping and Petersen (2011)

Poot et. al. (2011) calculated cumulative effects of Dutch wind farms based on the level of Potential Biological Removal. Considering 11 offshore wind farms across the Dutch North Sea (up to 20 km distance from shoreline) they predict 9.2 colliding divers and rate the cumulative effects as “highly unlikely”.

Referring the importance status an International important would be reached in a species with a very high conservation status, if 0.5% of the biogeographical pop-

ulation would be within the area large scale area of the wind farm (here: study areas). Referred to the Red-throated Diver with a 1% value of population of 2,600 individuals, Table 28) 1,300 individuals would exceed the limit to international importance. The sum of estimates of all three areas (Vesterhav Nord: 691; Vesterhav Syd: 959 individual, Horns Rev 3: >3.000 in spring) would justify an **International** status. The parameter "Likelihood of occurrence" is assessed to be **Medium** due to the expected habituation of divers to wind farms. With a **Permanent** persistence of the impact the magnitude of impact on a cumulative basis is the same as described for Vesterhav Syd project (see Section 8.4): **Moderate** (Table 59).

Table 59: Cumulative impact assessment on divers

Degree of disturbance	Importance	Likelihood of occurrence	Persis-tence	Magnitude of impact
Medium	International	Medium	Perma-nent	Moderate

10.2.2 *Common Scoter*

In the Vesterhav Nord project no Common Scoter were found within the development area and this project has therefore not to be considered in a cumulative assessment.

In the impact assessment of the Horns Rev 3 project 2,808 Common Scoter are predicted to be within the impact zone of 500 m. It is anticipated that only 50% will be displaced (1,404 individuals) corresponding to 0.26 % of the reference population (HR3: Orbicon 2014a). The severity of impact is rated as Medium in the Horns Rev 3 study. In the Vesterhav Syd study a different assessment system is used. Further, in the Vesterhav Syd study different assumptions are made and a more precautionary treatment of assessment is used. Therefore, the assessments of both studies are not directly comparable. Using a buffer zone of 500 m (334 birds displaced, see Table 38) and a displacement rate of 50% 167 birds would be displaced in the Vesterhav Syd study. This would be 0.03% of the reference population and a further 12% of affected birds added to the calculated value of 0.26% in the Horns Rev 3 study. This would only mean a relatively low increase in affected bird numbers if rating would follow the assumptions used in the Horns Rev study.

Following the assessment method of this study the cumulative value of 0.38% of the reference population would be affected (0.26% Horns Rev 2; 0.12% Vesterhav Syd). The birds within the impact zone in relation to the biogeographical population (Table 25) is rated as medium leading to a **Medium** degree of dis-

turbance in sensitive species such as the Common Scoter. After including the Common Scoters from the Horns Rev 3 area the importance will increase from Local to **National/regional** (combination of a very high abundance and a low conservation status, see Table 29). The likelihood of occurrence is rated as **Medium** due to expected habituation and the persistence is **Permanent**. According to the assessment Table 81 on a medium degree of disturbance the Magnitude of impact is rated as **Moderate** in a cumulative assessment (Table 60).

Table 60: Cumulative impact assessment on Common Scoter

Degree of disturbance	Importance	Likelihood of occurrence	Persistence	Magnitude of impact
Medium	National / regional	Medium	Permanent	Moderate

10.2.3 Velvet Scoter

In the Vesterhav Nord project no Velvet Scoter were found within the development area and this project has therefore not to be considered in a cumulative assessment. The Nissum Bredning offshore wind farm is on the coastline east of Vesterhav Nord and Velvet Scoter are not anticipated to interact with this wind farm.

In the Horns Rev 3 area Velvet Scoter are concentrated in the very southern part of the study area and the impact zone around the wind farm is only rarely used by Velvet Scoter (HR3: Orbicon 2014a). The severity of impact is assessed as low and it is only stated that ”low number” of Velvet Scoter are likely to be displaced (without giving exact figures). In the Vesterhav Syd study area a maximum of 66 Velvet Scoter were recorded within the impact zone representing 0.013% of the reference population. In a cumulative assessment only a low number of birds have to be added to those found in Vesterhav Syd (nearly no Velvet Scoter in Vesterhav Nord). Therefore, the degree of disturbance where the number of affected birds contributes to the assessment is still rated as **Low** (highly sensitive and low number of birds affected). The Horn Rev 3 area holds 0.39% of Velvet Scoter population during the spring season and the Vesterhav Syd area at maximum 0.026%. With a high conservation status the importance is assessed to be **National/regional** (see Table 29). The likelihood of occurrence is assessed to be **Medium** for the cumulative population of Horns Rev 3, Vesterhav Nord and Vesterhav Syd. A behavioural pattern similar to the Common Scoter is expected with possible habituation to the wind farm. The persistence is **Permanent**.

In a cumulative assessment the Magnitude of impact is rated as **Minor** (Table 61).

Table 61: Cumulative impact assessment on Velvet Scoter

Degree of disturbance	Importance	Likelihood of occurrence	Persis-tence	Magnitude of impact
Low	National/regional	Medium	Perma-nent	Minor

10.2.4 *Common Gull*

For the Common Gull a minor impact of collisions is predicted and therefore, the possible impacts on a cumulative basis are regarded.

In the wind farms Horns Rev 1 and Horns Rev 2 collision risks of Small Gulls are estimated to be 18 collisions at Horns Rev 1 and 10 collisions at Horns Rev 2 (Skov et al. 2012) for the period from November to April. This group consists of Common Gulls, Black-headed Gulls and Little gulls. The dominances of Common Gulls and Black-headed Gulls were similar (low numbers of Little Gulls; Skov et al. 2012) but on a precautionary basis all collisions are allocated to the Common Gull. For the Horns Rev 3 wind farm the collision risk for Common Gull is rated “High” and collisions of 18 individuals are predicted (98% avoidance rate for the period of January to September; HR3: Orbicon 2014b). For the Vesterhav Nord project a yearly value of 98 collisions are calculated (NIRAS 2015c).

In summary of Vesterhav Syd (208 collisions per year), Vesterhav Nord (98 collisions per year), Horns Rev 1 (18 collisions; November - April), Horns Rev 2 (10 collisions, November - April) and Horns Rev 3 (18 collisions, January - September), a total 352 yearly collisions would be expected corresponding to 0.021% of the biogeographical population. In both Vesterhav Nord and Vesterhav Syd projects approximately 20 % of gulls were not identified to species level. Therefore, these collision values have to be regarded as minimum values. An unknown number of collisions have to be added due to collisions with the Nissum Bredning wind farm. For the period from 1990 to 2002 the overall European trend is classified as “unknown” according to BirdLife International (2004) with decreasing populations in Sweden, Norway and the UK and increasing populations in Finland and Germany (constant in Denmark). More recent calculations confirm an ongoing decrease of Common Gull populations in UK (JNCC 2014) with decreasing rates of 44% from 1998 to 2011 (based on a breeding bird survey of the RSPB). The overall trend in the International Wadden Sea is stable (period 1998/99 to 2009/2010) with a decreasing trend in Denmark (JMMB 2011). Therefore, it is reasonable to regard the population trend as decreasing (at least on a precautionary basis) and take a removal factor (rf) of 0.1 for the assessment of the PBR population (see Section 6.2.5). In this case a removal of 0.9% of the population would cause an unacceptable additional mortality with negative effects on the population. Even if an unknown number of collisions in the Nissum

Bredning wind farm and further collisions of Common Gulls resulting from “unidentified gulls” and from limited seasonal coverage are added to the 0.021% the cumulative collision rate is most probably within the limits of a Minor impact (≥0.01% and < 0.1% of biogeographic population, Section 6.2.5). A Moderate impact would arise if 1,300 collisions would occur in addition to the predicted 352 collisions which seem to be very unlikely. Poot et al.(2011) estimate cumulative effects on the Dutch Common Gull populations due to multiple wind farms (11 offshore wind farms across the Dutch North Sea) as “highly unlikely”.

Due to these explanations the magnitude of impact of collisions on the Common Gulls is assessed to be **Minor** also on a cumulative basis.

10.2.5 Lesser Black-backed Gull

For Lesser Black-backed Gulls a minor impact of collisions is predicted and therefore, the possible impacts on a cumulative basis are regarded.

For the Horns Rev 3 wind farm the collision risk for Lesser Black-backed Gulls is rated to be “very high” and collisions of 115 individuals are predicted (January to September). For Horns Rev 1 and Horns Rev 2 collision numbers are calculated for the group of Large Gulls for the wintering period (November to April): 378 individuals in Horns Rev 1 and 360 individuals in Horns Rev 2 (Skov et al. 2012). The higher values in Horns Rev 1 and Horns Rev 2 compared to Horns Rev 3 are attributed to the fact that bird densities were higher and also to the higher proportion of birds flying at rotor height. Collision risks are not distinguished between Herring Gull, Lesser Black-backed Gull and Great Black-backed Gull who contribute to the group of Large Gulls. However, according to monitoring data it can be concluded that the Lesser Black-backed Gull contributes to a very little part to the Large Gulls. This is true for the wintering period but also during spring and autumn seasons, e.g. visual observations at three observation sites at the Horns Rev area from autumn 2010 to spring 2012 showed a total of 11,731 Herring Gulls, but only 621 Lesser Black-backed Gulls (Appendix 2 in Skov et al. 2012). Approximately 5% (or less) of Large Gulls can be attributed to the Lesser Black-backed Gull (Christensen et al. 2003, Skov et al. 2012, Petersen et al. 2014a). If 5% of the collisions of Large Gulls in Horns Rev 1 and Horns Rev 2 would be Lesser Black-backed Gulls 19 collisions in Horns Rev 1 and 18 in Horns Rev 2 would be expected. For the Vesterhav Nord project a yearly value of 4.6 collisions are calculated (NIRAS 2015c).

In summary of Vesterhav Syd (14.4 collisions per year), Vesterhav Nord (4.6 collisions per year), Horns Rev 3 (115 collisions, January - September), Horns Rev 1 (19 collisions, November - April) and Horns Rev 2 (18 collisions, November - April), a total of 171 collisions would be expected making up 0.045% of the biogeographical population. In both Vesterhav Nord and Vesterhav Syd projects approximately 20 % of gulls were not identified to species level. Therefore, these

collision values have to be regarded as minimum values, also because of the incomplete coverage of the season. Further, an unknown number of collisions have to be added due to collisions with the wind farm Nissum Bredning. For the period of from 1990 to 2002 the overall European trend is classified as “large increase” according to BirdLife International (2004) with increasing populations in Norway, Denmark, Germany and UK, but decreasing trends in Sweden and Finland. However, more recent calculations show a strong decrease in UK in the period from 2000 to 2013 of 48% (JNCC 2014). Therefore, it is reasonable to regard the population trend as decreasing (at least on a precautionary basis) and take a removal factor (rf) of 0.1 for the assessment of the PBR population (see Section 6.2.5). In this case a removal of 0.7% of the population would cause an unacceptable additional mortality with negative effects on the population. Considering the calculated proportion of colliding birds of 0.045% of the biogeographical population, an additional collision risk of 210 individuals would break the threshold for a Moderate impact (collision of ≥0.1% of the reference population corresponding to 381 colliding individuals, see Section 6.2.5). Even considering the uncertainties listed above (Nissum Bredning, temporal coverage of surveys, contribution to “unidentified gulls” in Vesterhav projects and to “Large Gulls” in Horns Rev 1 and 2) it seems very unlikely that the threshold to a moderate impact will be reached.

Poot et al.(2011) estimate cumulative effects on the Dutch Lesser Black-backed Gull populations due to multiple wind farms (11 offshore wind farms across the Dutch North Sea) as “highly unlikely”.

Therefore, the magnitude of impact is still rated as **Minor**.

10.2.6 Herring Gull

For the Herring Gull a minor impact of collisions is predicted and therefore, the possible impacts on a cumulative basis are regarded.

For the Horns Rev 3 wind farm the collision risk for Herring Gull is rated as “Very High” and collisions of 148 individuals for the period of January to September are predicted (98% avoidance rate; HR3: Orbicon 2014b). In the Horns Rev 1 and Horns Rev 2 wind farms a total of 378 and 360 collisions of Large Gulls are predicted, respectively (Skov et al. 2012). It has to be reminded that the avoidance rate has a very strong influence on the calculated number of collisions (Chamberlain et al. 2006). Skov et al. (2012) regard the application of 98% avoidance rate in Horns Rev 1 and 2 wind farms as a pessimistic scenario and with an application of 99.5% avoidance rate (assumed to be an optimistic scenario) the numbers of collisions would be 95 (Horns Rev 1) and 90 individuals (Horns Rev 2). As outlined in Section 10.2.5 on the Lesser Black-backed Gull most large gulls in these studies are assumed to be Herring Gulls (roughly 90% Herring Gulls, 5% Lesser Black-backed Gulls, 5% Great Black-backed Gull, with some

variation between the studies; less Herring Gulls when migration periods are included). If the species contribute to collisions according to their proportions in the local population (assuming similar variables related to collision risk: bird size, flight behaviour, nocturnal activity, proportions at rotor height according to Appendix 16.2) approximately 340 collisions at Horns Rev 1 and 324 collisions at Horns Rev 2 are predicted for the wintering period (90% of the Large Gull figures, avoidance rate 98%).

For the Vesterhav Nord project a yearly value of 44 collisions are calculated (NIRAS 2015c).

In summary of Vesterhav Syd (156 collisions per year), Vesterhav Nord (44 collisions per year), Horns Rev 1 (340 collisions, November - April), Horns Rev 2 (324 collisions, November - April) and Horns Rev 3 (148 collisions, January - September), 1,012 collisions would be expected corresponding to 0.05% of the biogeographical population. In both Vesterhav Nord and Vesterhav Syd projects approximately 20 % of gulls were not identified to species level. Therefore, these collision values have to be regarded as minimum values. An unknown number of collisions have to be added due to collisions with the Nissum Bredning wind farm.

For the period from 1990 to 2002 the overall European trend is classified to show a “moderate increase” according to BirdLife International (2004) with increasing populations in Scandinavia, Denmark and Germany (decreasing in the UK). More recent calculations confirm an ongoing decrease of Herring Gull populations in UK (JNCC 2014) with decreasing rates of 30% from 2000 to 2013 (based on a breeding bird survey of the RSPB). The overall trend in the International Wadden Sea is characterised by a moderate decrease (period 1998/99 to 2009/2010) with a stable population in Denmark (JMMB 2011). Regarding the population trend as decreasing (at least on a precautionary basis) a removal factor (rf) of 0.1 for the assessment of the PBR population is considered (see Section 6.2.5). In this case a removal of 0.4% of the population would cause an unacceptable additional mortality with negative effects on the population. Even if an unknown number of collisions are added to the 0.05% due to uncertainties in the determination of the exact collision numbers (Nissum Bredning, temporal coverage of surveys, contribution to “unidentified gulls” in Vesterhav projects and to “Large Gulls” in Horns Rev 1 and 2) the cumulative collision risk is unlikely to reach a level of a Moderate impact. The threshold to a Moderate impact of 0.1% of the biogeographical population would be reached if further 925 Herring Gulls would collide which seems to be very unlikely. Poot et al.(2011) estimate cumulative effects on the Dutch Herring Gull population due to multiple wind farms (11 offshore wind farms across the Dutch North Sea) as “highly unlikely”.

Due to these explanations the magnitude of impact of collisions on the Herring Gulls is assessed to be **Minor** also on a cumulative basis.

10.2.7 *Auks*

The Nissum Bredning offshore wind farm is on the coastline east near the Limfjord and auks are not anticipated to interact with this wind farm.

In the Vesterhav Nord offshore wind farm auks were found in the northern part of the development area and a total of 15 auks are predicted to be affected by displacement (NIRAS 2015c).

In the Horns Rev 3 area the winter population of auks is estimated to be around 1,500 individuals (HR3: Orbicon 2014a) with birds also using the wind farm area. A total of 53 Common Guillemots/Razorbills assumed to be displaced by the wind farm in operation representing 0.01% of the reference population. In the present study on Vesterhav Syd 28 indiviudals are supposed to be displaced from the wind farm area. Cumulatively taken into account the three wind farms, 96 Common Guillemots/Razorbills will be affected by displacement (0.019% of refrence population of the Razorbill). With a medium sensitivity and a still low number of affected birds the degree of disturbance is still rated as **Low.**

The Horn Rev 3 area holds a wintering population of 1,495 auks (HR3: Orbicon 2014a) and at Vesterhav Nord a maximum of 225 auks were found in March 2014 (NIRAS 2015c). Together with the maximum number of 771 auks in the Vesterhav Syd area, a total of 2,491 auks are within the cumulative area regarded. This number refers to 0.49 % of the biogeographical population (referred to Razorbills) and is rated as Medium. In combination with a low conservation status the importance is rated as **Local** for cumulative assessment.

In both Vesterhav Syd and Vesterhav Nord projects auks were concentrated in the western part of the study areas and relatively low number of local birds used the development area. In the Horns Rev study area auks used the wind farm area but a concentration of birds compared to other parts of the study area was not obvious. Therefore, the Likelihood of occurrence is rated as **Low**.

The persistence of project pressures is **Permanent** for wind farms in operation as operation period is supposed to be longer than five years.

In a cumulative assessment the Magnitude of Impact is rated as **Minor** (Table 62).

Table 62: Cumulative impact assessment on auks

Degree of disturbance	Importance	Likelihood of occurrence	Persis-tence	Magnitude of impact
Low	Local	Low	Perma-nent	Minor

11 CROSS-BORDER EFFECTS

The Espoo Convention on Environmental Impact Assessment in a Transboundary Context and EU Directive 85/337/EEC aims to identify effects on a transboundary scale in order to prevent, mitigate and monitor environmental damage.

The Vesterhav Syd development area is located completely in Danish waters. The EEZ border to Germany is about 60 km apart in southern direction, the Norwegian EEZ border is approximately 170 km apart in north western direction.

According to the location of the Vesterhav Syd wind farm cross-border effects for resting and staging birds are not expected.

12 MITIGATION MEASURES

If a potential impact is assessed as moderate negative, it is deemed necessary to consider mitigation measures. If impacts are evaluated as major, mitigation measures are deemed to be mandatory.

Impacts are assessed to be of moderate level for divers and Common Scoters during operation. In these species, mitigation measures have to be considered.

Mitigation measures in relation to the period of operation can only act via the spatial design of the wind farm. The moderate impact in Common Scoter is mainly caused by birds concentrating in the north eastern part of the development area. Excluding this area from wind farm layout would most probably reduce the moderate impact. Generally, minimizing the area covered by wind turbines e.g. by using fewer turbines (with higher power) could be a measure to reduce the impact.

13 POTENTIAL INSUFFICIENT KNOWLEDGE

The data base used for this assessment is regarded as sufficient. The lack of surveys in December and January due to adverse weather conditions has proved to cause no critical gaps in the estimation of wintering birds as no species peaks in this time and winter situation is covered by other surveys. In some species the data base could have been improved by covering the missing months, but this lack of information is not regarded as critical.

The key species in resting birds are divers, Common Scoter and auks. These species use the area for resting during the winter months until spring. The total period of presence was covered with aerial surveys and a reliable estimate of their abundance and distribution was possible. In other species (Northern Gannet and gulls) the presented values on abundance and collisions have to be re-

garded as minimum values as peak occurrence are supposed to be in months not covered by surveys.

14 CONCLUSION OF THE TOTAL IMPACT

In Table 63 all impacts predicted for the Vesterhav Syd offshore wind farm on resting birds are summarised that are of at least of minor magnitude.
The highest impact was assessed as **Moderate** for displacement and habitat loss / habitat change for divers and Common Scoter during the period of operation. This is mainly due to the high sensitivity of these species and the number of expected birds being affected. During operation, displacement and habitat loss are supposed to cause **Minor** impacts in Velvet Scoter and auks. During the periods of installation and decommissioning **Minor** impacts are predicted for divers due to displacement and habitat loss. Collision is assessed to cause **Minor** impact in Common Gulls, Herring Gulls and Lesser Black-backed Gulls during the period of operation. For all other resting species the impact of all pressures is regarded as **Negligible**.
The determined magnitudes of impact did not change when impacts of displacement are assessed cumulatively for the wind farms Vesterhav Syd, Vesterhav Nord, Nissum Bredning and Horns Rev 3 (and also including Horns Rev 1 and 2 for collisions).

Table 63: Summary of impact of Vesterhav Syd offshore wind farm of at least minor magnitude for all periods, pressures and species

Phase	Pressure	Species	Magnitude of impact
Installation	Habitat loss / change	Divers	Minor
	Displacement	Divers	Minor
Operation	Habitat loss / change	Divers	Moderate
		Common Scoter	Moderate
		Velvet Scoter	Minor
		Auks	Minor
	Displacement	Divers	Moderate
		Common Scoter	Moderate
		Velvet Scoter	Minor
		Auks	Minor
	Collision	Common Gull	Minor
		Herring Gull	Minor
		Lesser Black-backed Gull	Minor
Decommissioning	Habitat loss / change	Divers	Minor
	Displacement	Divers	Minor

The used assessment method considers important parameter for the assessment of impacts including the number of birds affected, the importance of the

area for the species, the likelihood that an effect occurs and the temporal persistence of the impact. The judgment follows data recorded during standardised surveys and procedures for analyses and the assessment is further modified by expert judgment. Therefore, there is a high confidence that the assessed impacts reflect a realistic situation when worst case assumptions are considered.

Using worst case assumptions in wind farm layout and selection of data follows a principle of precaution and is regarded to be necessary to consider all possible effects. Apart from this principle there are further interpretations of the data that may result in effects of lower magnitude. One of these assumption is a selection of one day of highest number of birds in the study area and in the development area. In divers, this selection leads to a moderate impact. As the distribution of divers showed high variation between surveys, periods with lower number of affected birds would be common (Figure 14, Table 12) and the rating of the impact assessment of the Vesterhav Syd offshore wind farm would most likely be lower using a data selection different from worst case. But even then, moderate cumulative effects would most probably persist due to the high number of divers in the Horns Rev area (cumulative rating as International importance). The densities of wintering divers were comparable to areas further south (e.g. in the Horns Rev 3 area where impact is rated as low; HR3: Orbicon 2014a) and the calculated number of displaced birds (0.071% of biogeographical population) was at a low level within the range of a Medium rating of affected birds (Medium: 0.05 to 0.5% of population) leading to a Moderate impact.

For Common Scoter the Moderate impacts during operation are nearly exclusively caused by birds found in the shallow waters in the north eastern part of the development area (Common Scoter: Figure 24, Figure 25). Excluding this part from analyses (e.g. if a wind farm layout without this area would be chosen) would substantially reduce the number of affected birds and the impact would most probably be lower.

It has to be noted that different approaches for impact assessments may be used in different studies and therefore, the comparability of impact assessments across studies may be limited. Besides the assessment methods also impact areas (species-specific buffer zones around the source of impact) and the level of impact (e.g. displacement affects 100% of birds or less) may differ between studies. For example, referring the latter issue (level of impact) habituation may be considered in the calculation of birds affected or in the rating of the likelihood of occurrence of an impact (as done in the present study).

15 REFERENCES

ALERSTAM, T., ROSÉN, M., BÄCKMAN, J., ERICSON, P. G. . & HELLGREN, O. 2007. Flight speeds among bird species: allometric and phylogenetic effects. *PLoS Biology* 5:1656–1662.

AUMÜLLER, R., BOOS, K., FREIENSTEIN, S., HILL, K. & HILL, R. 2013. Weichen Zugvögel Windenergieanlagen auf See aus? Eine Methode zur Untersuchung und Analyse von Reaktionen tagsüber ziehender Vogelarten auf Offshore-Windparks. *Vogelwarte* 51.

BAND, W. 2012. Using a collision risk model to assess bird collision risk for offshore windfarms. SOSS, The Crown Estate. UK.

BAND, W., MADDERS, M. & WHITFIELD, D. P. 2007. Developing field and analytical methods to assess avian collision risk at wind farms. Pp. 259–275 *Birds and wind farms: risk assessment and mitigation*. Quercus, Madrid.

BELLEBAUM, J., DIEDERICHS, A., KUBE, J., SCHULZ, A. & NEHLS, G. 2006. Flucht- und Meidedistanzen überwinternder Seetaucher und Meeresenten gegenüber Schiffen auf See. *Orn. Rundbrief Mecklenburg-Vorpommern* 45, Sonderheft 1 (Tagungsband 5. deutsches See- und Küstenvogelkolloquium):86–90.

BIRDLIFE INTERNATIONAL. 2004. Birds in Europe: population estimates, trends and conservation status. (I. Burfield and F. van Bommel, Eds.). Cambridge. 374 pp.

BIRDLIFE INTERNATIONAL. 2014. Species factsheet: Morus bassana. Download from http:\\www.birdlife.org on 19/06/2014.

BRUDERER, B. & BOLDT, A. 2008. Flight characteristics of birds: I. Radar measurements of speeds. *Ibis* 143:178–204.

BSH. 2007. Standard: Untersuchung der Auswirkungen von Offshore-Windenergieanlagen auf die Meeresumwelt (StUK3). P. 58. Bundesamt für Seeschifffahrt und Hydrographie, Hamburg, Rostock.

BUCKLAND, S. T., ANDERSON, D. R., BURNHAM, K. P. & LAAKE, J. L. 1993. Distance Sampling. Estimating Abundance of Biological Populations. Chapman and Hall, London, UK.

BUCKLAND, S. T., ANDERSON, D. R., BURNHAM, K. P., LAAKE, J. L., BORCHERS, D. L. & THOMAS, L. 2001. Introduction to Distance Sampling: estimating abundance of biological populations. Oxford University Press, Oxford. 448 pp.

BUCKLAND, S. T., BURT, M. L., REXSTAD, E. A., MELLOR, M., WILLIAMS, A. E. & WOODWARD, R. 2012. Aerial surveys of seabirds: the advent of digital methods. *Journal of Applied Ecology* 49:960–967.

CAMPHUYSEN, C. J., BERREVOETS, C. M., CREMERS, H. J. W. M., DEKINGA, A., DEKKER, R., ENS, B. J., HAVE, T. M. VAN DER, KATS, R. K. H., KUIKEN, T., LEOPOLD, M. F., MEER, J. VAN DER & T. PIERSMA. 2002. Mass mortality of common eiders (Somateria mollissima) in the Dutch Wadden Sea, winter 1999/2000: starvation in a commercially exploited wetland of international importance. *Biological Conservation*:303–317.

CAMPHUYSEN, K., FOX, T., LEOPOLD, M. F. & PETERSEN, I. K. 2004. Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the U.K. P. 39. Royal NIOZ & National Environmental Research Institute, Den Burg, Copenhagen.

CHAMBERLAIN, D. E., REHFISCH, M. R., FOX, A. D., DESHOLM, M. & ANTHONY, S. J. 2006. The effect of avoidance rates on bird mortality

predictions made by wind turbine collision risk models. *Ibis* 148:198–202.
CHRISTENSEN, T. J., KJÆR, T., PETERSEN, I. K. & FOX, A. D. 2006. Effects on birds of the Horns Rev 2 offshore wind farm: Environmental Impact Assessment. P. 82. National Environmental Research Institute Ministry of the Environment . Denmark, Denmark.
CHRISTENSEN, T. K., CLAUSAGER, I. & PETERSEN, I. K. 2003. Base-line investigations of birds in relation to an offshore wind farm at Horns Rev and results from the year of construction. NERI im Auftrag von Techwise A/S.
CHRISTENSEN, T. K., HOUNISEN, J. P., CLAUSAGER, I. & PETERSEN, I. K. 2004. Visual and radar observations of birds in relation to collision risk at he Horns Rev offshore wind farm. Annual status report 2003. National Environmental Research Institute, Ministry of the Environment, .
COOK, A. S. C. P., JOHNSTON, A., WRIGHT, L. J. & BURTON, N. H. K. 2012. A review of flight heights and avoidance rates of birds in relation to offshore wind farms. P. 59. Strategic Ornithological Support Services Project SOSS-02, British Trust for Ornithology, Norfolk.
COWI A/S. 2014. VESTERHAV SYD OFFSHORE WIND FARM: SEDIMENTS, WATER QUALITY AND HYDROGRAPHY BACKGROUND REPORT FOR EIA-STUDY. Commissioned by ENERGINET.DK, .
CRAMP, S. & PERRINS, C. M. in serie. Handbook of the birds of the Western Palearctic. Oxford University Press, Oxford.
DET NORSKE VERITAS. 2015. Technical Report. Navigational Risk Assessment. Vesterhav Syd Offshore Wind Farm. Report No/DNV Reg No: PD-644204-18PYFR2-5.
DIEDERICHS, A., NEHLS, G. & PETERSEN, I. K. 2002. Flugzeugzählungen zur großflächigen Erfassung von Seevögeln und marinen Säugern als Grundlage für Umweltverträglichkeitsstudien im Offshorebereich. *Seevögel* 23:38–46.
DIERSCHKE, V., EXO, K.-M., MENDEL, B. & GARTHE, S. 2012. Gefährdung von Sterntaucher (Gavia stellata) und Prachttaucher (G. arctica) in Brut-, Zug- und Überwinterungsgebieten - eine Übersicht mit Schwerpunkt auf den deutschen Meeresgebieten. *Die Vogelwelt* 133:163–194.
DILLINGHAM, P. W. & FLETCHER, D. 2008. Estimating the ability of birds to sustain additional human-caused mortalities using a simple decision rule and allometric relationship. *Biological Conservation* 141:1739–1792.
DIRKSEN, S., SPAANS, A., WINDEN, J. VAN DER & BERG, M. J. VAN DEN. 1998. Nachtelijke vliegpatronen en vlieghoogtes van duikeenden in het Ijsselmeergebied. *Limosa* 71:57–68.
DMU. 2014. The Danish Red Data Book. Danmarks Miljøundersøgelser, National Environmental Research Institute.
DTU. 2014. Wind farm layout for Vesterhav Syd. P. 22. DTU Wind Energy, Report-I-0198(EN), .
ENERGINET.DK. 2015. Technical Project Description for Offshore Wind Farms (200MW) Offshore Wind Farms at Vesterhav Nord, Vesterhav Syd, Sæby, Sejerø Bugt, Smålandsfarvandet and Bornholm. Appendix 1: Vesterhav Syd Offshore Wind Farm – Technical description, Offshore.
ERIKSSON, M. 2013. Trends in population size and reproduction of Black-throated Diver and Red-throated Diver in Sweden. International Loon and Diver Workshop; VARDØ, Norway.
FOX, A. D. 2003. Diet and habitat use of scoters Melanitta in the Western Palearctic- a brief overview. *Wildfowl* 54:163–182.
FURNESS, R. W., WADE, H. M. & MASDEN, E. A. 2013. Assessing vulnerability of marine bird populations to offshore wind farms. *Journal of Environmental Management* 119:56–66.

GARTHE, S. & HÜPPOP, 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.
GARTHE, S., SONNTAG, N., SCHWEMMER, P. & DIERSCHKE, V. 2007. Estimation of seabird numbers in the German North Sea throughout the annual cycle and their biogeographic importance. *Die Vogelwelt* 128:163–178.
GILL, J. P., SALES, D., PINDER, S. & SALAZAR, R. 2008. Kentish Flats wind farm fifth ornigholoigcal monitoring report. P. 122. Edinburgh.
HANSEN, L. 1954. Birds killed at lights in Denmark 1889-1939. *Vidensk. Medd. Dan. Naturhist. Foren. Kopenhagen* 116:269–368.
HR3: ORBICON. 2014a. Horns Reef 3 Offshore Wind Farm - Resting birds.
HR3: ORBICON. 2014b. Horns Rev 3 Offshore Wind Farm. Migratory birds (with an annex on migrating bats). Technical report nr. 8 for Energinet.dk, .
JACOBS, J. 1974. Quantitative measurement of food selection. *Oecologia* 14:413–417.
JAKOBSEN, B. 2008. Fuglene ved Blåvandshuk 1963-1992. Dansk Ornitologisk Forening og Ribe Amt.
JMMB. 2011. Trends of migratory and wintering waterbirds in the Wadden Sea 1987/1988-2009/2010. Common Wadden Sea Secretariat, Wilhelmshaven, Germany.
JNCC. 2014. Seabird Population Trends and Causes of Change: 1986-2013 Report (http://www.jncc.defra.gov.uk/page-3201). Joint Nature Conservation Committee. Updated August 2014.
JOHNSTON, A., COOK, A. S. C. P., WRIGHT, L. J., HUMPHREYS, E. M. & BURTON, N. H. K. 2014. Modelling flight heights of marine birds to more accurately assess collision risk with offshore wind turbines. *Journal of Applied Ecology* 51:31–41.
KAHLERT, J., PETERSEN, I. K., FOX, A. D., DESHOLM, M. & CLAUSAGER, I. 2004. Investigations of birds during construction and operation of Nysted offshore wind farm at Rødsand. P. 79. Im Auftrag von NERI.
KAISER, M. J., GALANIDI, M., SHOWLER, D. A., ELLIOTT, A. J., CALDOW, R. W. G., REES, E. I. S., STILLMAN, R. A. & SUTHERLAND, W. J. 2006. Distribution and behaviour of Common Scoter Melanitta nigra relative to prey resources and environmental parameters. *Ibis* 148:110–128.
KJÆR, P. A. 2000. Blåvand Fuglestation 1993-1999, en oversigt over observationer. Report from Danish Ornithological Society.
KRIJGSVELD, K. L., FIJN, R. C., JANPINK, M., VAN HORSSEN, P. W., HEUNKS, C., COLLIER, M., POOT, M. J. M., BEUKER, D. & DIRKSEN, S. 2011. Effect studies Offshore Wind Farm Egmond aan Zee. Final report on fluxes, flight altitudes and behaviour of flyig birds. P. 330. Bureau Waardenburg report, Culemborg, The Netherlands.
KRÜGER, T. & GARTHE, S. 2001. Flight altitude of coastal birds in relation to wind direction and speed. *Atlantic Seabirds* 3:203–216.
LAURSEN, K., KAHLERT, J. & FRIKKE, J. 2005. Factors affecting escape distances of staging waterbirds. *Wildlife Biology* 11:13–19.
LEONHARD, S. B. & SKOV, H. 2012. Food Resources for Common Scoter. Horns Reef Monitoring 2009-2010. Report commissioned by The Environmental Group through contract with DONG Energy, Orbicon, DHI, Wageningen IMARES.
LEOPOLD, M. F., DIJKMAN, E. M., TEAL, M. & OWEZ-TEAM. 2011. Local Birds in and around the Offshore Wind Farm Egmond aan Zee (OWEZ) (T-0 & T-1, 2002-2010). P. 176. IMARES - Institute for Marine Resources & Ecosystem Studies, Wageningen.
LEOPOLD, M. L., BEMMELEN, R. S. A. VAN & ZUUR, A. S. 2012. Responses of Local Birds to the Offshore Wind Farms PAWP and OWEZ off the Dutsch mainland coast. IMARES Report number C151/12, .

LINDEBOOM, H. J., KOUWENHOVEN, H. J., BERGMAN, M. J. N., BOUMA, S., BRASSEUR, S., DAAN, R., FIJN, R. C., HAAN, D. DE, DIRKSEN, S., HAL, R. VAN, LAMBERS, R. H. R., HOFSTEDE, R. TER, KRIJGSVELD, K. L., LEOPOLD, M. & SCHEIDAT, M. 2011. Short-term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation. *Environmental Research Letters* 6:13.

MENDEL, B., SONNTAG, N., WAHL, J., SCHWEMMER, P., DRIES, H. & GUSE, N. 2008. Artensteckbriefe von See- und Wasservögeln der deutschen Nord- und Ostsee: Verbreitung, Ökologie und Empfindlichkeiten gegenüber Eingriffen in ihren marinen Lebensraum. Landwirtschaftsverlag. 438 pp.

NATURAL ENGLAND. 2014. Hornsea Project Two Wind Farm pre-application consultation under Section 42 of the Planning Act 2008 (the '2008 Act').

NIRAS. 2013. Guidance document on Environmental Impact Assessment. Danish Offshore Wind Farms Danish Energy Agency.

NIRAS. 2015a. Vesterhav Syd OWF: Baseline & EIA report on benthic flora, fauna and habitats. Niras, Marlim.

NIRAS. 2015b. VESTERHAV SYD HAVMØLLEPARK VVM -redegørelse - baggrundsrapport: Fisk og fiskesamfund.

NIRAS. 2015c. Vesterhav Nord. EIA background report. ATR10 Resting birds.

NIRAS. 2015d. Vesterhav Syd. EIA background report. ATR10 Resting birds.

NOER, H., CHRISTENSEN, T. K., CLAUSAGER, I. & PETERSEN, I. K. 2000. Effects on birds of an offshore wind park at Horns Rev: Environmental impact assessment. P. 112. Technical Report, Department of Coastal Zone Ecology, Dänemark.

PERCIVAL, S. 2009. Kentish Flats Offshore Wind Farm: Review of Monitoring of Red Throated Divers 2008-2009. P. 37. Vattenfall, Durham, UK.

PERCIVAL, S. 2013. Thanet Offshore Wind Farm Ornitholoigcal Monitoring 2012-2013. Report commissioned by Thanet Offshore Wind Limited, .

PETERSEN, I. K., CHRISTENSEN, T. J., KAHLERT, J., DESHOLM, M. & FOX, A. D. 2006a. Final results of bird studies at the offshore wind farms at Nysted and Horns Rev, Denmark. P. 166. National Environmental Research Institute Ministry of the Environment, Denmark.

PETERSEN, I. K., CLAUSAGER, I. & CHRISTENSEN, T. J. 2004. Bird numbers and distribution in the Horns Rev offshore wind farm area. Annual status report, Im Auftrag von Elsam Engineering A/S.

PETERSEN, I. K. & FOX, A. D. 2007. Changes in bird habitat utilization around the Horns Rev 1 offshore wind farm, with particular emphasis on Common Scoter. NERI Report, commissioned by Vattenfall A/S, DK.

PETERSEN, I. K., FOX, T., KAHLERT, J., CHRISTENSEN, T. K. & HOUNISEN, J. P. 2006b, 29.11. Changes in waterbird habitat utilisation in the Horns Rev and Nysted offshore windfarms. Helsingør.

PETERSEN, I. K. & NIELSEN, R. D. 2011. Abundance and distribution of selected waterbird species in Danish marine areas. P. 62. Report commissioned by Vattenfall A/S. National Environmental Research Institute, Aarhus University, Aarhus University, Aarhus, Denmark.

PETERSEN, I. K., NIELSEN, R. D. & MACKENZIE, M. L. 2014a. Post-construction evaluation of bird abundances and distributions in the Horns Rev 2 offshore wind farm area, 2011 and 2012. Pp. 1–51. Report commissioned by Dong energy, Aarhus University, DCE – Danish Centre for Environment and Energy, Aarhus.

PETERSEN, I. K., NIELSEN, R. D. & MACKENZIE, M. L. 2014b. Post-construction Evaluation of Bird Abundances and Distributions in the Horns Rev 2 Offshore Wind Farm Area, 2011 and 2012. P. 51. Aarhus University, DCE – Danish Centre for Environment and Energy.

PIPER, W., KULIK, G., DURINCK, J., SKOV, H. & LEONHARD, S. B. 2007. Horns Rev II Offshore Wind Farm Monitoring of Migrating Waterbirds

Baseline Studies 2007-08. P. 43. DONG energy / DHI-Water-Enviroment-Health / Orbicon, Viby & Hørsholm, Denmark.
PMSS. 2007. Annual FEPA Monitoring Report (2005-6), March 2007. North Hoyle Offshore Wind Farm. PMSS.
POOT, M. J. M., VAN HORSSEN, P. W., COLLIER, M. P., LENSINK, R. & DIRKSEN, S. 2011. Effect studies Offshore Wind Egmond aan Zee: cumulative effects on seabirds. A modelling approach to estimate effects on population levels in seabirds. P. 247. Final Report, Bureau Waardenburg bv, Culemborg, The Netherlands.
SCHWEMMER, P. & GARTHE, S. 2005. At-sea distribution and behaviour of a surface-feeding seabird, the Lesser Black-Backed Gull Larus fuscus, and its association with different prey. *Marine Ecology Progress Series* 285:245–258.
SCHWEMMER, P., MENDEL, B., SONNTAG, N., DIERSCHKE, V. & GARTHE, S. 2011. Effects of ship traffic on seabirds in offshore waters: implications for marine conservation and spatial planning. *Ecological Applications* 21:1851–1860.
SKOV, H. & DURINCK, J. 2001. Seabird attraction to fishing vessels is a local process. *MARINE ECOLOGY PROGRESS SERIES* 214:289–298.
SKOV, H., DURINCK, J., ERICHSEN, A., RIKKE MARGRETHE, R. M., MØHLENBERG, F. & LEONHARD, S. B. 2008. Horns Rev II Offshore Wind Farm Food Basis for Common Scoter Baseline Studies 2007-08. P. 47. DONG energy / DHI-Water-Enviroment-Health / Orbicon, Viby & Hørsholm, Denmark.
SKOV, H., DURINCK, J., LEOPOLD, M. F. & TASKER, M. L. 1995. Important bird areas for seabirds in the North Sea including the Channel and the Kattegat. Birdlife International, Cambridge. 156 pp.
SKOV, H., DURINCK, J., LEOPOLD, M. & TASKER, M. L. 2007. A quantitative method for evaluating the importance of marine areas for conservation of birds. *Biological Conservation* 136:362–371.
SKOV, H., LEONHARD, S. B., HEINÄNEN, S., ZYDELIS, R., JENSEN, N. E., DURINCK, J., JOHANSEN, T. W., JENSEN, B. P., HANSEN, B. L. & PIPER, W. 2012. Horns Rev 2 Offshore Wind Farm. Bird Monitoring Program. 2010-2012. Bird Migration. P. 134.
SKOV, H. & PRINS, E. 2001. Impact of estuarine fronts on the dispersal of piscivorous birds in the German Bight. *Marine Ecology Progress Series* 214:279–287.
SNH. 2010. Use of Avoidance Rates in the SNH Wind Farm Collision Risk Model. P. 10. Scottisch Natural Heritage, Argyll, Scotland.
TASKER, M. 2000. The impacts of fishing on marine birds. *ICES Journal of Marine Science* 57:531–547.
THOMAS, L., BUCKLAND, S. T., REXSTAD, E. A., LAAKE, J. L., STRINDBERG, S., HEDLEY, S. L., BISHOP, J. R. B., MARQUES, T. A. & BURNHAM, K. P. 2010. Distance software: design and analysis of distance sampling surveys for estimating population size. *Journal of Applied Ecology* 47:5–14.
TOPPING, C. & PETERSEN, I. K. 2011. Report on a Red-throated Diver Agent-Based Model to assess the cumulative impact from offshore wind farms. P. 44. DCE - Danish Centre for Environment and Energy, Aarhus University, DK.
WETLANDS INTERNATIONAL. 2014. Waterbird Population Estimates. Retrieved from wpe.wetlands.org.

16 APPENDIX

16.1 Worked example of collision rate model for the Herring Gull

The following example for Herring Gull at Vesterhav Syd (66 x 3 MW) shows the steps taken in the collision rate model (Band 2012) during the calculation of the estimated number of collision victims based on densities recorded in April 2014.

Step 1. Number of flights through the rotor-swept area

The number of flights through the rotor-swept area is calculated by the numbers of birds in the 'risk area'. This 'risk area' is a volume infront of the rotors and is turbine- and species-specific. For Herring Gull at the 66 x 3 MW variant at Vesterhav Syd, this is based on:
The total area of the rotors

πr^2 x number of turbines
π . 3136 x 66
650234 m^2

and the flight speed of Herring Gull (12.8 m/s), which is used to calculate the volume

12.8 x 650234 m^2
8322995 m^3

The density of flying birds in this 'risk area' is taken from the recorded density from the survey data with adjustments made for the proportion at rotor height and differing activity during the night.

For the 66 x 3 MW turbines in Vesterhav Syd, Herring Gulls are estimated to cross the rotors a total of ***4858*** times in April 2014.

Step 2. Probability of collision for a single crossing

The probability of collision with the moving rotors during a single crossing of the rotor-swept area is based on the size and flight speed of the bird and size and speed of the rotors. For Herring Gull and a 3MW turbine at Vesterhav Syd the probability of collision is ***0.079***.

Step 3. Numbers of collisions assuming no avoidance

The probability of collision for a single transit of the rotors then is multiplied by the number of flights through the rotors during the month in question.

n flights through rotor-swept area x probability of collision
4858 x 0.079
385 collisions in April 2014 assuming no avoidance

Step 4. Application of avoidance rates

Band (2012) recommends the use of four different avoidance rates, which are applied to the estimated number of collisions as follows[2]:

***n* collisions**	**x avoidance rate**	**= *n* collisions with avoidance**
385	0.95	*19.26*
385	0.98	*7.70*
385	0.99	*3.85*
385	0.995	*1.93*

COLLISION RISK ASSESSMENT										
Sheet 3 - probability of collision for single bird transit through rotor										
	All input data must be entered on Sheet 1, not here									
	However the blade profile (orange) may be revised here to match the actual turbine blades used									
	Calculated outputs									
	Main output copied to sheet 1									
			Calculation of alpha and p(collision) as a function of radius							
NoBlades	3					**Upwind:**			**Downwind:**	
MaxChord	3.50	m	r/R	c/C	α	collide			collide	
Pitch (degrees)	6		radius	chord	alpha	length	p(collision)		length	p(collision)
Species name	Herring Gull		0.00				1.000			1.000
BirdLength	0.61	m	0.05	0.73	2.76	11.27	0.695		10.74	0.662
Wingspan	1.44	m	0.10	0.79	1.38	6.08	0.375		5.50	0.339
F: flapping (0) or gliding (+1)	0		0.15	0.88	0.92	4.47	0.276		3.83	0.236
Proportion of flights upwind	50%	%	0.20	0.96	0.69	3.66	0.226		2.95	0.182
Bird speed	12.8	m/sec	0.25	1.00	0.55	3.09	0.190		2.36	0.145
Rotor Radius	56	m	0.30	0.98	0.46	2.59	0.160		1.88	0.116
Rotation Speed	15.79	rpm	0.35	0.92	0.39	2.21	0.136		1.54	0.095
Rotation Period	3.80	sec	0.40	0.85	0.35	1.94	0.120		1.32	0.082
			0.45	0.80	0.31	1.76	0.108		1.17	0.072
			0.50	0.75	0.28	1.61	0.099		1.06	0.065
Bird aspect ratio: β	0.42		0.55	0.70	0.25	1.48	0.091		0.97	0.060
			0.60	0.64	0.23	1.36	0.084		0.89	0.055
Integration interval	0.05		0.65	0.58	0.21	1.25	0.077		0.83	0.051
			0.70	0.52	0.20	1.16	0.071		0.78	0.048
			0.75	0.47	0.18	1.08	0.067		0.74	0.046
			0.80	0.41	0.17	1.01	0.062		0.71	0.044
			0.85	0.37	0.16	0.95	0.059		0.68	0.042
			0.90	0.30	0.15	0.88	0.054		0.66	0.041
			0.95	0.24	0.15	0.82	0.051		0.64	0.040
			1.00	0.00	0.14	0.61	0.038		0.61	0.038
			Overall p(collision) integrated over disk							
						Upwind	**9.1%**		**Downwind**	**6.7%**
		Proportion	upwind:	downwind						
			50%	50%			**Average**	**7.9%**	(copied to sheet 1)	

Figure 65: Screenshot of the Band model spreadsheet for the calculation of collision probability (Step 1.)

[2] Result of the calculation given here can vary to that in the figures due to rounding of figures in this worked example.

COLLISION RISK ASSESSMENT														
Sheet 2 - Overall collision risk			**All data input on Sheet 1:**											
			no data entry needed on this sheet!											
Bird details:														
	Species		Herring Gull											
	Flight speed	m/sec	12.8											
	Nocturnal activity factor (1-5)		3											
	Nocturnal activity (% of daytime)		50%											
Windfarm data:														
	Latitude	degrees	56.1											
	Number of turbines		66											
	Rotor radius	m	56											
	Minimum height of rotor	m	81											
	Total rotor frontal area	sq m	650234											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Proportion of time operational	%			100%	100%	100%							100%	
Stage A - flight activity															
	Daytime areal bird density	birds/sq km			0.01053	0.183	0.1248							0.287659	
	Proportion at rotor height	%	25.4%												
	Total daylight hours per month	hrs			267	366	425							250	
	Total night hours per month	hrs			405	378	295							470	
		Flux factor			1322	27153	19107							37308	
Option 1 -Basic model - Stages B, C and D															
	Potential bird transits through rotors				336	6897	4853							9476	
	Collision risk for single rotor transit	(from sheet 3)	7.9%												
	Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year			**27**	**547**	**385**							**751**	
Stage E - applying avoidance rates															
	Using which of above options?	**Option 1**	0.00%		27	547	385							751	
Collisions assuming avoidance rate		birds per month or year	95.00%		1.33	27.34	19.24							37.57	
			98.00%		0.53	10.94	7.70							15.03	
			99.00%		0.27	5.47	3.85							7.51	
			99.50%		0.13	2.73	1.92							3.76	

	from Sheet 1 - input data
	from Sheet 6 - available hours
	from Sheet 3 - single transit collision risk
	from survey data
	calculated field

Figure 66: Screenshot of the Band model spreadsheet for the calculation of number of flights through rotor-swept area (Step 2.), numbers of collisions assuming no avoidance (Step 3.) and application of avoidance rates (Step 4.)

16.2 Parameters for collision modelling in resting birds

Table 64: Parameters used in collision risk modeling for 16 resting bird species and species groups according to Band et al. (2012)

Species	Length[1] (m)	Wingspan[1] (m)	Flight speed[2] (m/s)	Flapping (0) or gliding (1)	Nocturnal activity factor[3] (1-5)	Proportion at rotor height 3MW[4]	Proportion at rotor height 10MW[4]
Red-throated Diver	0.74	1.1	18.6	0	1	0.04	0.02
Northern Gannet	0.935	1.725	14.9	0	2	0.083	0.049
Long-tailed Duck	0.47	0.82	22.0	0	3[10]	0.009[10]	0.003[10]
Common Scoter	0.54	0.84	22.1	0	3	0.009	0.003
Velvet Scoter	0.58	0.97	22.2	0	3[10]	0.009[10]	0.003[10]
Little Gull	0.28	0.69	11.5	0	2	0.103	0.063
Common Gull	0.43	1.035	13.4	0	3	0.162	0.111
Lesser Black-backed Gull	0.56	1.34	11.9[5]	0	3	0.219	0.159
Herring Gull	0.61	1.44	12.8	0	3	0.254	0.191
Great Black-backed Gull	0.74	1.66	13.7	0	3	0.260	0.197
Black-legged Kittiwake	0.39	1.075	13.1	0	3	0.102	0.063
Common Guillemot	0.395	0.67	19.1	0	2	0.0013	0.0003
divers	0.74[6]	1.1[6]	18.6[6]	0	1[6]	0.035	0.017
small gulls	0.37[7]	0.93[7]	12.7[7]	0	2[7]	0.122	0.079
large gulls	0.64[8]	1.48[8]	12.8[6]	0	3[8]	0.244	0.182
alcids	0.35[9]	0.625[9]	17.6[9]	0	1[9]	0.0081	0.0034

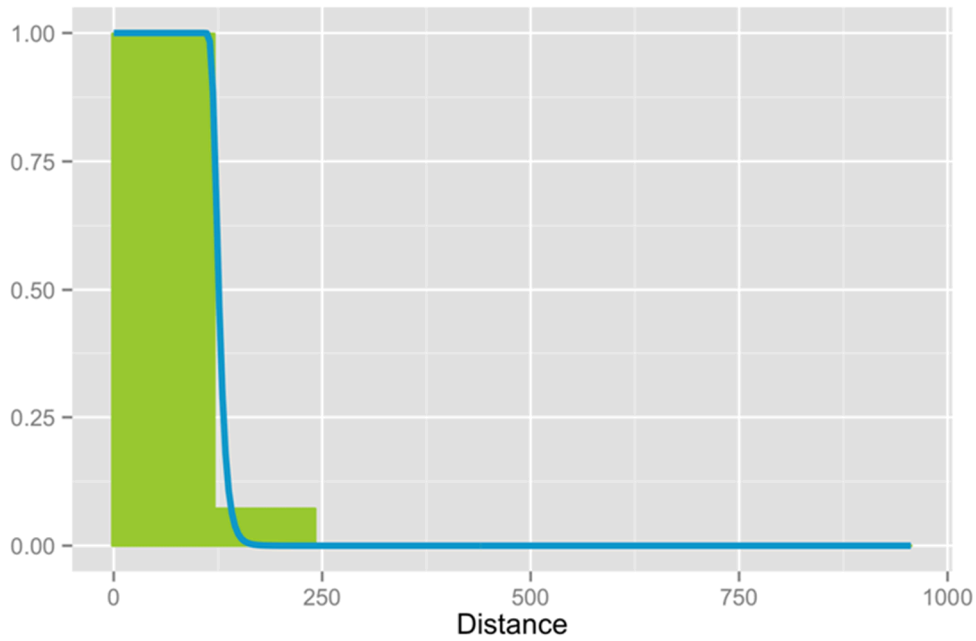
1 Taken from Cramp & Perrins (in serie)
2 Taken from Alerstam et al. (2007)
3 Taken from Garthe & Hüppop (2004)
4 Taken from Johnston et al. (2014)
5 Taken from Bruderer & Boldt (2008)
6 Based on Red-throated Diver
7 Taken as the mean values of Little Gull, Common Gull and Black-legged Kittiwake.
8 Taken as the mean values of Lesser Black-backed Gull, Herring Gull and Great Black-backed Gull.
9 Taken as the mean values of Puffin, Common Guillemot and Razorbill.

16.3 Distance functions for resting birds

Red-throated diver

A total of 152 individual Red-throated Divers were recorded over 117 sightings during the aerial surveys at Bornholm, Vesterhav Syd and Vesterhav Syd. This species was most common in the North Sea parks, but some were recorded in the Bornholm waters. Due to the large number of unidentified divers, probably most of them Red-throated diver and smaller numbers of Black-throated Divers and Great Northern Divers, divers were also analysed as one group together.

ESW model selection



Model function	Hazard-rate	
Covariates		NA
Analysed distance strips		A, B, C strip
Selection criterium		Visual assessment of Detection Function
ESW (lower and upper 95% CI)	127.56 (89.033 – 182.75)	

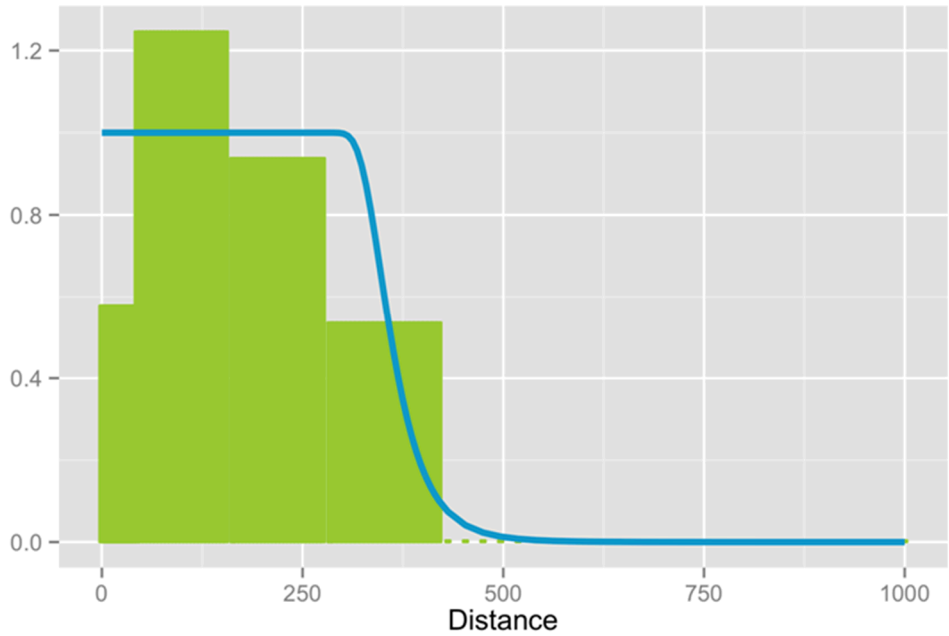
In this species avoidance of birds from the 0-strip was expected, yet visual inspection of the data showed that these birds avoided by diving instead of flying away from the transect line. Hence we chose to analyse only the strips A – C and exclude sightings in the 0-strip (13 sightings). A Half-normal detection function yielded the lowest AIC, but we overruled this automatic model selection by the Distance software as such a detection function overestimated the numbers of birds in strip A heavily.

Divers: see Section 5.3.1

Northern Gannet

A total of 183 individual Northern Gannets were recorded over 159 sightings during the aerial surveys at Bornholm, Vesterhav Syd and Vesterhav Syd. This species is most common in the North Sea parks, but some were recorded in the Bornholm waters.

ESW model selection



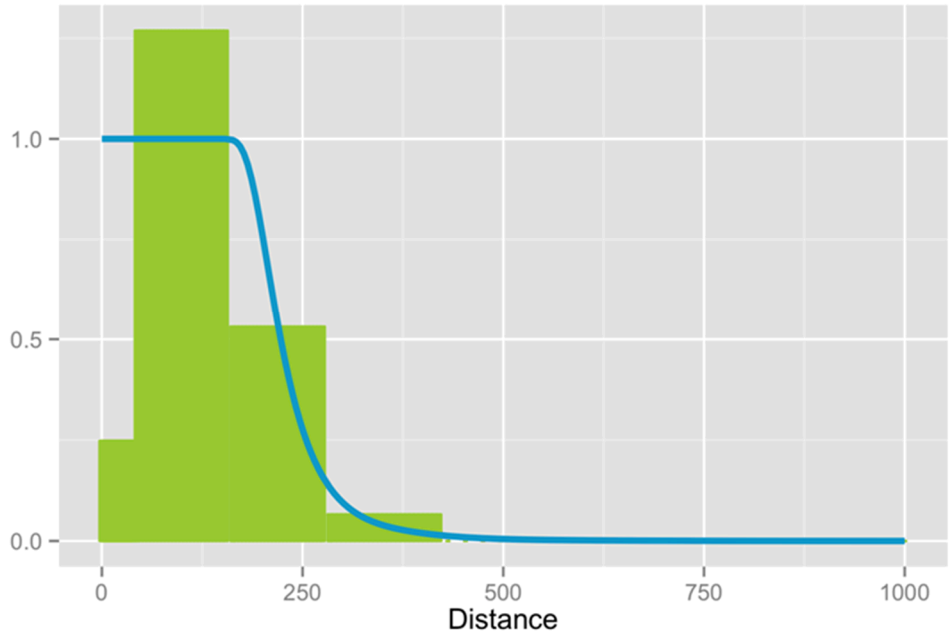
Model function	Hazard-rate	
Covariates		Cluster size
Analysed distance strips	0, A, B, C, D strip	
Selection criterium		AIC
ESW (lower and upper 95% CI)	368.42 (325.20 – 417.39)	

In this species the inclusion of Cluster Size as covariate improved the model and yielded a more realistic detection function than without.

Common Scoter

A total of 3085 individual Common Scoters were recorded over 389 sightings during the aerial surveys at Bornholm, Vesterhav Syd and Vesterhav Syd. This species is most common in the North Sea parks, but some were recorded in the Bornholm waters.

ESW model selection



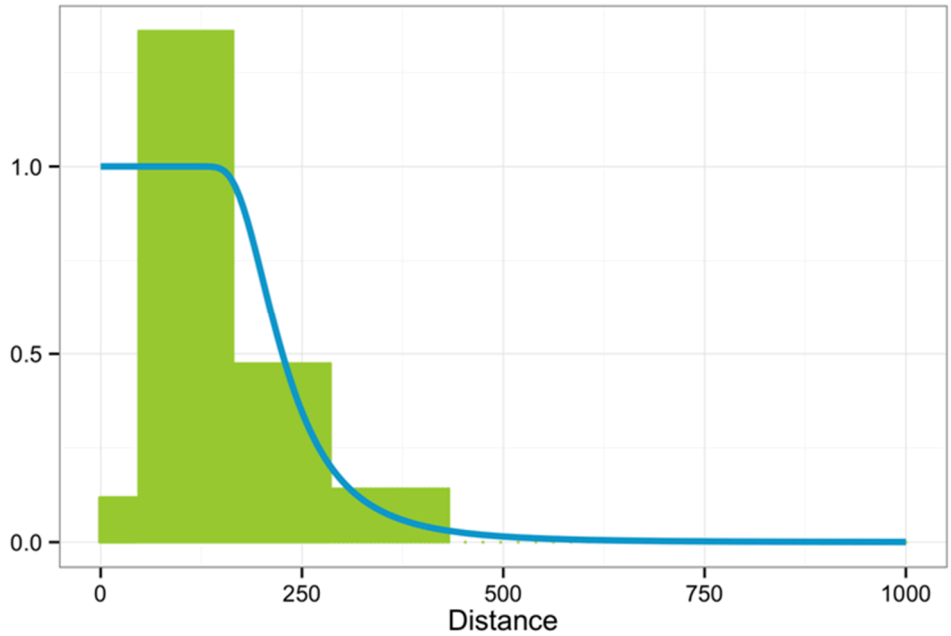
Model function	Hazard-rate
Covariates	Cluster size
Analysed distance strips	0, A, B, C, D strip
Selection criterium	AIC
ESW (lower and upper 95% CI)	235.93 (216.04 – 257.65)

This species shows strong avoidance from the 0-strip due to disturbance of the aircraft. Inclusion of the covariate Cluster size improved the models. A Half-normal detection function yielded the lowest AIC, but we overruled this automatic model selection by the Distance software as such a detection function overestimated the numbers of birds in strip A heavily.

Velvet Scoter

A total of 205 individual Velvet Scoters were recorded over 47 sightings during the aerial surveys at Bornholm, Vesterhav Syd and Vesterhav Syd. The number of sightings is less than the recommended 60 for Distance analysis (Buckland et al. 1993), yet the detection function seemed realistic, and thus this analysis has been included in this report. This species is most common in the North Sea parks, but some were recorded in the Bornholm waters.

ESW model selection



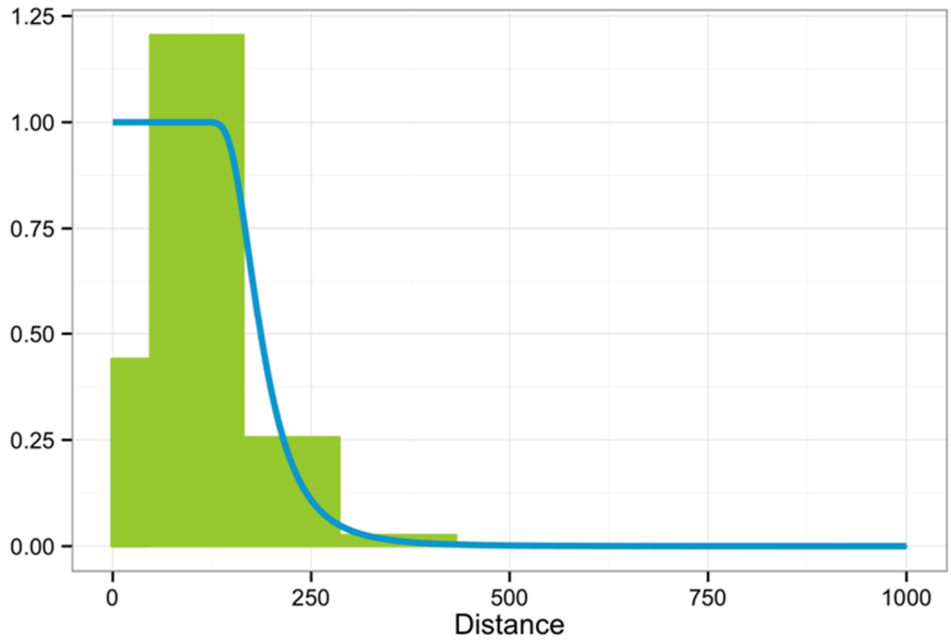
Model function	Hazard-rate
Covariates	NA
Analysed distance strips	0, A, B, C, D strip
Selection criterium	Visual assessment of Detection Function
ESW (lower and upper 95% CI)	127.56 (89.033 – 182.75)

This species shows strong avoidance from the 0-strip due to disturbance of the aircraft. Inclusion of Behaviour as a covariate improved the models, logically as flying Velvet Scoters are a lot easier to identify when flying, but encountered problems in the Distance software when running these on a stratified level. A Half-normal detection function yielded the lowest AIC, but we overruled this automatic model selection by the Distance software as such a detection function overestimated the numbers of birds in strip A heavily.

Little Gull

A total of 78 individual Little Gulls were recorded over 51 sightings during the aerial surveys at Bornholm, Vesterhav Syd and Vesterhav Syd. The number of sightings is less than the recommended 60 for Distance analysis (Buckland et al. 1993), yet the detection function seemed realistic, and thus this analysis has been included in this report. This species was recorded in low numbers in all three study areas.

ESW model selection



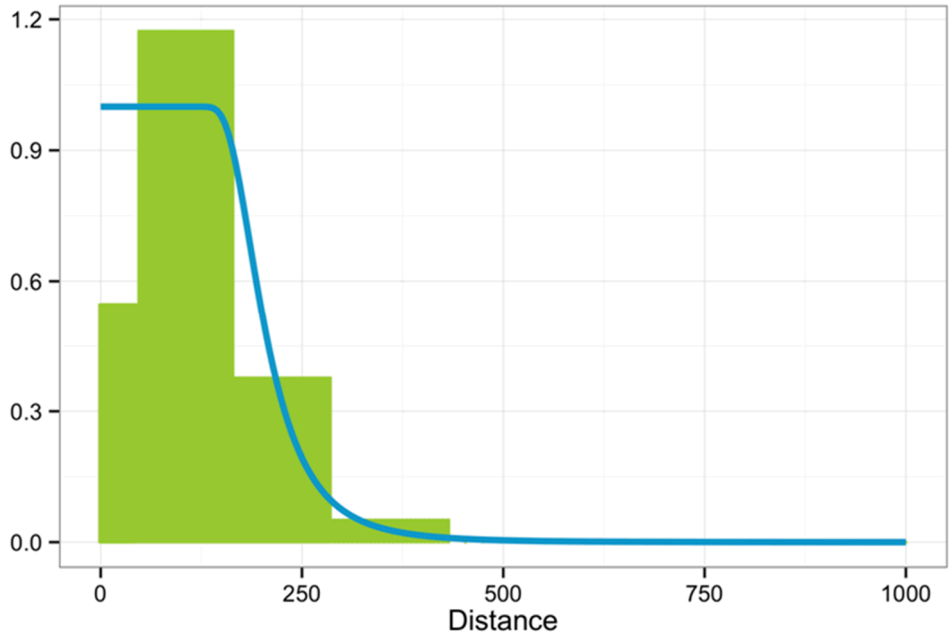
Model function	Hazard-rate
Covariates	NA
Analysed distance strips	0, A, B, C, D strip
Selection criterium	AIC
ESW (lower and upper 95% CI)	197.69 (165.32 – 236.39)

This species shows avoidance from the 0-strip due to disturbance of the aircraft. These will be recorded in the A and B strip. Excluding the 0-strip would therefor overestimate the population size and density in the study area.

Common Gull

A total of 1295 individual Common Gulls were recorded over 604 sightings during the aerial surveys at Bornholm, Vesterhav Syd and Vesterhav Syd. This species is common in all three parks.

ESW model selection

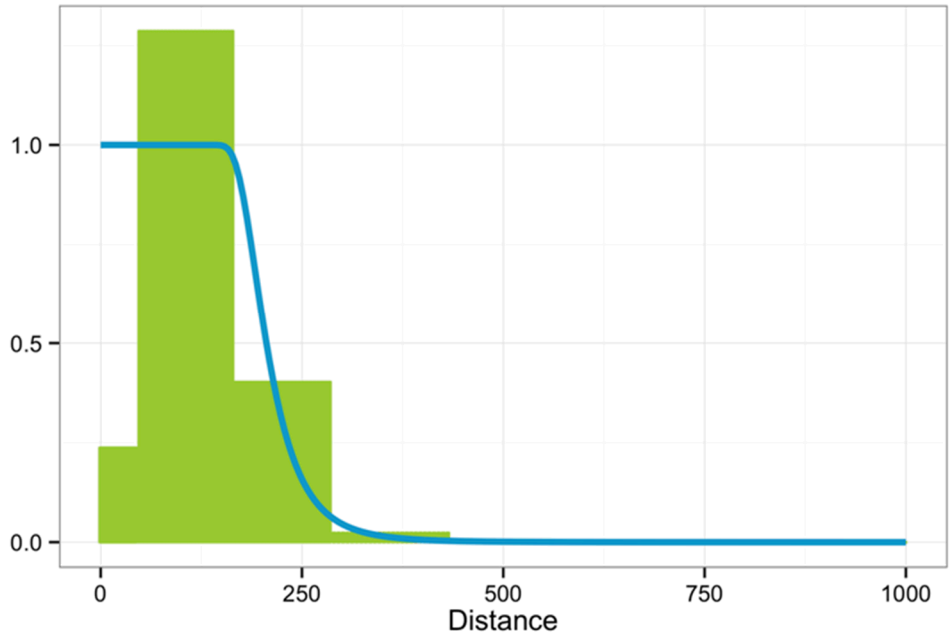


Model function	Hazard-rate
Covariates	NA
Analysed distance strips	0, A, B, C, D strip
Selection criterium	AIC
ESW (lower and upper 95% CI)	216.78 (182.95 – 256.86)

This species shows avoidance from the 0-strip due to disturbance of the aircraft. These will be recorded in the A and B strip. Excluding the 0-strip would therefor overestimate the population size and density in the study area.

Lesser Black-backed Gull

A total of 75 individual Lesser Black-backed Gulls were recorded over 62 sightings during the aerial surveys at Bornholm, Vesterhav Syd and Vesterhav Syd. This species was recorded in low numbers in all three parks.



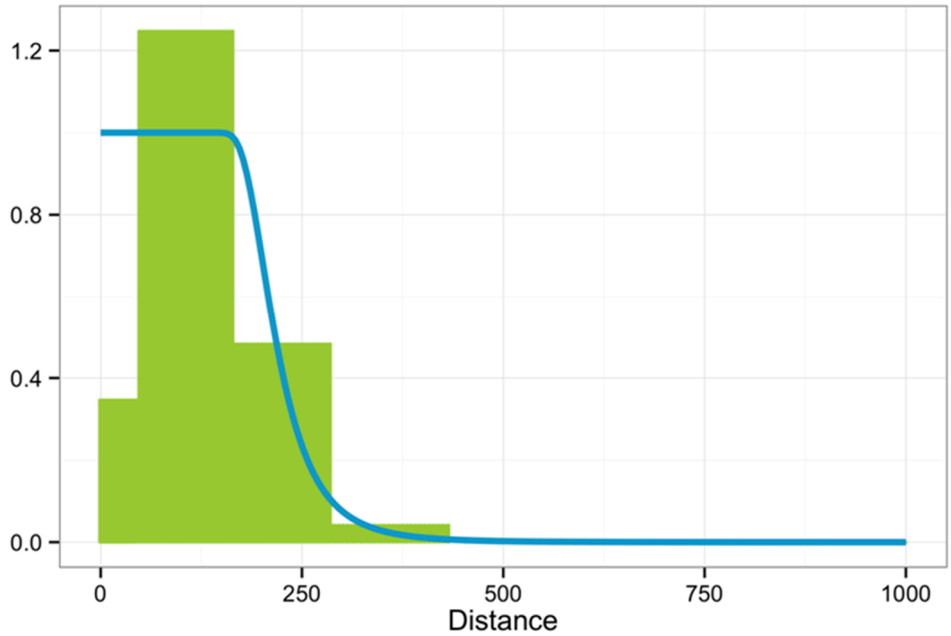
Model function	Hazard-rate
Covariates	NA
Analysed distance strips	0, A, B, C, D strip
Selection criterium	AIC
ESW (lower and upper 95% CI)	215.64 (185.82 – 250.24)

This species shows avoidance from the 0-strip due to disturbance of the aircraft. These will be recorded in the A and B strip. Excluding the 0-strip would therefor overestimate the population size and density in the study area.

Herring Gull

A total of 816 individual Red-throated divers were recorded over 449 sightings during the aerial surveys at Bornholm, Vesterhav Syd and Vesterhav Syd. This species was recorded in low numbers in all three parks.

ESW model selection



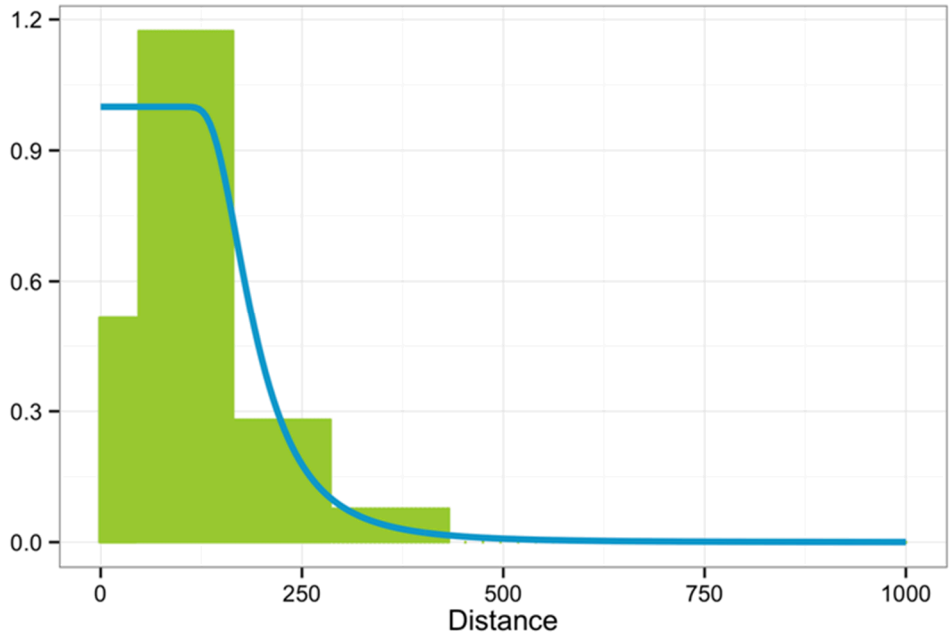
Model function	Hazard-rate
Covariates	NA
Analysed distance strips	0, A, B, C, D strip
Selection criterium	AIC
ESW (lower and upper 95% CI)	228.38 (186.29 – 279.74)

This species shows avoidance from the 0-strip due to disturbance of the aircraft. These will be recorded in the A and B strip. Excluding the 0-strip would therefor overestimate the population size and density in the study area. Inclusion of Seastate as covariate improved the model, but when running this model stratified per survey the Distance software encountered convergence failures and was not able to come up with reliable population estimates.

Great Black-backed Gull

A total of 62 individual Great Black-backed Gulls were recorded over 55 sightings during the aerial surveys at Bornholm, Vesterhav Syd and Vesterhav Syd. The number of sightings is less than the recommended 60 for Distance analysis (Buckland et al. 1993), yet the detection function seemed realistic, and thus this analysis has been included in this report. This species was recorded in low numbers in all three study areas.

ESW model selection



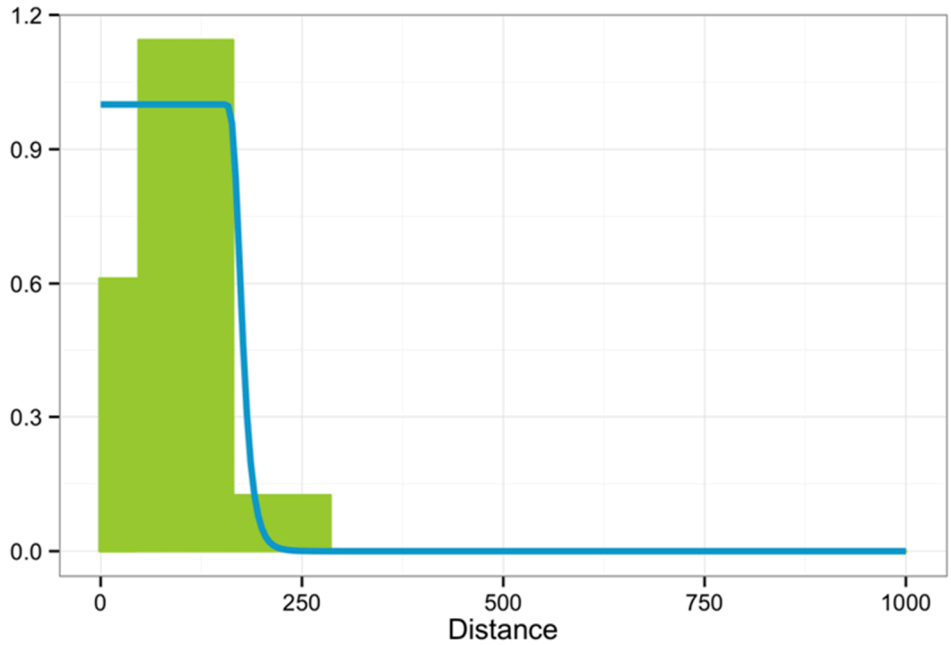
Model function	Hazard-rate
Covariates	NA
Analysed distance strips	0, A, B, C, D strip
Selection criterium	Visual assessment of Detection Function
ESW (lower and upper 95% CI)	207.58 (168.32 – 256.01)

In this species avoidance of birds from the 0-strip was expected, yet a Half-normal detection function yielded the lowest AIC. We overruled this automatic model selection by the Distance software as such a detection function overestimated the numbers of birds in strip A heavily.

Black-legged Kittiwake

A total of 130 individual Black-legged Kittiwakes were recorded over 106 sightings during the aerial surveys at Bornholm, Vesterhav Syd and Vesterhav Syd. This species is most common in the North Sea parks, but some were recorded in the Bornholm waters.

ESW model selection



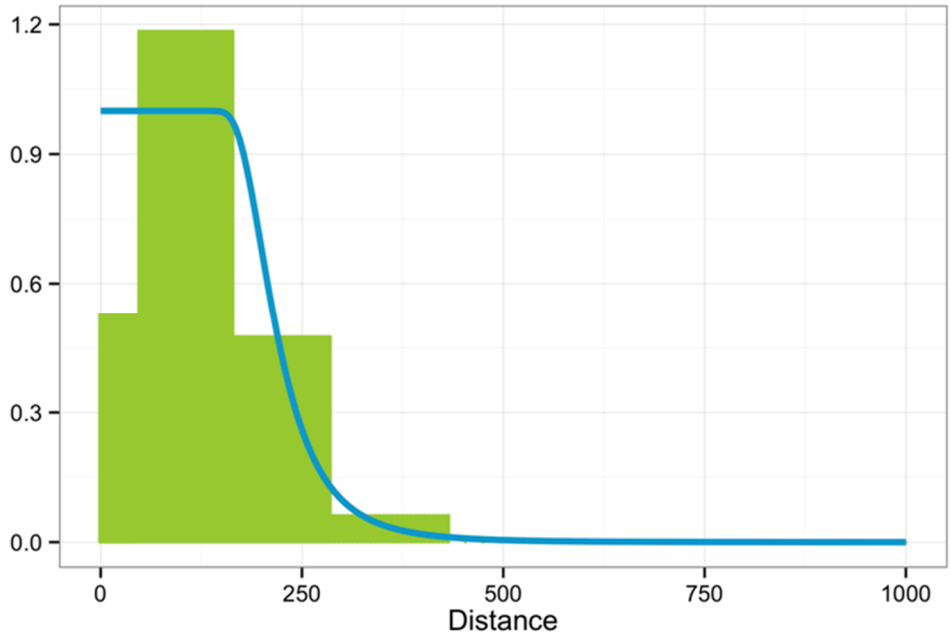
Model function	Hazard-rate
Covariates	NA
Analysed distance strips	0, A, B, C, D strip
Selection criterium	AIC
ESW (lower and upper 95% CI)	178.13 (124.21 – 255.46)

This species shows avoidance from the 0-strip due to disturbance of the aircraft. These will be recorded in the A and B strip. Excluding the 0-strip would therefor overestimate the population size and density in the study area.

Small gulls

A total of 1753 individual small gulls were recorded over 886 sightings during the aerial surveys at Bornholm, Vesterhav Syd and Vesterhav Syd. This species-group consists of sightings of Little Gull, Black-headed Gull, Common Gull, Black-legged Kittiwake, and unidentified small gulls, and was found in all three study areas although more were found in the North Sea areas.

ESW model selection



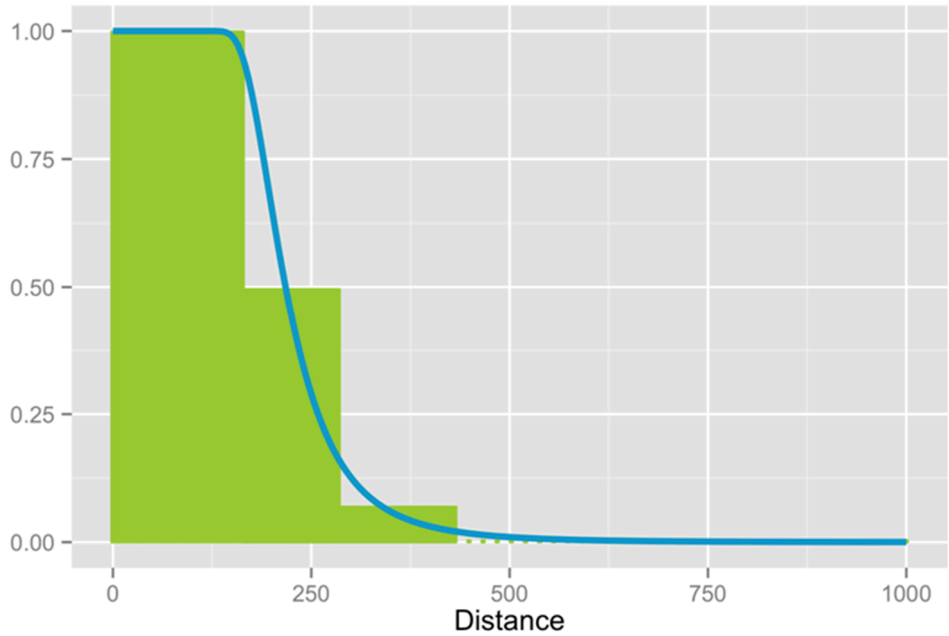
Model function	Hazard-rate
Covariates	NA
Analysed distance strips	0, A, B, C, D strip
Selection criterium	AIC
ESW (lower and upper 95% CI)	230.88 (199.50 – 267.19)

All members of this species-goup show avoidance from the 0-strip due to disturbance of the aircraft. These will be recorded in the A and B strip. Excluding the 0-strip would therefor overestimate the population size and density in the study area.

Large gulls

A total of 1195 individual large gulls were recorded over 603 sightings during the aerial surveys at Bornholm, Vesterhav Syd and Vesterhav Syd. This species-group consists of sightings of Lesser Black-Backed Gull, Herring Gull, Great Black-backed Gull, Common/Herring Gull, and unidentified large gull, and was found in all three study areas although more were found in the North Sea areas.

ESW model selection:

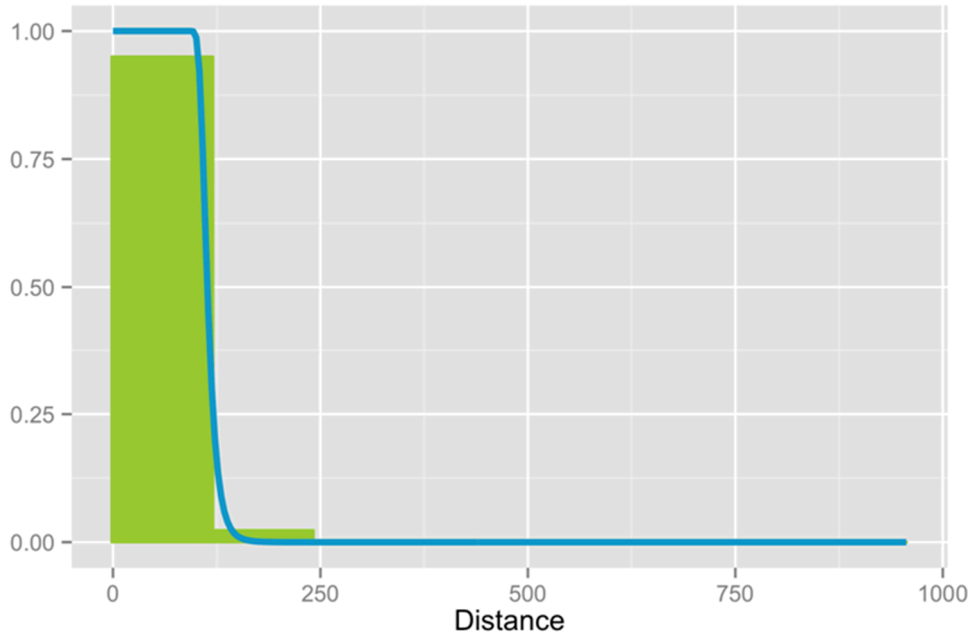


Model function	Hazard-rate
Covariates	NA
Analysed distance strips	0 + A (bin), B, C strip
Selection criterium	Visual assessment of Detection Function
ESW (lower and upper 95% CI)	234.85 (70.233 – 785.28)

Remarks:
All members of this species-goup show avoidance from the 0-strip due to disturbance of the aircraft. These will be recorded in the A and B strip. Excluding the 0-strip would therefor overestimate the population size and density in the study area. Yet, including the 0-strip yielded an unrealistic detection function with a spike in distance strip A. When binning the 0-strip and A-strip a Half-normal detection function yielded the lowest AIC. We overruled this automatic model selection by the Distance software as such a detection function overestimated the numbers of birds in strip A heavily. In conclusion we chose to force a Hazard-rate function through the binned data of strip 0 and A, yielding a realistic detection function, and realistic population estimates with reasonable confidence intervals

Common Guillemot
A total of 106 individual Common Guillemots were recorded over 82 sightings during the aerial surveys at Bornholm, Vesterhav Syd and Vesterhav Syd. This species is most common in the North Sea parks, but some were recorded in the Bornholm waters.

ESW model selection



Model function	Hazard-rate
Covariates	NA
Analysed distance strips	A, B, C strip
Selection criterium	Visual assessment of Detection Function
ESW (lower and upper 95% CI)	115.88 (24.742 – 542.71)

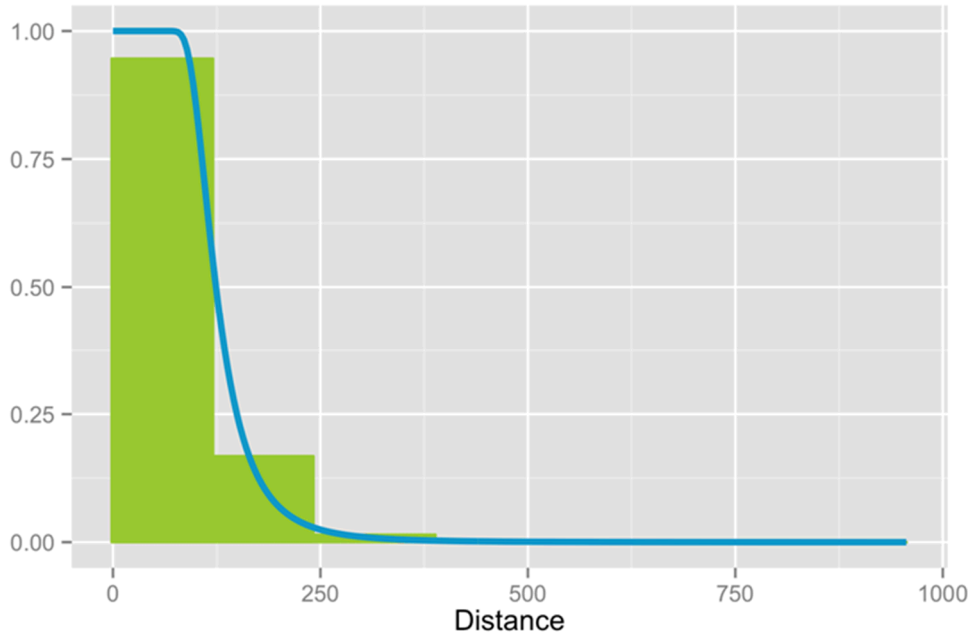
This species avoids the 0-strip by diving under in response to the aircraft. Hence we chose to analyse only the strips A – C and exclude sightings in the 0-strip (15 sightings). A Half-normal detection function yielded the lowest AIC, but we overruled this automatic model selection by the Distance software as such a detection function overestimated the numbers of birds in strip A heavily.

Auks

A total of 779 individual alcids were recorded over 558 sightings during the aerial surveys at Bornholm, Vesterhav Syd and Vesterhav Syd. This species-group consists of sightings of Common Guillemots, Razorbills, Guillemot/Razorbill, and Black Guillemots, and was found in all three study areas although more were found in the North Sea areas.

To give an impression of total populations of the different species we can determine the ratio between Razorbill, Common Guillemot and Black Guillemot from identified individuals in the database. This ratio is 0.017 Razorbills, 0.149 Common Guillemots, 0.817 Guillemot/Razorbills, and 0.022 Black Guillemots. And to seperate Guillemot/Razorbill per species the ratio between Razorbill and Guillemot is that for each Razorbill, 9.00 Guillemots were recorded.

ESW model selection



Model function	Hazard-rate
Covariates	NA
Analysed distance strips	A, B, C strip
Selection criterium	AIC
ESW (lower and upper 95% CI)	135.12 (125.08 – 145.98)

Members of this species-group avoid the 0-strip by diving in response to the aircraft. Hence we chose to analyse only the strips A – C and exclude sightings in the 0-strip (51 sightings).

16.4 Distribution maps with bird counts and bathymetry

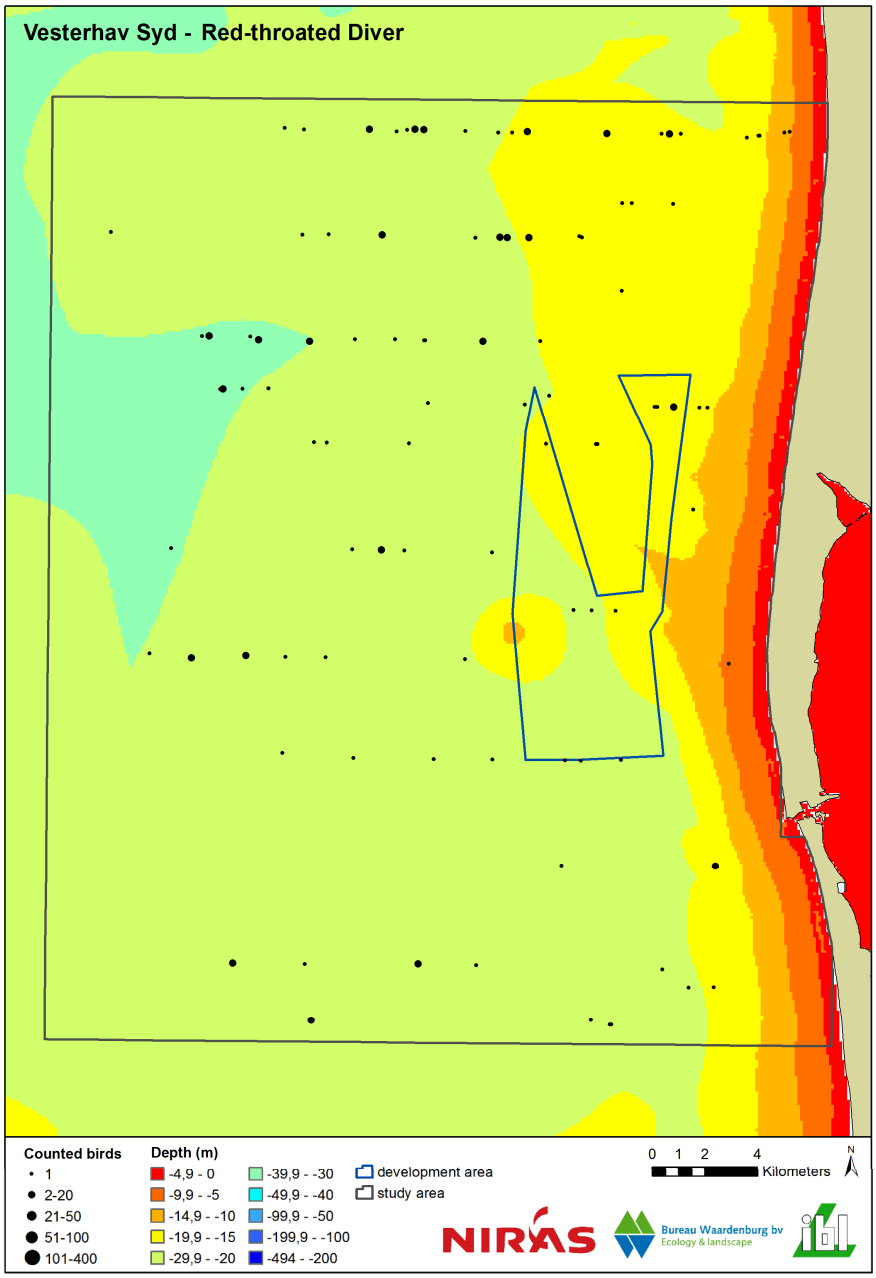


Figure 67: Distribution of counted Red-throated Divers as a sum of all six surveys in relation to water depth

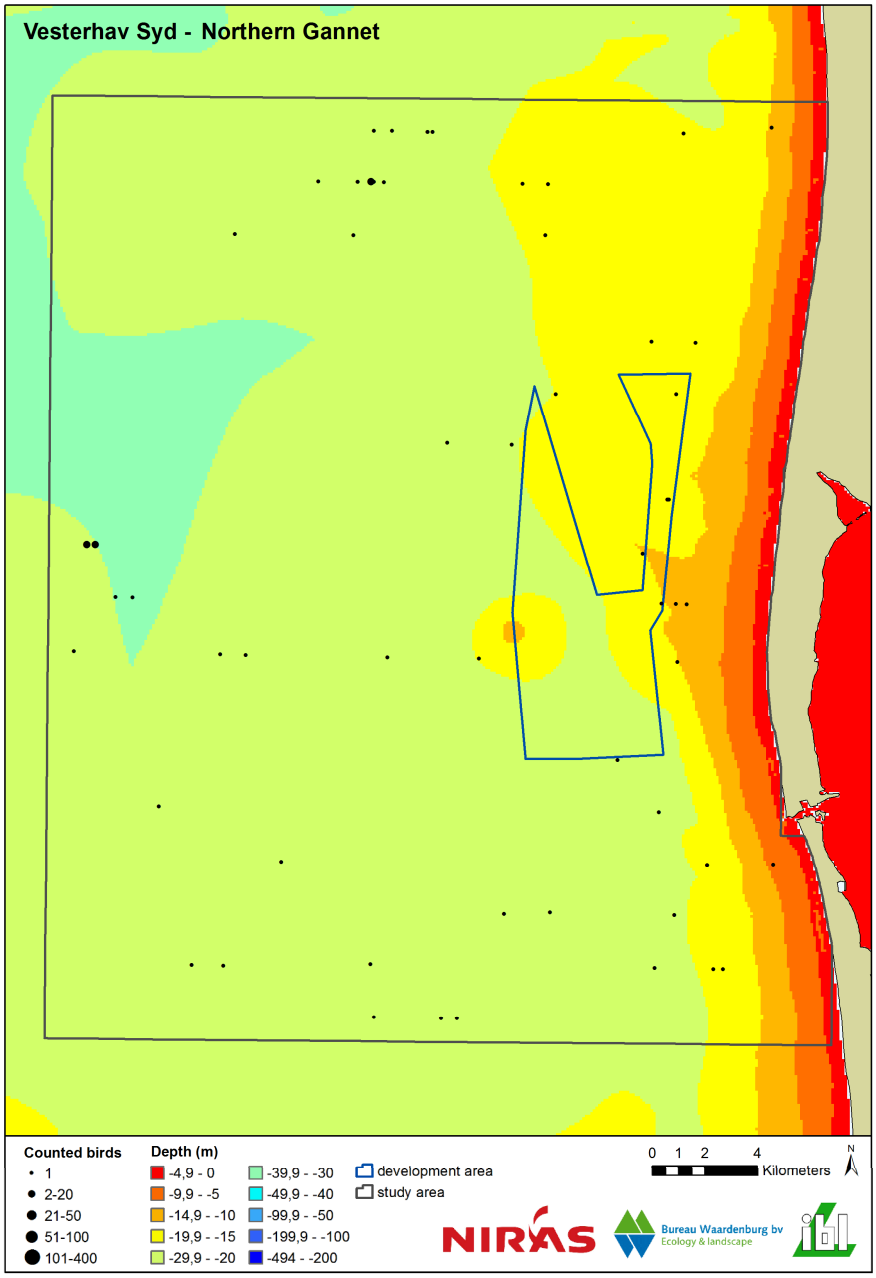


Figure 68: Distribution of counted Northern Gannets as a sum of all six surveys in relation to water depth

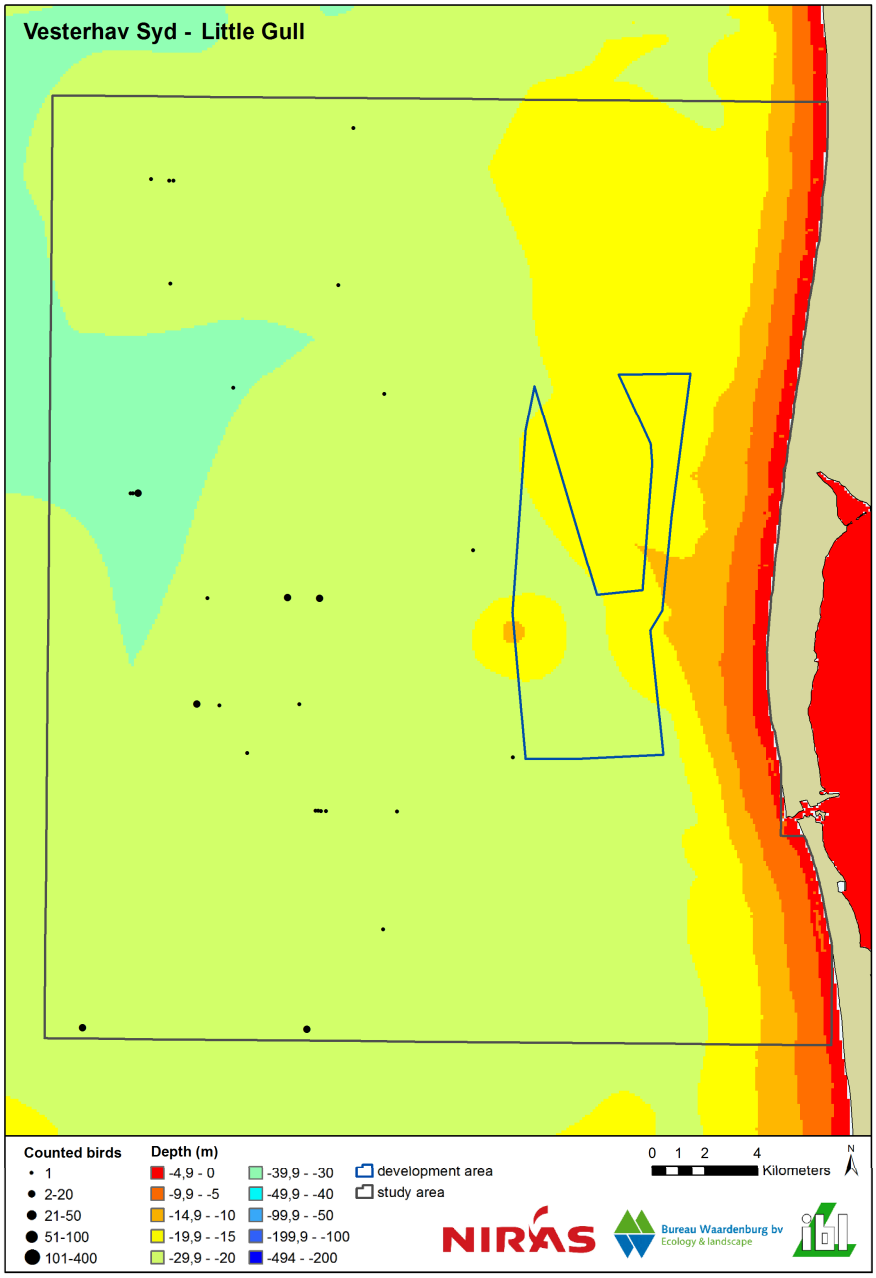


Figure 69: Distribution of counted Little Gulls as a sum of all six surveys in relation to water depth

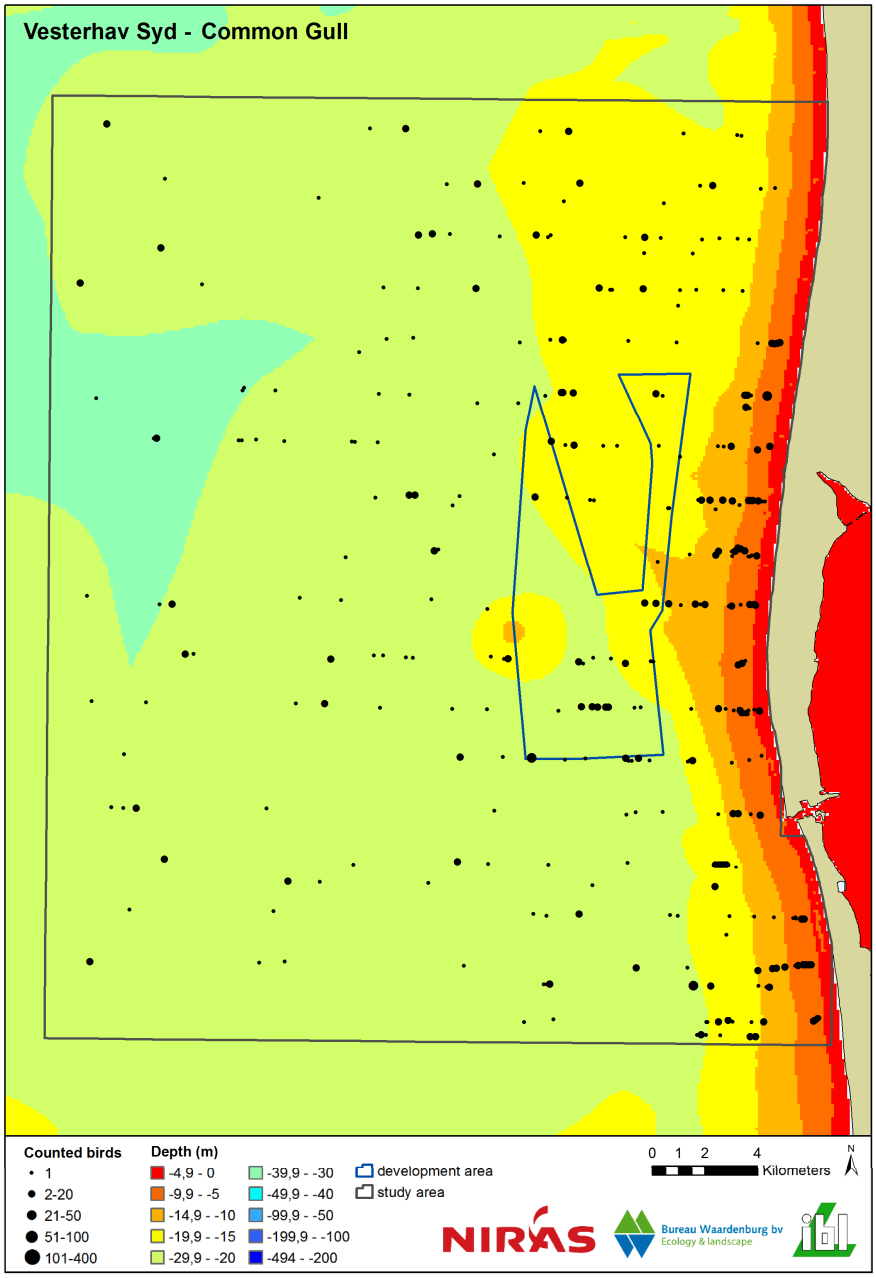


Figure 70: Distribution of counted Common Gulls as a sum of all six surveys in relation to water depth

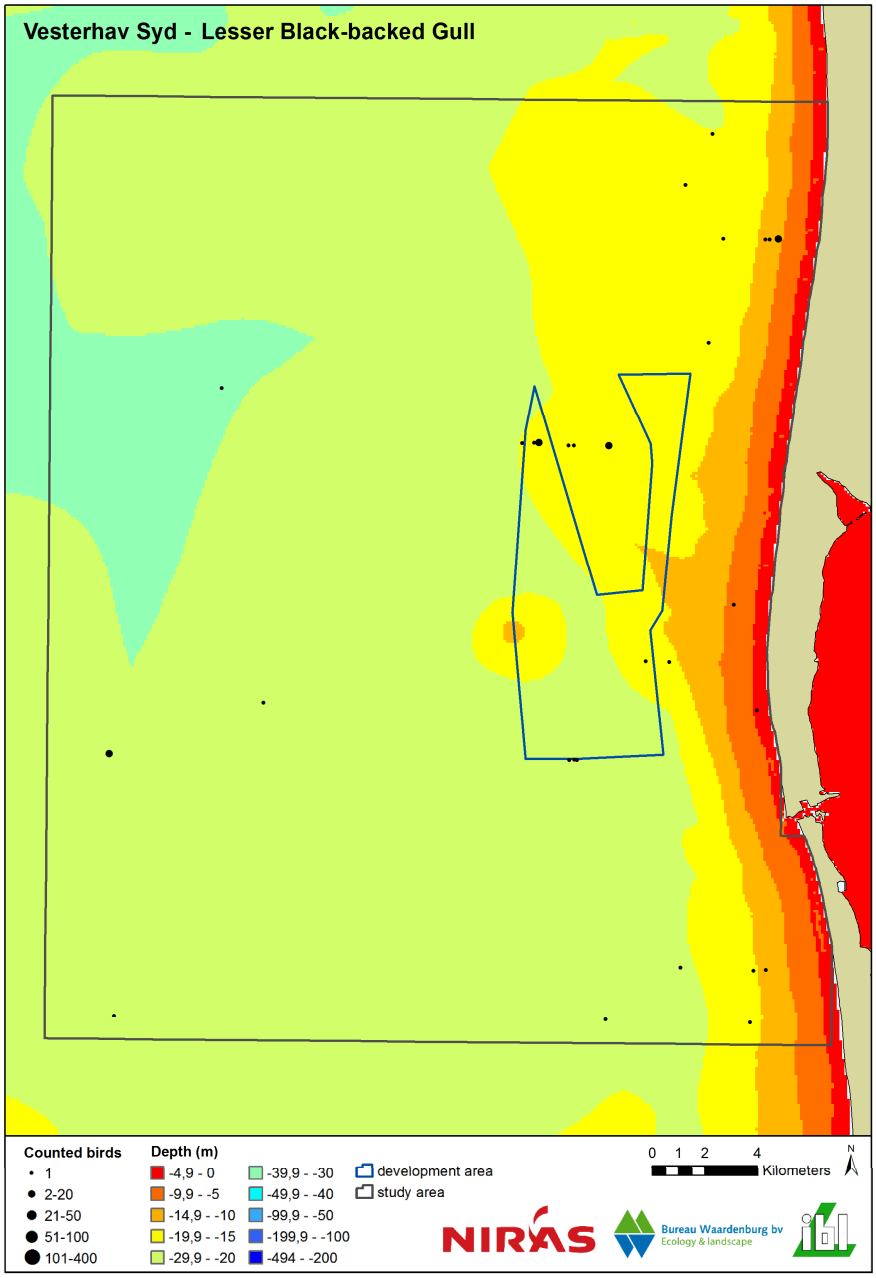


Figure 71: Distribution of counted Lesser Black-backed Gulls as a sum of all six surveys in relation to water depth

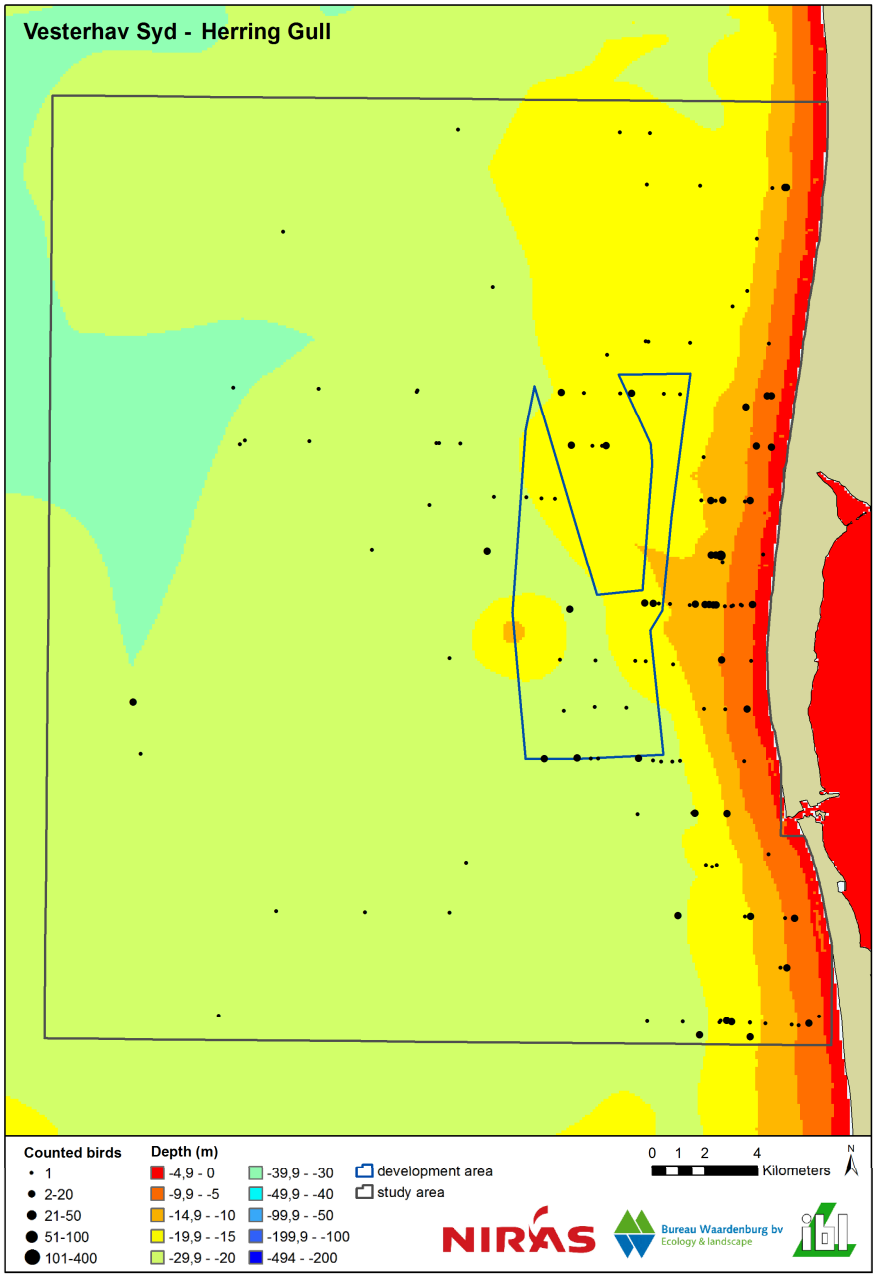


Figure 72: Distribution of counted Herring Gulls as a sum of all six surveys in relation to water depth

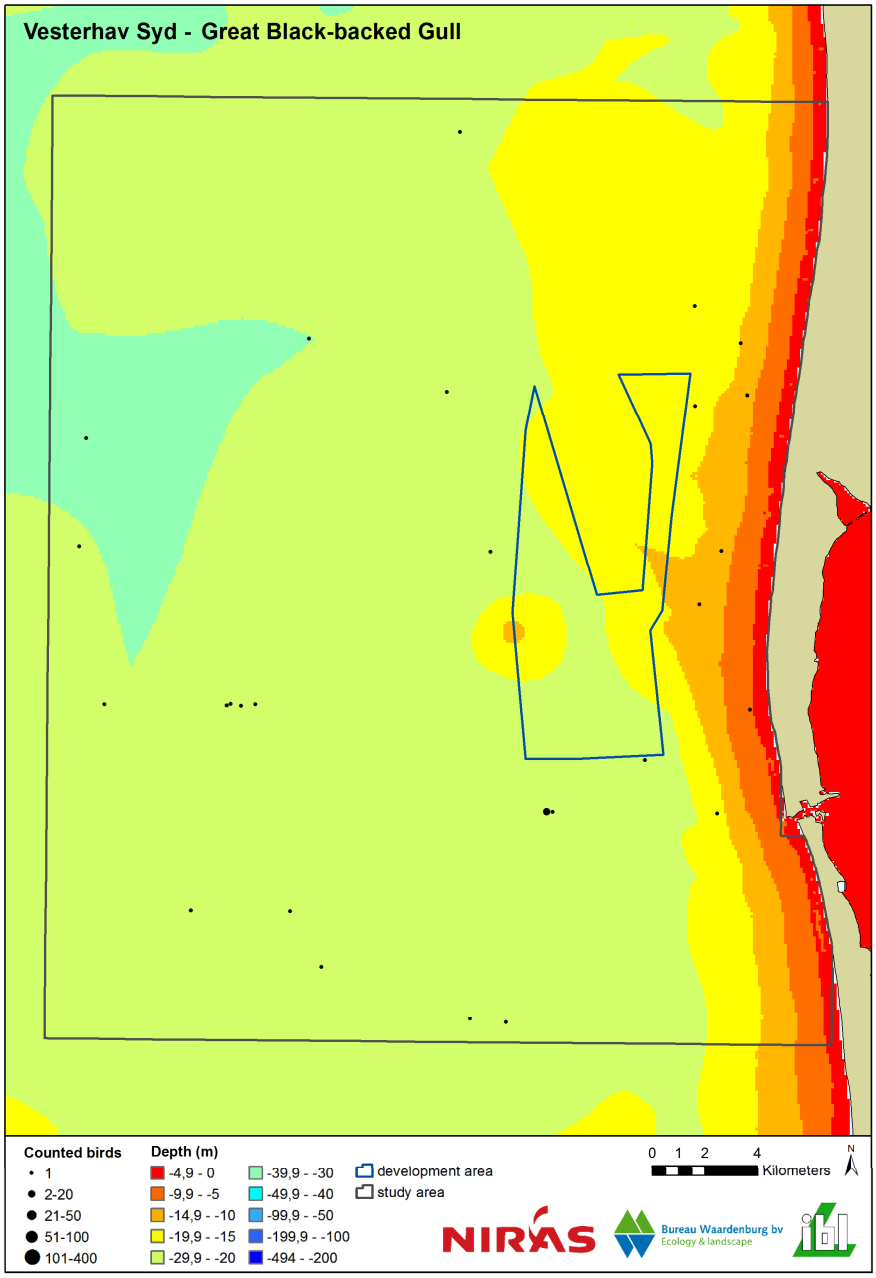


Figure 73: Distribution of counted Great Black-backed Gulls as a sum of all six surveys in relation to water depth

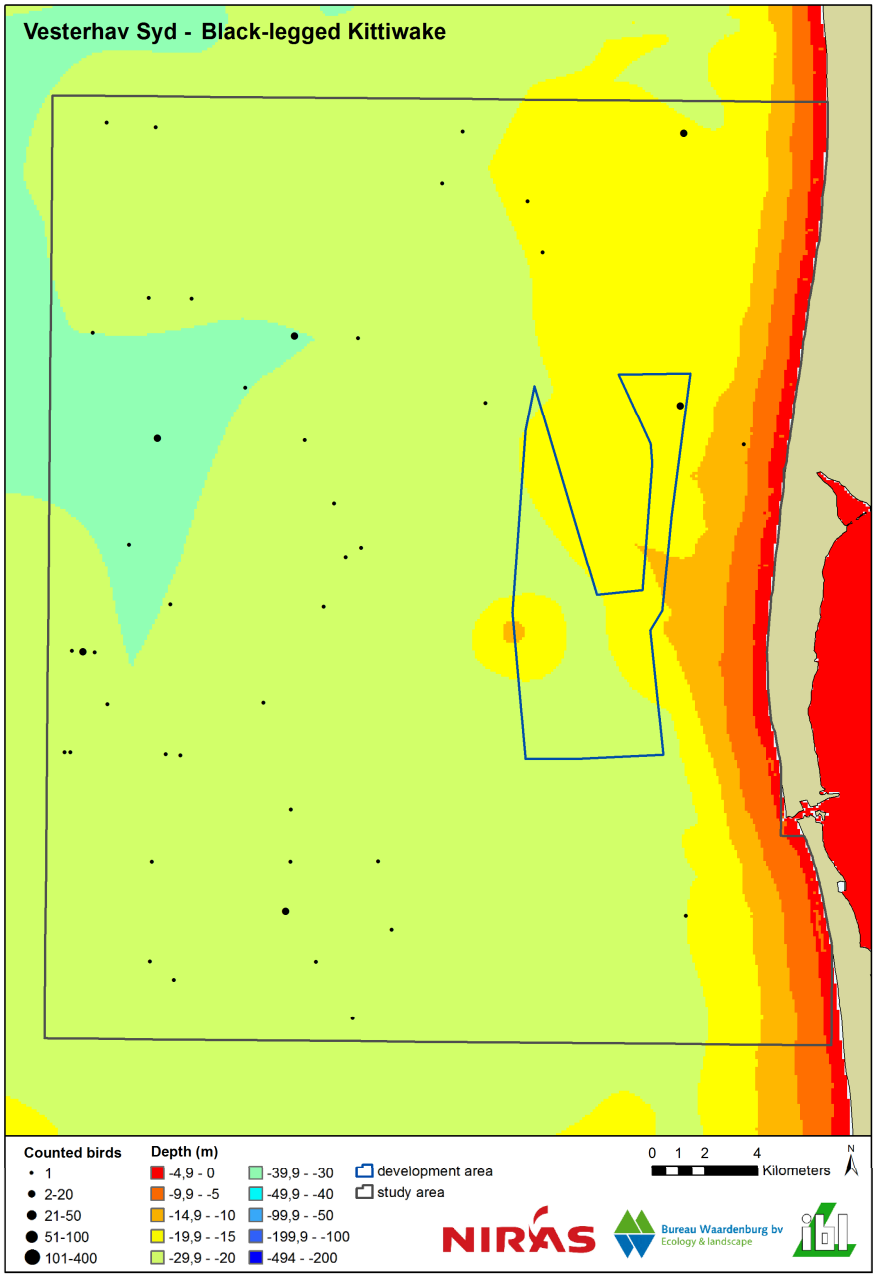


Figure 74: Distribution of counted Black-legged Kittiwakes as a sum of all six surveys in relation to water depth

16.5 Collision modeling of resting birds with different turbine size

Table 65: Collision modelling with 66 turbines / 3 MW

Vesterhav Syd 66x3MW	**Avoidance rate 95%**					
Species	**25.11.2013**	**03.02.2014**	**11.02.2014**	**11.03.2014**	**25.03.2014**	**16.04.2014**
Red-throated Diver	0,16	0,00	0,02	0,00	0,00	0,33
Northern Gannet	0,00	0,00	0,00	0,25	3,70	0,28
Long-tailed Duck	0,00	0,00	0,00	0,00	0,00	0,00
Common Scoter	10,02	2,98	18,52	14,10	6,17	3,70
Velvet Scoter	0,00	0,00	0,00	1,20	1,26	0,05
Little Gull	0,00	0,00	0,41	0,00	0,00	0,00
Common Gull	27,66	3,90	16,26	48,94	57,16	5,45
Lesser Black-backed Gull	0,00	0,00	0,00	3,43	6,48	1,27
Herring Gull	37,61	1,33	1,97	27,37	34,10	19,26
Great Black-backed Gull	2,42	7,91	1,56	0,00	4,28	1,34
Black-legged Kittiw ake	1,53	0,41	0,00	0,00	0,00	0,00
Common Guillemot	0,00	0,00	0,00	0,00	0,00	0,00
divers	0,33	0,49	0,07	0,36	0,95	0,02
small gulls	14,96	2,27	14,34	25,72	30,96	3,53
large gulls	35,26	7,33	2,26	29,98	37,51	20,08
auks	0,00	0,00	0,00	0,00	0,00	0,00
Vesterhav Syd 66x3MW	**Avoidance rate 98%**					
Species	**25.11.2013**	**03.02.2014**	**11.02.2014**	**11.03.2014**	**25.03.2014**	**16.04.2014**
Red-throated Diver	0,06		0,01	0,00	0,00	0,13
Northern Gannet	0,00	0,00	0,00	0,10	1,48	0,11
Long-tailed Duck	0,00	0,00	0,00	0,00	0,00	0,00
Common Scoter	4,01	1,19	7,41	5,64	2,47	1,48
Velvet Scoter	0,00	0,00	0,00	0,48	0,50	0,02
Little Gull	0,00	0,00	0,16	0,00	0,00	0,00
Common Gull	11,06	1,56	6,51	19,58	22,86	2,18
Lesser Black-backed Gull	0,00	0,00	0,00	1,37	2,59	0,51
Herring Gull	15,04	0,53	0,79	10,95	13,64	7,70
Great Black-backed Gull	0,97	3,16	0,62	0,00	1,71	0,54
Black-legged Kittiw ake	0,61	0,16	0,00	0,00	0,00	0,00
Common Guillemot	0,00	0,00	0,00	0,00	0,00	0,00
divers	0,13	0,20	0,03	0,14	0,38	0,01
small gulls	5,98	0,91	5,74	10,29	12,39	1,41
large gulls	14,10	2,93	0,90	11,99	15,01	8,03
auks	0,00	0,00	0,00	0,00	0,00	0,00
Vesterhav Syd 66x3MW	**Avoidance rate 99%**					
Species	**25.11.2013**	**03.02.2014**	**11.02.2014**	**11.03.2014**	**25.03.2014**	**16.04.2014**
Red-throated Diver	0,03	0,00	0,00	0,00	0,00	0,07
Northern Gannet	0,00	0,00	0,00	0,05	0,74	0,06
Long-tailed Duck	0,00	0,00	0,00	0,00	0,00	0,00
Common Scoter	2,00	0,60	3,70	2,82	1,23	0,74
Velvet Scoter	0,00	0,00	0,00	0,24	0,25	0,01
Little Gull	0,00	0,00	0,08	0,00	0,00	0,00
Common Gull	5,53	0,78	3,25	9,79	11,43	1,09
Lesser Black-backed Gull	0,00	0,00	0,00	0,69	1,30	0,25
Herring Gull	7,52	0,27	0,39	5,47	6,82	3,85
Great Black-backed Gull	0,48	1,58	0,31	0,00	0,86	0,27
Black-legged Kittiw ake	0,31	0,08	0,00	0,00	0,00	0,00
Common Guillemot	0,00	0,00	0,00	0,00	0,00	0,00
divers	0,07	0,10	0,01	0,07	0,19	0,00
small gulls	2,99	0,45	2,87	5,14	6,19	0,71
large gulls	7,05	1,47	0,45	6,00	7,50	4,02
auks	0,00	0,00	0,00	0,00	0,00	0,00
Vesterhav Syd 66x3MW	**Avoidance rate 99.5%**					
Species	**25.11.2013**	**03.02.2014**	**11.02.2014**	**11.03.2014**	**25.03.2014**	**16.04.2014**
Red-throated Diver	0,02	0,00	0,00	0,00	0,00	0,03
Northern Gannet	0,00	0,00	0,00	0,03	0,37	0,03
Long-tailed Duck	0,00	0,00	0,00	0,00	0,00	0,00
Common Scoter	1,00	0,30	1,85	1,41	0,62	0,37
Velvet Scoter	0,00	0,00	0,00	0,12	0,13	0,01
Little Gull	0,00	0,00	0,04	0,00	0,00	0,00
Common Gull	2,77	0,39	1,63	4,89	5,72	0,54
Lesser Black-backed Gull	0,00	0,00	0,00	0,34	0,65	0,13
Herring Gull	3,76	0,13	0,20	2,74	3,41	1,93
Great Black-backed Gull	0,24	0,79	0,16	0,00	0,43	0,13
Black-legged Kittiw ake	0,15	0,04	0,00	0,00	0,00	0,00
Common Guillemot	0,00	0,00	0,00	0,00	0,00	0,00
divers	0,03	0,05	0,01	0,04	0,09	0,00
small gulls	1,50	0,23	1,43	2,57	3,10	0,35
large gulls	3,53	0,73	0,23	3,00	3,75	2,01
auks	0,00	0,00	0,00	0,00	0,00	0,00

Table 66: Collision modelling with 20 turbines / 10 MW

Vesterhav Syd 20x10MW	**Avoidance rate 95%**					
Species	**25.11.2013**	**03.02.2014**	**11.02.2014**	**11.03.2014**	**25.03.2014**	**16.04.2014**
Red-throated Diver	0,04	0,00	0,00	0,00	0,00	0,06
Northern Gannet	0,00	0,00	0,00	0,06	0,86	0,06
Long-tailed Duck	0,00	0,00	0,00	0,00	0,00	0,00
Common Scoter	1,73	0,49	3,08	2,19	0,96	0,54
Velvet Scoter	0,00	0,00	0,00	0,18	0,19	0,01
Little Gull	0,00	0,00	0,12	0,00	0,00	0,00
Common Gull	8,61	1,17	4,88	13,75	16,06	1,44
Lesser Black-backed Gull	0,00	0,00	0,00	0,99	1,87	0,34
Herring Gull	12,37	0,42	0,62	8,13	10,13	5,37
Great Black-backed Gull	0,79	2,50	0,49	0,00	1,27	0,37
Black-legged Kittiw ake	0,43	0,11	0,00	0,00	0,00	0,00
Common Guillemot	0,00	0,00	0,00	0,00	0,00	0,00
divers	0,09	0,12	0,02	0,07	0,19	0,00
small gulls	4,89	0,69	4,37	6,94	8,35	0,85
large gulls	11,49	2,30	0,71	8,82	11,03	5,54
auks	0,00	0,00	0,00	0,00	0,00	0,00
Vesterhav Syd 20x10MW	**Avoidance rate 98%**					
Species	**25.11.2013**	**03.02.2014**	**11.02.2014**	**11.03.2014**	**25.03.2014**	**16.04.2014**
Red-throated Diver	0,02	0,00	0,00	0,00	0,00	0,02
Northern Gannet	0,00	0,00	0,00	0,02	0,34	0,02
Long-tailed Duck	0,00	0,00	0,00	0,00	0,00	0,00
Common Scoter	0,69	0,20	1,23	0,88	0,38	0,22
Velvet Scoter	0,00	0,00	0,00	0,07	0,08	0,00
Little Gull	0,00	0,00	0,05	0,00	0,00	0,00
Common Gull	3,44	0,47	1,95	5,50	6,42	0,57
Lesser Black-backed Gull	0,00	0,00	0,00	0,40	0,75	0,14
Herring Gull	4,95	0,17	0,25	3,25	4,05	2,15
Great Black-backed Gull	0,32	1,00	0,20	0,00	0,51	0,15
Black-legged Kittiw ake	0,17	0,04	0,00	0,00	0,00	0,00
Common Guillemot	0,00	0,00	0,00	0,00	0,00	0,00
divers	0,04	0,05	0,01	0,03	0,08	0,00
small gulls	1,96	0,28	1,75	2,77	3,34	0,34
large gulls	4,59	0,92	0,28	3,53	4,41	2,22
auks	0,00	0,00	0,00	0,00	0,00	0,00
Vesterhav Syd 20x10MW	**Avoidance rate 99%**					
Species	**25.11.2013**	**03.02.2014**	**11.02.2014**	**11.03.2014**	**25.03.2014**	**16.04.2014**
Red-throated Diver	0,01	0,00	0,00	0,00	0,00	0,01
Northern Gannet	0,00	0,00	0,00	0,01	0,17	0,01
Long-tailed Duck	0,00	0,00	0,00	0,00	0,00	0,00
Common Scoter	0,35	0,10	0,62	0,44	0,19	0,11
Velvet Scoter	0,00	0,00	0,00	0,04	0,04	0,00
Little Gull	0,00	0,00	0,02	0,00	0,00	0,00
Common Gull	1,72	0,23	0,98	2,75	3,21	0,29
Lesser Black-backed Gull	0,00	0,00	0,00	0,20	0,37	0,07
Herring Gull	2,47	0,08	0,12	1,63	2,03	1,07
Great Black-backed Gull	0,16	0,50	0,10	0,00	0,25	0,07
Black-legged Kittiw ake	0,09	0,02	0,00	0,00	0,00	0,00
Common Guillemot	0,00	0,00	0,00	0,00	0,00	0,00
divers	0,02	0,02	0,00	0,01	0,04	0,00
small gulls	0,98	0,14	0,87	1,39	1,67	0,17
large gulls	2,30	0,46	0,14	1,76	2,21	1,11
auks	0,00	0,00	0,00	0,00	0,00	0,00
Vesterhav Syd 20x10MW	**Avoidance rate 99.5%**					
Species	**25.11.2013**	**03.02.2014**	**11.02.2014**	**11.03.2014**	**25.03.2014**	**16.04.2014**
Red-throated Diver	0,00	0,00	0,00	0,00	0,00	0,01
Northern Gannet	0,00	0,00	0,00	0,01	0,09	0,01
Long-tailed Duck	0,00	0,00	0,00	0,00	0,00	0,00
Common Scoter	0,17	0,05	0,31	0,22	0,10	0,05
Velvet Scoter	0,00	0,00	0,00	0,02	0,02	0,00
Little Gull	0,00	0,00	0,01	0,00	0,00	0,00
Common Gull	0,86	0,12	0,49	1,38	1,61	0,14
Lesser Black-backed Gull	0,00	0,00	0,00	0,10	0,19	0,03
Herring Gull	1,24	0,04	0,06	0,81	1,01	0,54
Great Black-backed Gull	0,08	0,25	0,05	0,00	0,13	0,04
Black-legged Kittiw ake	0,04	0,01	0,00	0,00	0,00	0,00
Common Guillemot	0,00	0,00	0,00	0,00	0,00	0,00
divers	0,01	0,01	0,00	0,01	0,02	0,00
small gulls	0,49	0,07	0,44	0,69	0,83	0,09
large gulls	1,15	0,23	0,07	0,88	1,10	0,55
auks	0,00	0,00	0,00	0,00	0,00	0,00

16.6 Bird numbers within buffer zones around Development area

Table 67: Number of divers in different areas around the Development area (DA, buffer zones) for each survey. Population Estimate (PE), lower 95% confidence interval (LCI) and higher 95 % confidence interval (HCI) are given

		DA +4km			DA +3km			DA +2km			DA +1km			DA +0.5km		
Date	Survey	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI
25.11.2013	13_01	295	210	415	210	149	295	186	132	261	125	89	176	93	66	131
03.02.2014	14_02	96	60	154	48	30	77	15	9	24	11	7	18	4	2	6
11.02.2014	14_03	55	41	73	35	27	47	23	17	30	10	7	13	0	0	0
11.03.2014	14_04	338	228	501	289	195	429	182	123	269	111	75	164	40	27	59
25.03.2014	14_05	100	63	160	91	57	145	28	18	45	9	6	15	9	6	15
16.04.2014	14_06	4	2	8	4	2	8	4	2	8	0	0	0	0	0	0

Table 68: Number of Northern gannets in different areas around the Development area (DA, buffer zones) for each survey. Population Estimate (PE), lower 95% confidence interval (LCI) and higher 95 % confidence interval (HCI) are given

		DA +4 km			DA +3 km			DA +2 km			DA +1 km			DA +0.5 km		
date	Surve	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI
25.11.2013	13_01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03.02.2014	14_02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.02.2014	14_03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.03.2014	14_04	1	1	4	1	1	4	1	1	4	0	0	0	0	0	0
25.03.2014	14_05	22	14	36	22	14	36	21	13	33	13	8	20	6	4	10
16.04.2014	14_06	1	1	3	0	0	0	0	0	0	0	0	0	0	0	0

Table 69: Number of Common Scoter in different areas around the Development area (DA, buffer zones) for each survey. Population Estimate (PE), lower 95% confidence interval (LCI) and higher 95 % confidence interval (HCI) are given

		DA +4 km			DA +3 km			DA +2 km			DA +1 km			DA +0.5 km		
date	Surve	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI
25.11.2013	13_01	539	284	1025	344	181	655	316	166	602	167	88	318	84	44	159
03.02.2014	14_02	183	90	369	151	75	305	144	71	292	81	40	164	50	25	100
11.02.2014	14_03	1266	629	2550	1066	529	2146	674	335	1358	456	226	919	334	166	673
11.03.2014	14_04	744	296	1870	668	266	1680	587	234	1476	149	59	375	31	12	79
25.03.2014	14_05	310	92	1048	295	87	997	92	27	311	62	18	210	43	13	146
16.04.2014	14_06	168	69	413	168	69	413	93	38	229	52	21	128	6	2	14

Table 70: Number of Velvet Scoter in different areas around the Development area (DA, buffer zones) for each survey. Population Estimate (PE), lower 95% confidence interval (LCI) and higher 95 % confidence interval (HCI) are given

		DA +4 km			DA +3 km			DA +2 km			DA +1 km			DA +0.5 km		
date	Surve	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI
25.11.2013	13_01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03.02.2014	14_02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.02.2014	14_03	7	2	22	7	2	22	7	2	22	5	2	14	5	2	14
11.03.2014	14_04	60	17	207	60	17	207	60	17	207	0	0	0	0	0	0
25.03.2014	14_05	49	2	1011	49	2	1011	2	0	48	0	0	0	0	0	0
16.04.2014	14_06	2	0	12	2	0	12	2	0	12	0	0	0	0	0	0

Table 71: Number of Little Gulls in different areas around the Development area (DA, buffer zones) for each survey. Population Estimate (PE), lower 95% confidence interval (LCI) and higher 95 % confidence interval (HCI) are given

		DA +4 km			DA +3 km			DA +2 km			DA +1 km			DA +0.5 km		
date	Surve	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI
25.11.2013	13_01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03.02.2014	14_02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.02.2014	14_03	5	3	10	5	3	10	3	1	5	0	0	0	0	0	0
11.03.2014	14_04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25.03.2014	14_05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.04.2014	14_06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 72: Number of Common Gulls in different areas around the Development area (DA, buffer zones) for each survey. Population Estimate (PE), lower 95% confidence interval (LCI) and higher 95 % confidence interval (HCI) are given

		DA +4 km			DA +3 km			DA +2 km			DA +1 km			DA +0.5 km		
date	Surve	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI
25.11.2013	13_01	266	174	406	196	128	300	81	53	124	75	49	115	54	35	82
03.02.2014	14_02	18	11	30	13	8	22	13	8	22	8	5	13	8	5	13
11.02.2014	14_03	67	50	90	60	44	80	18	14	24	13	10	17	0	0	0
11.03.2014	14_04	175	108	285	31	19	50	14	9	24	11	7	18	7	4	12
25.03.2014	14_05	495	347	706	258	181	369	213	149	304	78	55	111	74	52	105
16.04.2014	14_06	23	13	38	8	4	13	8	4	13	5	3	8	3	1	4

Table 73: Number of Lesser Black-backed Gulls in different areas around the Development area (DA, buffer zones) for each survey. Population Estimate (PE), lower 95% confidence interval (LCI) and higher 95 % confidence interval (HCI) are given

		DA +4 km			DA +3 km			DA +2 km			DA +1 km			DA +0.5 km		
date	Surve	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI
25.11.2013	13_01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03.02.2014	14_02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.02.2014	14_03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.03.2014	14_04	13	6	28	13	6	28	10	5	22	10	5	22	8	3	17
25.03.2014	14_05	21	12	37	21	12	37	13	7	23	5	3	9	3	1	5
16.04.2014	14_06	4	1	21	4	1	21	4	1	21	0	0	0	0	0	0

Table 74: Number of Herring Gulls in different areas around the Development area (DA, buffer zones) for each survey. Population Estimate (PE), lower 95% confidence interval (LCI) and higher 95 % confidence interval (HCI) are given

		DA +4 km			DA +3 km			DA +2 km			DA +1 km			DA +0.5 km		
date	Surve	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI
25.11.2013	13_01	111	48	254	104	46	240	71	31	162	46	20	106	40	17	92
03.02.2014	14_02	3	1	7	3	1	7	3	1	7	0	0	0	0	0	0
11.02.2014	14_03	8	3	19	8	3	19	0	0	0	0	0	0	0	0	0
11.03.2014	14_04	121	68	215	13	7	23	11	6	20	6	3	10	2	1	3
25.03.2014	14_05	281	167	473	275	164	464	150	90	253	30	18	51	27	16	45
16.04.2014	14_06	53	30	94	24	14	43	11	6	20	7	4	12	2	1	4

Table 75: Number of Great black-Backed Gulls in different areas around the Development area (DA, buffer zones) for each survey. Population Estimate (PE), lower 95% confidence interval (LCI) and higher 95 % confidence interval (HCI) are given

		DA +4 km			DA +3 km			DA +2 km			DA +1 km			DA +0.5 km		
date	Surve	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI
25.11.2013	13_01	6	2	18	3	1	9	3	1	9	3	1	9	0	0	0
03.02.2014	14_02	15	5	42	3	1	7	3	1	7	0	0	0	0	0	0
11.02.2014	14_03	5	2	16	5	2	16	0	0	0	0	0	0	0	0	0
11.03.2014	14_04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25.03.2014	14_05	8	3	20	8	3	20	6	2	14	3	1	7	3	1	7
16.04.2014	14_06	5	2	12	0	0	0	0	0	0	0	0	0	0	0	0

Table 76: Number of Black-legged Kittiwakes in different areas around the Development area (DA, buffer zones) for each survey. Population Estimate (PE), lower 95% confidence interval (LCI) and higher 95 % confidence interval (HCI) are given

		DA +4 km			DA +3 km			DA +2 km			DA +1 km			DA +0.5 km		
date	Surve	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI
25.11.2013	13_01	11	7	18	11	7	18	11	7	18	7	4	12	7	4	12
03.02.2014	14_02	3	1	7	3	1	7	0	0	0	0	0	0	0	0	0
11.02.2014	14_03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.03.2014	14_04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25.03.2014	14_05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.04.2014	14_06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 77: Number of “small gulls” in different areas around the Development area (DA, buffer zones) for each survey. Population Estimate (PE), lower 95% confidence interval (LCI) and higher 95 % confidence interval (HCI) are given

		DA +4 km			DA +3 km			DA +2 km			DA +1 km			DA +0.5 km		
date	Surve	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI
25.11.2013	13_01	296	214	410	227	164	315	117	85	162	108	78	150	86	62	119
03.02.2014	14_02	19	13	29	14	10	21	12	8	18	7	5	11	7	5	11
11.02.2014	14_03	110	82	146	101	76	135	19	14	25	11	8	14	0	0	0
11.03.2014	14_04	170	110	262	31	20	48	15	10	24	12	8	19	7	4	11
25.03.2014	14_05	475	350	644	251	185	340	208	153	282	76	56	103	72	53	98
16.04.2014	14_06	23	12	41	8	4	14	8	4	14	5	3	9	3	1	5

Table 78: Number of “large gulls” in different areas around the Development area (DA, buffer zones) for each survey. Population Estimate (PE), lower 95% confidence interval (LCI) and higher 95 % confidence interval (HCI) are given

		DA +4 km			DA +3 km			DA +2 km			DA +1 km			DA +0.5 km		
date	Surve	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI
25.11.2013	13_01	105	28	402	97	25	370	67	17	254	44	12	169	36	9	137
03.02.2014	14_02	16	4	62	5	1	18	5	1	18	0	0	0	0	0	0
11.02.2014	14_03	11	3	41	11	3	41	0	0	0	0	0	0	0	0	0
11.03.2014	14_04	129	36	455	22	6	77	18	5	64	13	4	45	7	2	26
25.03.2014	14_05	349	100	1212	292	84	1015	181	52	630	63	18	219	57	16	198
16.04.2014	14_06	61	18	211	28	8	98	15	4	53	7	2	23	2	1	8

Table 79: Number of auks in different areas around the Development area (DA, buffer zones) for each survey. Population Estimate (PE), lower 95% confidence interval (LCI) and higher 95 % confidence interval (HCI) are given

		DA +4 km			DA +3 km			DA +2 km			DA +1 km			DA +0.5 km		
date	Surve	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI	PE	LCI	HCI
25.11.2013	13_01	60	44	81	55	41	75	37	27	50	32	24	44	28	20	37
03.02.2014	14_02	4	3	7	4	3	7	4	3	7	4	3	7	4	3	7
11.02.2014	14_03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.03.2014	14_04	14	10	20	11	8	15	7	5	10	7	5	10	0	0	0
25.03.2014	14_05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.04.2014	14_06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

16.7 Tables for determination of the magnitude of impact (assessement methodology)

Table 80: Assessment of degree of impact (high degree of disturbance)

Degree of disturbance	Importance	Likelihood of occurrence	Persistence	Magnitude of impact
High	International interests	High (>75 %)	Permanent (> 5 years)	Major
			Temporary (1-5 years)	Major
			Short-term (0-1 year)	Moderate
		Medium (25-75 %)	Permanent (> 5 years)	Major
			Temporary (1-5 years)	Major
			Short-term (0-1 year)	Moderate
		Low (<25 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Moderate
			Short-term (0-1 year)	Minor
	National or regional interests	High (>75 %)	Permanent (> 5 years)	Major
			Temporary (1-5 years)	Moderate
			Short-term (0-1 year)	Moderate
		Medium (25-75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Moderate
			Short-term (0-1 year)	Minor
		Low (<25 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Minor
	Local interests (important for the area directly affected or for the immediate surroundings)	High (>75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Moderate
			Short-term (0-1 year)	Minor
		Medium (25-75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Negligible/neutral/no impact
		Low (<25 %)	Permanent (> 5 years)	Minor
			Temporary (1-5 years)	Negligible/neutral/no impact
			Short-term (0-1 year)	Negligible/neutral/no impact
	Negligible/not important	High (>75 %)	Permanent (> 5 years)	Negligible/neutral/no impact
			Temporary (1-5 years)	Negligible/neutral/no impact
			Short-term (0-1 year)	Negligible/neutral/no impact
		Medium (25-75 %)	Permanent (> 5 years)	Negligible/neutral/no impact
			Temporary (1-5 years)	Negligible/neutral/no impact
			Short-term (0-1 year)	Negligible/neutral/no impact
		Low (<25 %)	Permanent (> 5 years)	Negligible/neutral/no impact
			Temporary (1-5 years)	Negligible/neutral/no impact
			Short-term (0-1 year)	Negligible/neutral/no impact

Table 81: Assessment of degree of impact (medium degree of disturbance)

Degree of disturbance	Importance	Likelihood of occurrence	Persistence	Magnitude of impact
Medium	International interests	High (>75 %)	Permanent (> 5 years)	Major
			Temporary (1-5 years)	Moderate
			Short-term (0-1 year)	Moderate
		Medium (25-75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Moderate
			Short-term (0-1 year)	Minor
		Low (<25 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Minor
	National or regional interests	High (>75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Moderate
			Short-term (0-1 year)	Minor
		Medium (25-75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Minor
		Low (<25 %)	Permanent (> 5 years)	Minor
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Negligible/neutral/no impact
	Local interests (important for the area directly affected or for the immediate surroundings)	High (>75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Minor
		Medium (25-75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Negligible/neutral/no impact
		Low (<25 %)	Permanent (> 5 years)	Minor
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Negligible/neutral/no impact
	Negligible/not important	High (>75 %)	Permanent (> 5 years)	Negligible/neutral/no impact
			Temporary (1-5 years)	Negligible/neutral//no impact
			Short-term (0-1 year)	Negligible/neutral/no impact
		Medium (25-75 %)	Permanent (> 5 years)	Negligible/neutral/no impact
			Temporary (1-5 years)	Negligible/neutral/no impact
			Short-term (0-1 year)	Negligible/neutral/no impact
		Low (<25 %)	Permanent (> 5 years)	Negligible/neutral/no impact
			Temporary (1-5 years)	Negligible/neutral/no impact
			Short-term (0-1 year)	Negligible/neutral/no impact

Table 82: Assessment of degree of impact (low degree of disturbance)

Degree of disturbance	Importance	Likelihood of occurrence	Persistence	Magnitude of impact
Low	International interests	High (>75 %)	Permanent (> 5 years)	Moderate
			Temporary(1-5 years)	Minor
			Short-term (0-1 year)	Minor
		Medium (25-75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Negligible/neutral/no impact
		Low (<25 %)	Permanent (> 5 years)	Minor
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Negligible/neutral/no impact
	National or regional interests	High (>75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Negligible/neutral/no impact
		Medium (25-75 %)	Permanent (> 5 years)	Minor
			Temporary (1-5 years)	Negligible/neutral/no impact
			Short-term (0-1 year)	Negligible/neutral/no impact
		Low (<25 %)	Permanent (> 5 years)	Minor
			Temporary (1-5 years)	Negligible / neutral/no impact
			Short-term (0-1 year)	Negligible/ neutral/no impact
	Local interests (important for the area directly affected or for the immediate surroundings)	High (>75 %)	Permanent (> 5 years)	Minor
			Temporary (1-5 years)	Negligible/ neutral/no impact
			Short-term (0-1 year)	Negligible/ neutral/no impact
		Medium (25-75 %)	Permanent (> 5 years)	Minor
			Temporary (1-5 years)	Negligible/ neutral/no impact
			Short-term (0-1 year)	Negligible/ neutral/no impact
		Low (<25 %)	Permanent (> 5 years)	Minor
			Temporary (1-5 years)	Negligible/ neutral/no impact
			Short-term (0-1 year)	Negligible/ neutral/no impact
	Negligible/not important	High (>75 %)	Permanent (> 5 years)	Negligible/ neutral/no impact
			Temporary (1-5 years)	Negligible/ neutral/no impact
			Short-term (0-1 year)	Negligible/ neutral/no impact
		Medium (25-75 %)	Permanent (> 5 years)	Negligible/ neutral/no impact
			Temporary (1-5 years)	Negligible/ neutral/no impact
			Short-term (0-1 year)	Negligible/ neutral/no impact
		Low (<25 %)	Permanent (> 5 years)	Negligible/ neutral/no impact
			Temporary (1-5 years)	Negligible/ neutral/no impact
			Short-term (0-1 year)	Negligible/ neutral/no impact