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Horns Rev 3 Offshore Wind Farm

Technical report no. 9

RESTING BIRDS

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SUMMARY

Horns Rev 3 Offshore Wind Farm will be established in a designated area situated north of the wind farms Horns Rev 1 and Horns Rev 2. There have been different wind farm layouts and locations with different turbine and foundation specifications suggested for Horns Rev 3 OWF, of which a worst case scenario with regard to impacts on resting birds was chosen for the impact assessment.

The aim of this report is to present the result of the baseline investigations and to assess the impacts on the resting birds from the construction, operation and decommissioning of Horns Rev 3 OWF.

The Horns Rev area is an important wintering and staging area for a number of different waterbird species. Among these, Common Scoter is the most abundant species in the area with internationally important numbers occurring in the area especially in winter. In spring also very high numbers of divers use the area for stop-over on their spring migration.

As baseline studies for the Horns Rev 3 OWF a total of 10 aerial surveys have been conducted between January and November 2013, covering a survey area from Blåvands Huk in the south to Hvide Sande at Ringkøbing Fjord in the north, stretching from the coast to c. 50 km offshore. Thus the study area ended north of Horns Rev 1 OWF, but covered the area around Horns Rev 2 OWF.

During baseline investigations in 2013 very high numbers of Common Scoters were observed in the study area with numbers peaking in February with a total abundance estimate of 118,336 Common Scoters using the area during that time. Scoters generally were found occurring in highest densities in the southern part of the study area close to the reef area. High densities of Common Scoters were also recorded within the wind farm area of Horns Rev 2 OWF. Highest diver numbers were recorded during the survey in May 2013 with a total abundance estimate of 5,337 divers using the study area. Divers distributions were found to vary considerably between surveys with generally higher densities recorded in the northern part of the study area. Divers were recorded in high densities in the offshore areas, but during some surveys also high numbers were observed close to the coast.

The study area of baseline investigations was also found to be of high importance to the Velvet Scoter, the Little Gull and the Sandwich Tern. For all other waterbird species the area was assessed being of medium or low importance as resting and foraging site.

The impact assessment for construction, operation and decommissioning of the Horns Rev 3 OWF concluded with the following pressures being relevant to resting birds:

- Disturbance
- Habitat loss
- Habitat change

The pressure collisions with structures is only relevant to flying birds and thus assessed as part of the impact assessment report on migrating birds and thus not further considered here.

The impact assessment on resting birds concluded with mostly low impacts to resting birds. The highest effects are predicted to result from disturbances, which result in displacement of sensitive species both from the construction and the wind farm site. Relevant numbers of displaced birds due to disturbance effects are predicted for divers and the Common Scoter. However, no significant impacts are predicted to any resting bird species during construction and operation of the Horns Rev 3 OWF.

Red-throated Diver © Thomas W. Johansen

1. INTRODUCTION

In 1996 the Danish Government passed a new energy plan, 'Energy 21', that stipulates the need to reduce the emission of the greenhouse gas CO_2 by 20% in 2005 compared to 1988. Energy 21 also sets the scene for further reductions after the year 2005 (Miljø- og Energiministeriet 1996).

The number of offshore wind farms (OWF) is steadily increasing in Denmark and the rest of Europe due to the high demand both economically and politically, for renewable energy. Denmark plans to establish OWFs with a total capacity of 4,400 MW (Energistyrelsen 2011). The overall aim is that offshore wind will contribute as much as 50% of the total national consumption of electricity in 2025. The energy generated from OWFs was approximately 665 MW in 2012 (www.offshorecenter.dk).

In 1998, an agreement was signed between the Danish Government and the energy companies to establish a large-scale demonstration programme. The development of Horns Rev and Nysted OWFs was the result of this action plan (Elsam Engineering & ENERGI E2 2005). The aim of this programme was to investigate the impacts on the environment before, during and after establishment of the wind farms. A series of studies of the environmental conditions and possible impacts from the OWFs were undertaken for the purpose of ensuring that offshore wind power does not have damaging effects on the natural ecosystems. These environmental studies are of major importance for the establishment of new wind farms and extensions of existing OWFs like Nysted and Horns Rev 1 OWF.

Prior to the construction of the demonstration wind farms at Nysted and Horns Rev, a number of baseline studies were carried out in order to describe the environment before the construction. The studies were followed up by investigations during and after the construction phase, and all environmental impacts were assessed. Detailed information on methods and conclusions of these investigations can be found in the annual reports (www.hornsrev.dk; www.nystedhavmoellepark.dk).

On August 25th, 2005 the Danish Energy Authorities issued permission to ENERGI E2 to carry out an Environmental Impact Assessment (EIA) at Horns Rev with particular reference to the construction of a new OWF at the site, Horns Rev 2 OWF. The wind farm has operated since November 2009 and the installed capacity of this wind farm is 209 MW, equivalent to 2% of the Danish consumption of electricity (http://www.hornsrev2.dk/).

On the 22nd of March 2011 a broad political majority agreed on the construction of two new OWFs:

- Horns Rev 3 (400 MW)
- Kriegers Flak (600 MW)

With orders from the Danish Energy Agency (ESA), Energinet.dk has to perform and contract the preparation of background reports, impact assessment and environmental impact statements for the two wind farms.

The present report comprises the results of the baseline investigations and the impact assessment of the possible impacts from construction, operation and decommissioning of the Horns Rev 3 OWF on resting birds. The impact assessment covers the impacts from construction works and operation of the wind farm itself as well as the installation and operation of the subsea cables within the wind farm and from the transformer platform to land.

The assessment is based on the dedicated aerial surveys conducted in the Horns Rev 3 area from January to November 2013 and available information and data from other studies conducted in the greater Horns Rev area in the past decade. The results of these studies supplement the data collected during this study to describe abundance and distribution of waterbirds in the area. Also the sensitivity of the bird species to different pressures from construction and operation of an OWF was conducted based on literature wherever possible.

Northern Gannet

2. DESCRIPTION OF THE PROJECT

2.1. Description of the wind farm area

The planned Horns Rev 3 OWF (400 MW) is located north of Horns Rev in a shallow area in the eastern North Sea, about 20-35 km northwest of the westernmost point of Denmark, Blåvands Huk. The area covers approximately 145 km^2. To the west it is delineated by gradually deeper waters, to the south/southwest by the existing OWF Horns Rev 2, to the southeast by the export cable from Horns Rev 2 OWF, and to the north by oil/gas pipelines. The wind farm will be located within the Horns Rev 3 project area, however not the entire area is expected to be used for the OWF (Figure 2.1).

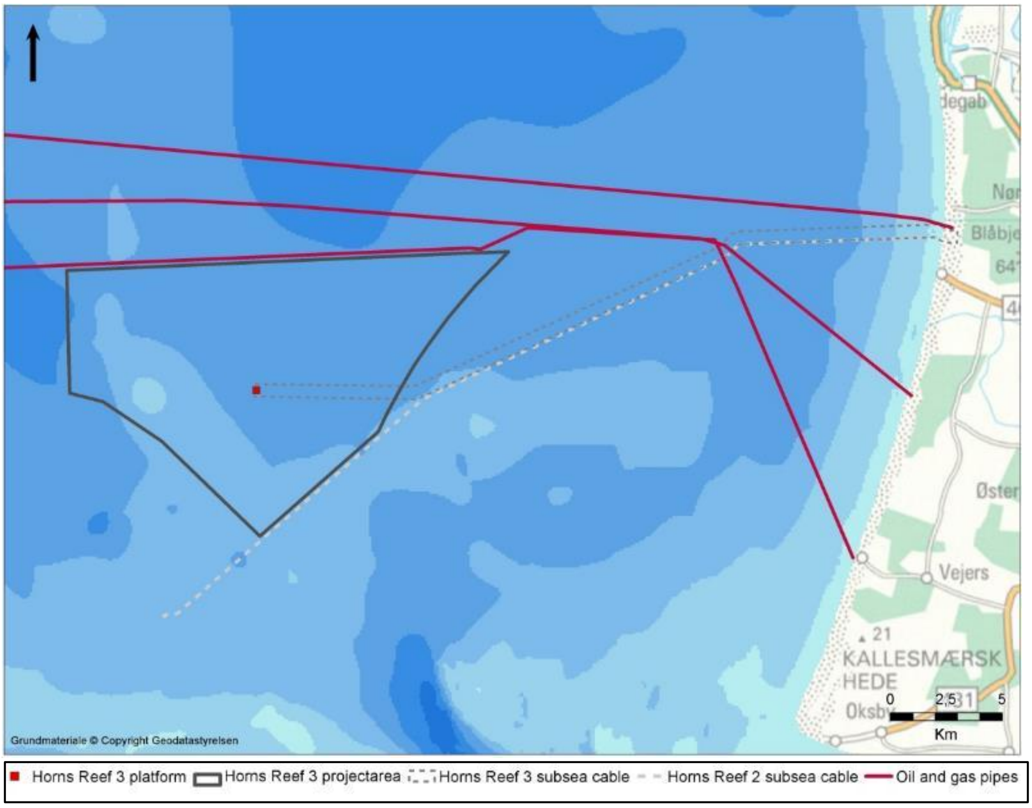


Figure 2.1 Location of the Horns Rev 3 OWF (400 MW) and the projected corridor for export cables towards shore. The area enclosed by the polygon is app. 150 km^2. The marked area includes the whole pre-investigation area, i.e. with an overlap of existing cables etc.

In the center of the Horns Rev 3 project area lies a zone occupying 30–35% of the total area which is classified as a former WWII minefield oriented 'no fishing, no anchoring zone'. Also, just south/southeast of the Horns Rev 2 export cable an existing military training field is delineated. In 2012 the engineering consultant NIRAS completed a desk study on potential UXO (UneXploded Ordnance) contaminations in the Horns Rev 3 project area. For the central and eastern parts of the area the report concludes a medium to high UXO threat is present, while for the western part of the Horns Rev 3 project area the report concludes a low UXO threat is present.

The water depth in the Horns Rev 3 project area varies between approximately 10-21 m (Figure 2.2). The shallowest part is located on a ridge in the southwest of the site and the maximum water depth is reached in the northern part of the area. Sand waves and mega-ripples are observed throughout the area.

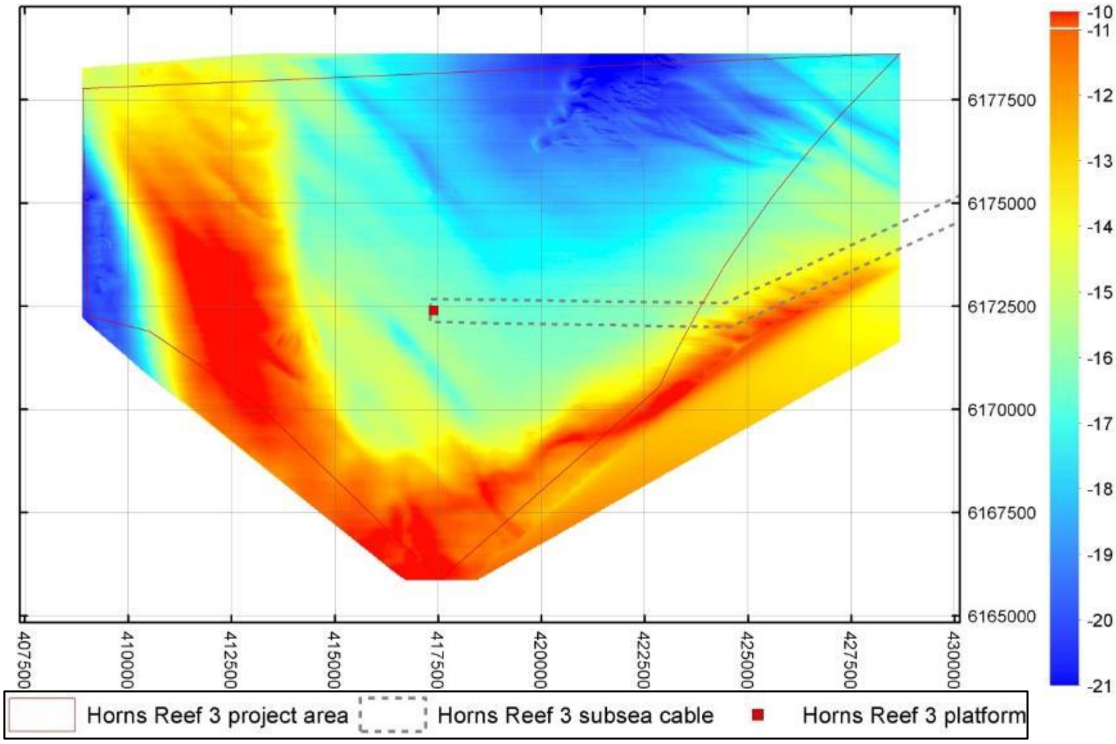


Figure 2.2 Bathymetric map of the Horns Rev 3 area showing depths below DVR90 as graded colour. The map is based upon the Geophysical survey in 2012.

2.2. The turbines

The maximum rated capacity of the wind farm is limited to 400 MW.

The type of turbine and foundation has not yet been decided. However, the wind farm will feature between 40 and 136 turbines depending on the rated energy of the selected turbines corresponding to the range of 3–10 MW. The 3 MW turbine was launched in 2009 and is planned to be installed at the Belgium Northwind project. The 3.6 MW turbine was released in 2009 and has since been installed at various wind farms, e.g. Anholt Offshore Wind Farm. The 4 MW turbines are gradually replacing the 3.6 MW on coming offshore wind farm installations. The 6 MW turbine was launched in 2011 and the 8 MW was launched in late 2012, both turbines are being tested and may be another option for the Horns Rev 3 OWF. A 10 MW turbine is under development which may also be an option for Horns Rev 3 OWF. There is a possibility that more than one turbine model will be installed due to the rapid development of the wind turbine industry and a construction program that can be spread over more than one year.

Suggested layouts for different scenarios are presented in the figures below. Three layouts were made for 3 MW, 8 MW and 10 MW, respectively – and for three different locations of the wind farm; closest to the shore (eastern part of the project area), in the northern part of the project area, and in the western part of the project area.

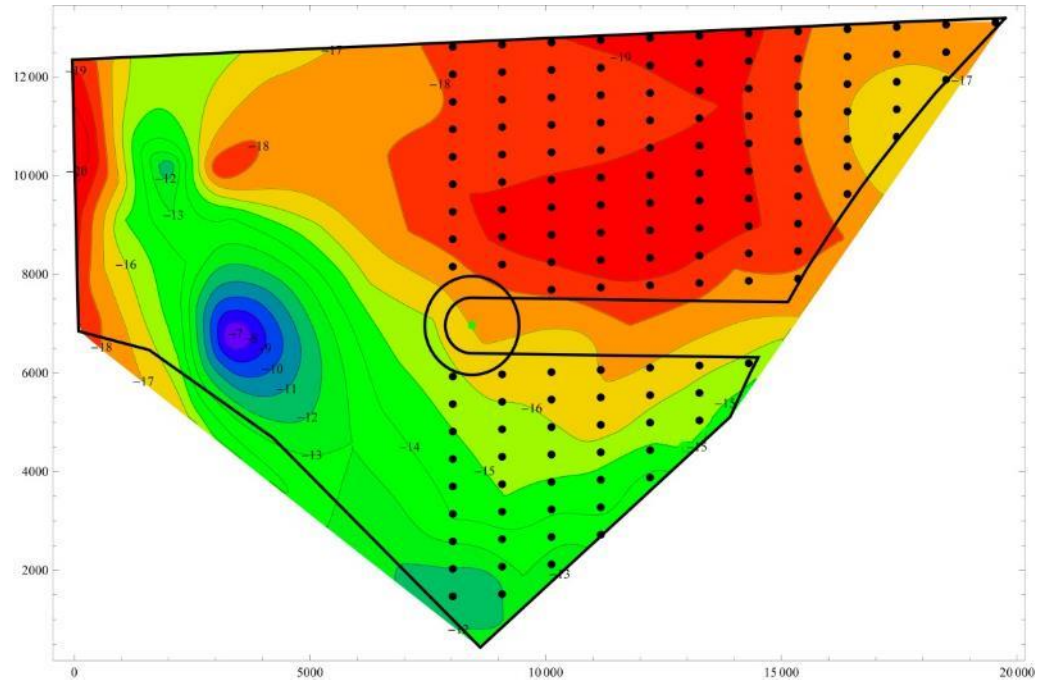


Figure 2.3 Suggested layout for the 3.0 MW wind turbine at Horns Rev 3, closest to shore.

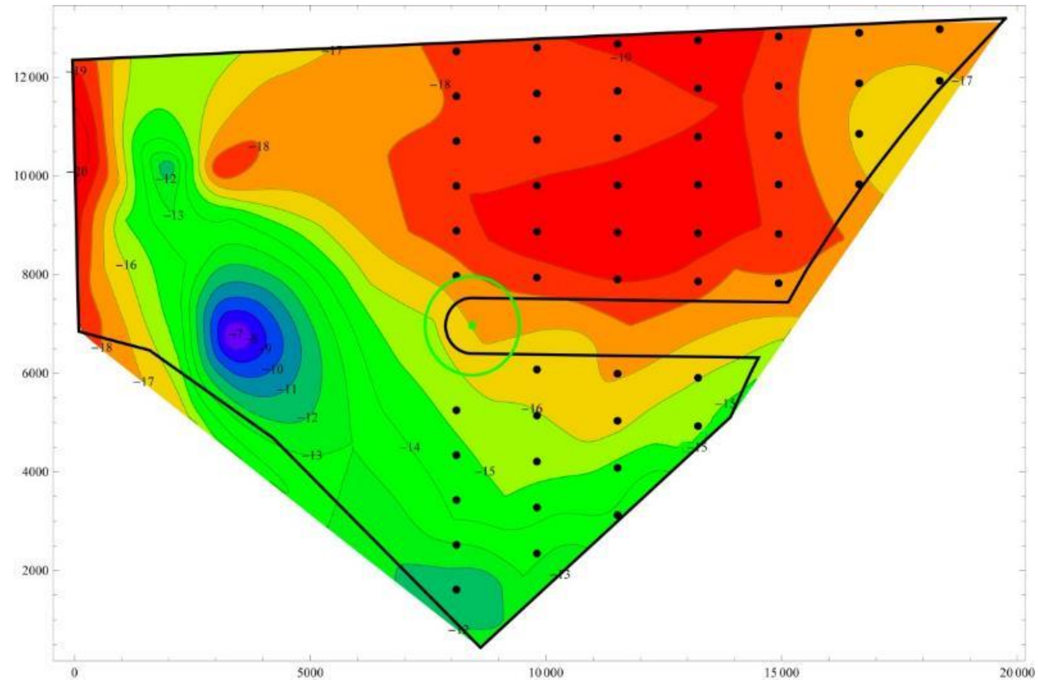


Figure 2.4 Suggested layout for the 8.0 MW wind turbine at Horns Rev 3, closest to shore.

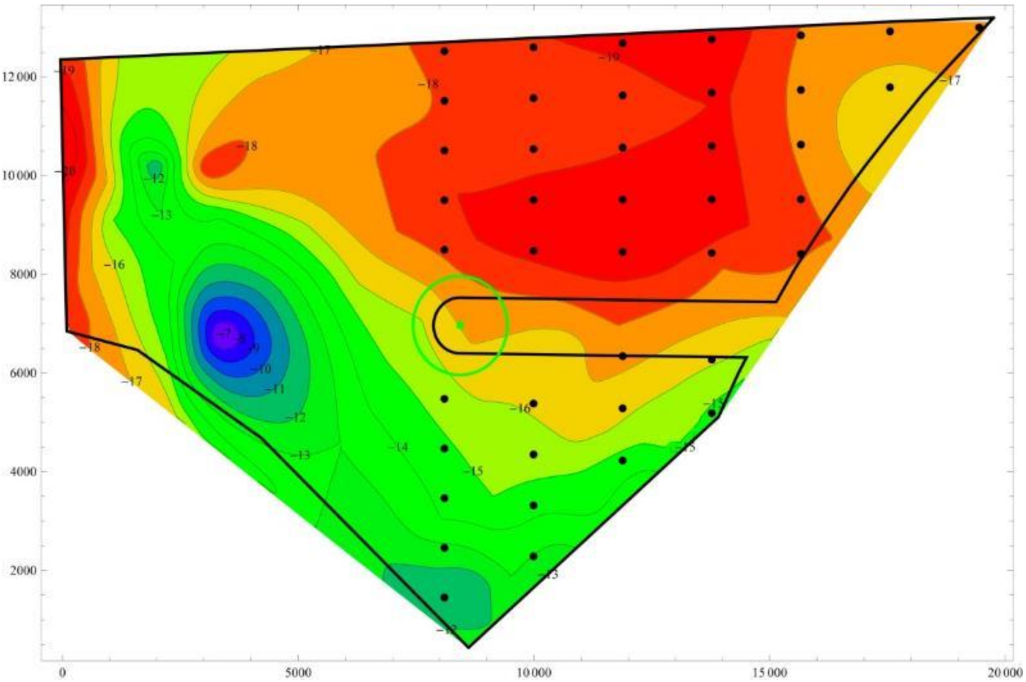


Figure 2.5 Suggested layout for the 10.0 MW wind turbine at Horns Rev 3, closest to shore.

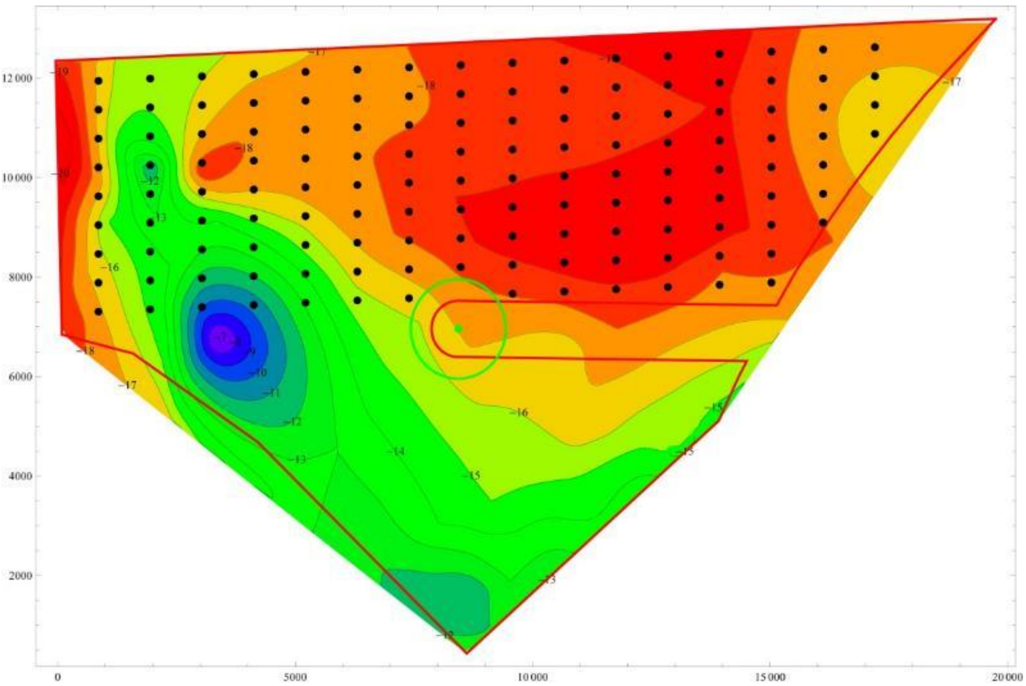


Figure 2.6 Suggested layout for the 3.0 MW wind turbine at Horns Rev 3, located in the northern part of the area.

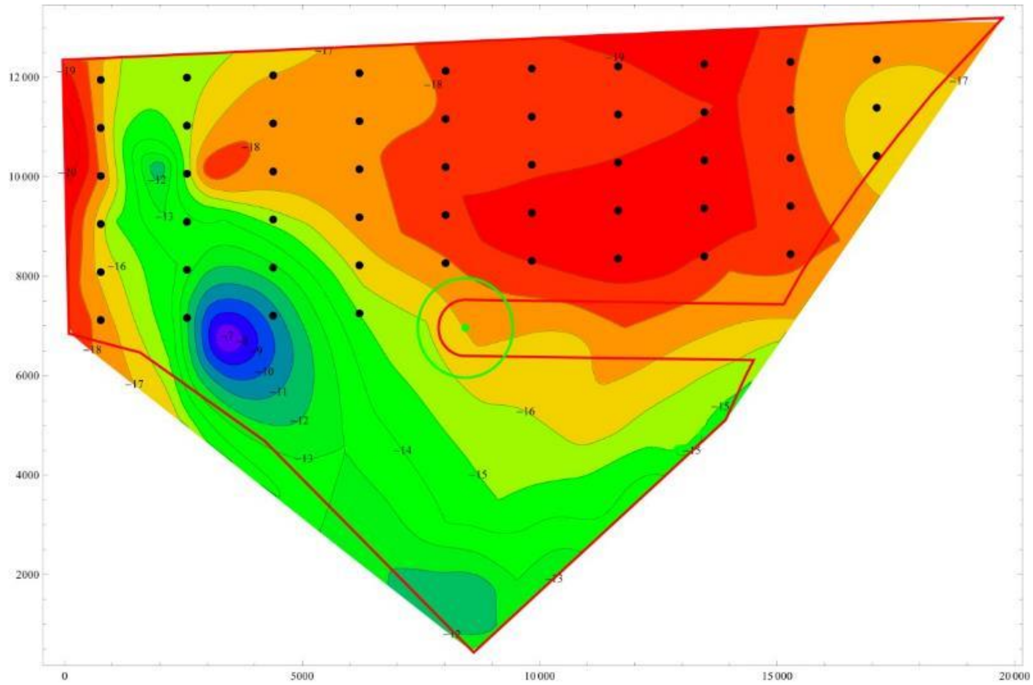


Figure 2.7 Suggested layout for the 8.0 MW wind turbine at Horns Rev 3, located in the northern part of the area.

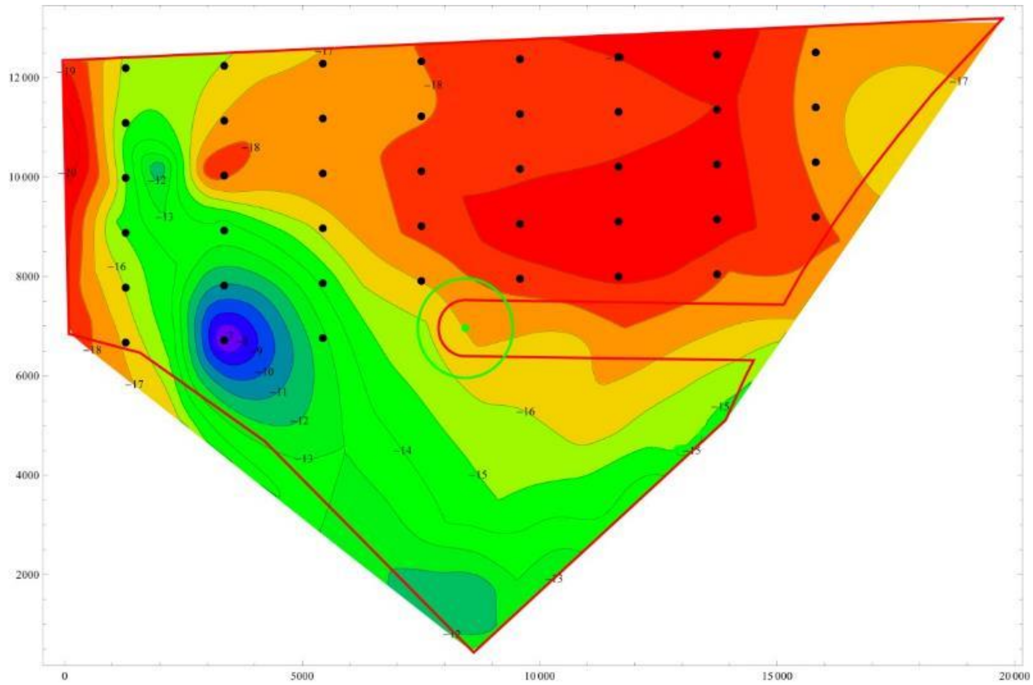


Figure 2.8 Suggested layout for the 10.0 MW wind turbine at Horns Rev 3, located in the northern part of the area.

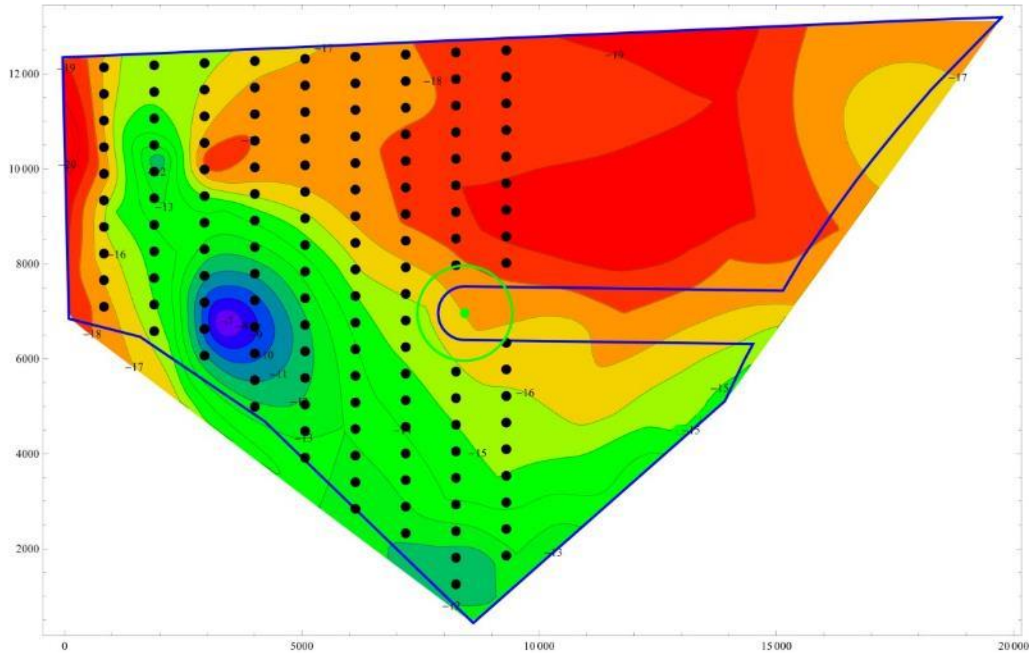


Figure 2.9 Suggested layout for the 3.0 MW wind turbine at Horns Rev 3, located in the western part of the area.

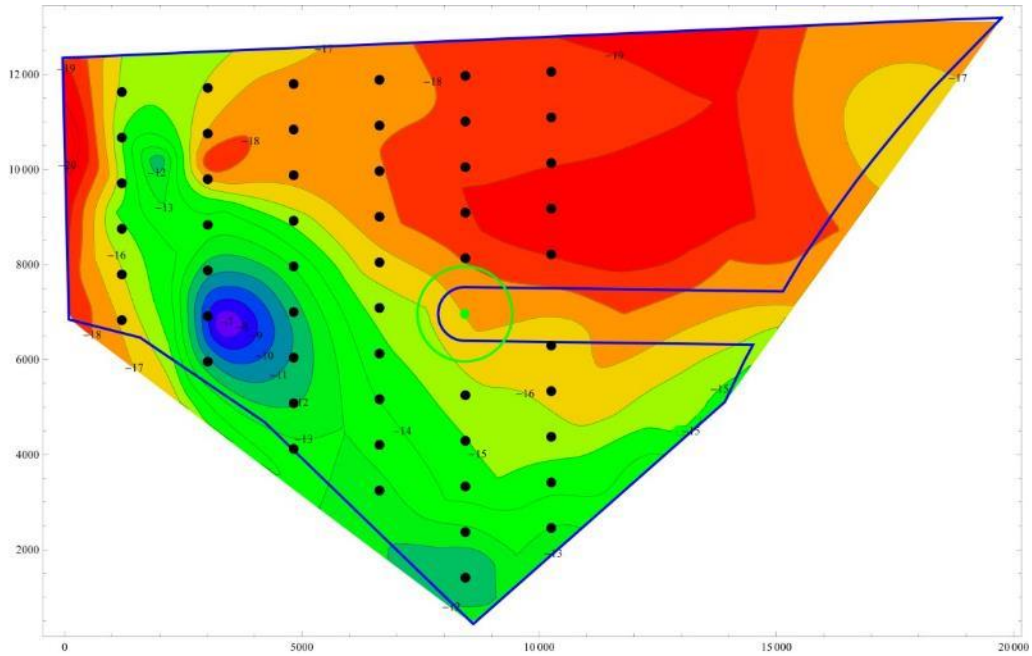


Figure 2.10 Suggested layout for the 8.0 MW wind turbine at Horns Rev 3, located in the western part of the area.

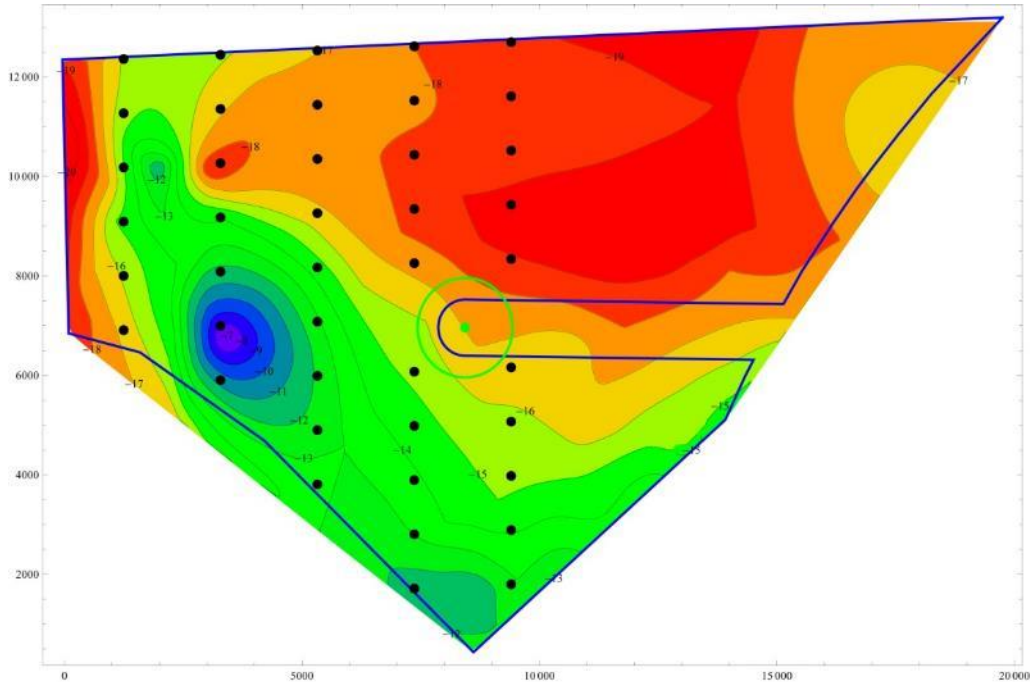


Figure 2.11 Suggested layout for the 10.0 MW wind turbine at Horns Rev 3, located in the western part of the area.

It is expected that turbines will be installed at a rate of one every one or two days. The construction works will be carried out day and night for 24 hours per day, with lighting of barges at night, and accommodation for crew on board. The installation is weather dependent so installation time may be prolonged by unsuitable weather conditions.

2.2.1 Foundation

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

- Driven steel monopile
- Concrete gravity base
- Jacket foundations
- Suction buckets

2.2.1.1. Driven steel monopile

Monopiles have been installed at a large number of wind farms in the UK and in Denmark e.g. Horns Rev 1, Horns Rev 2 and Anholt OWF. The solution comprises driving a hollow steel pile into the seabed. The monopile, for the relevant sizes of turbines (3-10 MW), is driven 25-40 m into the seabed and has a diameter of 4.5-10 m (given quantities have to be seen as rough estimate). The pile diameter and the depth of the penetration are determined by the size of the turbine and the sediment characteristics.

The monopile concept is not expected to require much preparation work, but some removal of seabed obstructions may be necessary.

A scour protection filter layer may be installed prior to pile driving and after installation of the pile, a second layer of scour protection may be installed. Scour protection of nearby cables may also be necessary. Scour protection is especially important when the turbine is situated in turbulent areas with high flow velocities.

2.2.1.2. Concrete gravity base

These structures rely on their mass including ballast to withstand the loads generated by the offshore environment and the wind turbine.

The gravity base concept has been used successfully at operating wind farms such as Middelgrunden, Nysted, Rødsand II and Sprogø in Denmark, Lillgrund in Sweden and Thornton Bank in Belgium.

Usually, seabed preparation is needed prior to installation, i.e. the top layer of sediment is removed and replaced by a stone bed. When the foundation is placed on the seabed, the foundation base is filled with a suitable ballast material, and a steel "skirt" may be installed around the base to penetrate into the seabed and to constrain the seabed underneath the base.

The ballast material is typically sand, which is likely to be obtained from an offshore source. An alternative to sand can be heavy ballast material, which has a higher density than natural sand. For a given ballast weight, using heavy ballast material will result in a reduction of foundation size, which may be an advantage for the project.

Noise emissions during construction are considered to be small but the footprint of the foundation is larger compared to the driven steel monopile.

2.2.1.3. Jacket foundations

Jacket foundation structures are three or four-legged steel lattice constructions in the shape of a square tower or tripod. The jacket structure is supported by piles in each corner of the foundation construction.

The jacket foundation has been used successfully at operating wind farms such as in the East Irish Sea, the North Sea and the Baltic Sea.

The construction is built of steel tubes with varying diameters depending on their location in the lattice structure. The three or four legs of the jacket are interconnected by cross bonds, which provide sufficient rigidity to the construction.

Fastening the jacket with piles in the seabed can be done in several ways:

- Pilling inside the legs

- Pilling through pile sleeves attached to the legs at the bottom of the foundation structure
- Pre-pilling by use of a pile template

Scour protection of the foundation piles and cables may be applied depending on the seabed conditions. In sandy sediments, scour protection is normally considered necessary in order to protect the construction from bearing failure. Scour protection consists of natural well graded stones

The footprint of the jacket foundation is intermediate between driven steel monopile and concrete gravity base.

2.2.1.4. Suction Bucket

The suction bucket foundation is a relatively new concept and is a quality proven hybrid design which combines aspects of a gravity base foundation and a monopile in the form of a suction caisson.

Homogeneous deposits of sand and silts, as well as clays, are ideal for the suction bucket concept.

Layered soils are likewise suitable strata for the bucket foundation. However, installation in hard clays and tills may prove to be challenging and will rely on a meticulous penetration analysis, while rocks are not ideal soil conditions for installing the bucket foundation.

The concept has been used offshore for supporting met masts at Horns Rev 2 and Dogger Bank. Bucket foundations for wind turbines are expected to be available by 2015/2016.

As a proven suction bucket design concept for the turbines involved in Horns Rev 3 does not yet exist, suction buckets are here assumed to have same plate diameter as gravity foundations for the respective turbines. However, it is expected that the maximum height of the installed bucket foundation will not rise more than 1 m above the surrounding seabed.

2.2.2 Scour protection

Monopile solution

Depending on the hydrodynamic environment, the horizontal extent of the armour layer can be seen according to experiences from former projects in ranges between 10 m and 15 m having thicknesses between 1 m and 1.5 m. Filter layers are usually of 0.8 m thickness and reach up to 2.5 m further out than the armour layer. Expected stone sizes range between d_{50} = 0.30 m to d_{50} = 0.5 m. The total diameter of the scour protection is assumed to be 5 times the pile diameter.

Gravity base solution
Scour protection may be necessary, depending on the sediment properties at the installation location. The envisaged design for scour protection may include a ring of rocks around the structure.

Jacket solution
Scour protection may be installed as appropriate by a Dynamically Positioned Fall Pipe Vessel and/or a Side Dumping vessel. The scour protection may consist of a two layer system comprising filter stones and armour stones. Nearby cables may also be protected with filter and armour stones. The effect of scour may be incorporated into the foundation design, in which case scour protection would not be necessary.

Suction bucket solution
Scour protection of the bucket foundations and cables may be necessary, depending on the seabed conditions at the installation locations. Scour protection may consist of natural well graded stones around the structure, but during detailed foundation design, it might be determined that scour protection is not necessary.

Alternative scour protection solutions
Alternative scour protection systems such as the use of frond mats may be introduced by the contractor. Frond mats contain continuous rows of polypropylene fronds which project up from the mats and reduce scour.

Another alternative scour protection system is the use of sand filled geotextile bags around the foundations. This system is planned to be installed at the Amrumbank West OWF during 2014, where some 50,000 t of sand filled bags will be used around the 80 foundations. Each bag will contain around 1.25 t of sand. If this scour protection system will be used at Horns Rev 3, it would require approximately 31,000 to 84,000 t of sand for the 50-133 turbine foundations.

2.2.3 Subsea cables

A medium voltage inter-array cable will be connected to each of the wind turbines and for each row of 8-10 wind turbines a medium voltage cable is connected to the transformer station. The medium voltage is expected to be 33 kV (max. voltage 36 kV), but 66 kV (max. voltage 72 kV) is also possible.
After pulling the cable into the J-tubes on the foundation structure of the wind turbine the cables are fixed to a hang-off flange. At the transformer station the cables are fixed to a cable deck or similar.

The inter-array cables may be protected with bending restrictors at each J-tube. Scour protection shall also be considered for protecting the cables if exposed.

A 220 kV transmission cable will be installed from the offshore transformer station and to the connection point on land – landfall – at Blåbjerg Substation. The length of the transmission cable can be up to 38 km depending on the final position of the transformer station.

Depending on the final position is it most likely that the transmission cable will follow either the northern border of the park or aligned in parallel with the existing transmission cable from Horns Rev 2.

Transportation of the electric power from the wind farm through cables is associated with formation of electromagnetic fields (EMF) around the cables. This is not a relevant aspect for the assessment of resting birds and thus not further described in this report.

Installation of subsea cable

3. RESTING BIRDS IN THE HORNS REV AREA

3.1. Methods

3.1.1 Aerial surveys

Baseline aerial surveys were conducted using the German "Standards for the Environmental Impact Assessment" for offshore wind farms (BSH 2007) as guidance. The survey was designed as a line transect survey using five perpendicular distance bands. This is a commonly used survey design applied elsewhere during several EIA studies and monitoring programmes applied elsewhere during several EIA studies and monitoring programmes (e.g. Diederichs et al. 2002, Noer et al. 2000, Petersen and Fox 2007).

3.1.1.1. Survey planes

For safety reasons only twin-engine high-wing planes of the type Partenavia P-68 Observer with professional pilots by Bioflight A/S (Holte) were chartered for the aerial surveys. In this type of aircraft the two main observers survey the area through so called bubble windows and the third observer is seated directly behind the two main observers (Figure 3.1).

Figure 3.1 Survey plane Partenavia P68 Observer. Photo: Kasper Roland Høberg.

3.1.1.2. Aerial survey design

The Horns Rev 3 study area for the aerial surveys comprised 2,663 km². In the East it follows the coast line between south of Blåvands Huk in the South and about 5 km south of Hvide Sande in the North. To the West the study area extends to 52-59 km offshore. Thus, the Horns Rev 3 study area ends north of Horns Rev 1 wind farm, but covers the area of the Horns Rev 2 wind farm. The water depth in the surveyed area varies from shallow waters to a maximum of 35 m (Figure 3.2).

Line transect methodology was used for counting the staging birds following the Distance sampling approach of Buckland et al. (2001). A total of 12 parallel transect lines in East-West orientation were used with a 4 km spacing between the lines. All survey flights were conducted at an altitude of 250 ft (76 m). Birds and marine mammals were recorded during the same survey flights.

The length of individual transects ranged from 52.5-58.8 km. The total transect length was approximately 685 km. Due to various reasons (mainly active military areas, weather conditions) the achieved survey effort varied slightly between survey flights. The transect design is shown in Figure 3.2, which also shows the military areas where conducting of surveys was restricted if the areas were active on that particular day. Whenever possible surveys were conducted on days without military activities or transect parts within the closed military areas were flown either if the military gave a permit to enter the area for a short period during the active time or it was possible to finish the transect lines after the military reopened the area in the afternoon.

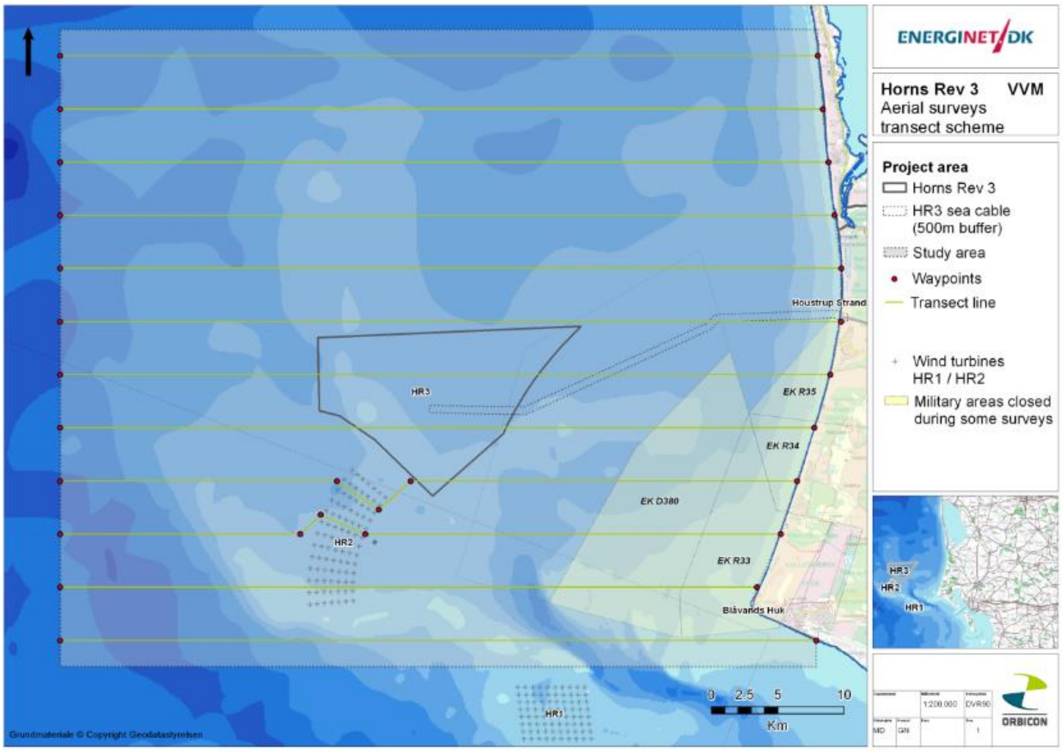


Figure 3.2 Aerial transect survey scheme in the Horns Rev 3 area.

3.1.1.3. Recording techniques

Three experienced observers recorded birds and marine mammals during the surveys: two main observers sitting next to the bubble windows (which allow also observations directly underneath the plane, see also Figure 3.1). The third observer was observing through a normal planar window in the back of the plane behind the main observers (no observations directly underneath the plane possible). The third observer changed the seat between transect lines, depending on which side provided the better observation conditions (usually observing towards North). Observers used headsets and did not communicate with each other while on transect. While on transect the observers continuously scanned the area for birds and marine mammals. For every observation the exact time was noted (UTC, synchronised with an on-board GPS) and recorded on a dictaphone. Following the recommendations for sampling of densities in distance intervals (Buckland et al. 2001), survey transects were subdivided into perpendicular bands to allow calculations of detection probabilities. Five standard bands were used (Figure 3.3): 0-44 m (band D), 44-91 m (band-A1), 91-163 m (band-A2), 163-431 m (band B) and 431-2,000 m (band C; all distances are distances to the transect line), which corresponded to inclinations in degrees from horizon of 90-60° (band D), 60-40° (band-A1), 40-25° (band-A12), 25-10° (band B) and <10° (band C). This number of bands is assumed to be the best compromise between obtaining accurate density data and the short period of time available for cognitive processing and recording of the information.

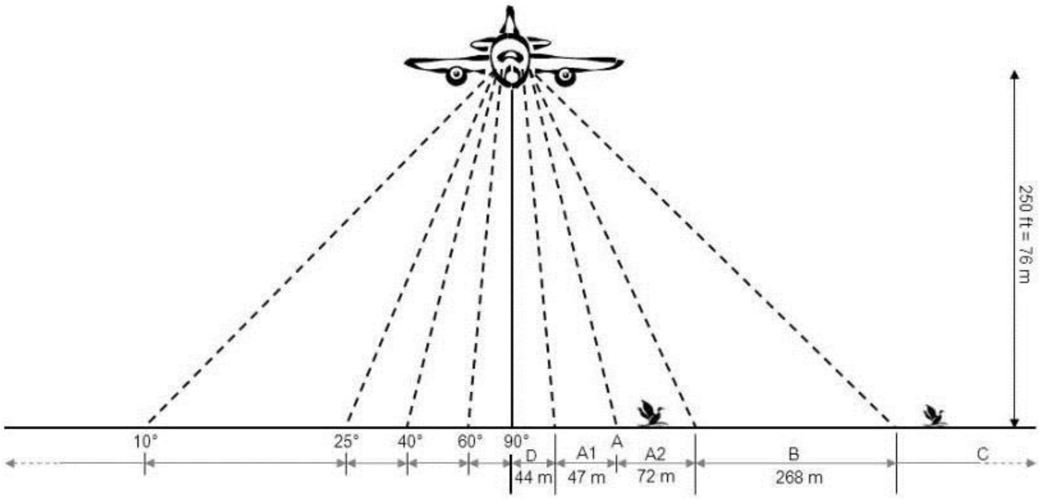


Figure 3.3 Standardised aerial survey method for counting resting birds.

From the angle and the aircraft altitude the perpendicular distance range of the sighting was calculated. For every observation the following information was recorded: Species or species group, number of birds, behaviour, transect band and associations (e.g. with fishing vessels). The flight-track was logged at 3 second intervals by the GPS. Further details on the aerial survey techniques used are described in Diederichs et al. (2002) and Christensen et al. (2006).

Weather conditions (sea state, glare, cloud reflections, cloud coverage, precipitation and water turbidity) were recorded at the start of each transect line and whenever conditions changed. Additionally all vessels and fishing equipment observed were recorded (including information on type, distance to the transect line and heading of the vessel).

Survey speed was approximately 100 kn (185 km/h, 115 mph) and flight altitude 250 ft (76 m).

Weather limitations:
Data were only collected in good survey conditions (Douglas sea states below Beaufort 3, visibility more than 5 km). If during parts of the survey sea state 4 was recorded these parts were not included in the data analysis. Also sections with strong glare (usually only on one side) were excluded from the analysis.

3.1.1.4. Aerial survey effort

Aerial survey effort varied between the different surveys (Table 3.1). Depending on weather conditions (especially sun glare) transect lines could either be covered in 1- or 2-sided valid effort. Transect lines or parts of it are regarded as covered with either 1-sided or 2-sided valid effort. In total 10 aerial surveys were carried out between January and November 2013.

Table 3.1 Aerial survey effort (valid effort for resting bird observations, sum of both main observers in km) and coverage of the study area (under 1-sided or 2-sided valid conditions, in %) between January 2013 and November 2013.

Date of survey	Valid effort	Coverage
16.01.2013	916 km	76%
13.02.2013	1,367 km	100%
04.03.2013	932 km	94%
01.04.2013	944 km	100%
07.05.2013	822 km	90%
05.06.2013	965 km	97%
06.07.2013	910 km	100%
22.08.2013	1,172 km	99%
13.09.2013	963 km	92%
17.11.2013	1,151 km	100%

3.1.2 Data Analyses

3.1.2.1. Distance analysis

The term 'Distance analysis' used in this report refers to analyses conducted using Distance software (Distance v.6. r2, http://www.ruwpa.st-and.ac.uk, Thomas et al. 2010). These analyses were conducted with the objective to calculate species-specific distance detection functions for data collected during aerial transect surveys, which were used in the estimation of bird densities and abundance in the study area. The detection probability of waterbirds along a line transect declines with perpendicular distance from the line. The decline is typically non-linear with a high detection rate from the line to a deflection point in the transect from where the detection gradually drops to low values in the more distant parts of the transect (Buckland et al. 2001).

Key parametric functions were evaluated with cosines and simple polynomials for adjustment terms: uniform, half-normal and hazard rate, and the best fitting function was chosen on the basis of the smallest Akaike Information Criterion (AIC) values (Burnham and Anderson 2002). Parameter estimates were obtained by maximum likelihood methods. The aerial data were analysed based on a transect width of 2,000 m.

Global detection functions were calculated for the entire dataset for each species with sufficient number of observations, assuming that detectability of bird species was similar among surveys. Estimated global detection functions were used to estimate species-specific densities for each survey. Detection functions were estimated using the conventional distance sampling (CDS) engine.

Total estimates of bird numbers were calculated on the basis of the area actually covered during each survey: 100% coverage by aerial surveys encompassed an area of 2,663 km². For some surveys this resulted in estimates, which should be regarded as minimum numbers due to incomplete coverage of the survey area. The variable survey effort between aerial surveys was mostly due to limited access to military areas within the study area.

For species, where data did not allow Distance analysis (e.g. due to small sample size or high proportion of unidentified birds in distant bands), densities were calculated from number of birds recorded within band-A1 and A2 (band-A). Estimating bird densities from observations in band-A is a standard method to obtain bird densities from visual aerial surveys according to BSH (2007). Four species/species groups (divers, Gannet, Common Scoter and auks) were chosen for a comparison of the two methods. For all four species (groups) both methods resulted in comparable density estimates and the comparison indicated a high correlation between both methods (see Appendix Figure 0.3, page 144).

3.1.2.2. Distribution modelling

Species distribution models were used to analyse the relationships between the observed densities of divers and a series of environmental predictors. The model served two purposes:

i. to quantify the magnitude of the effects for each density prediction
ii. to predict the density across the whole area of interest. The process of species distribution modelling is complex and involves decisions related to the nature of the dataset being analysed and the biology of the species that is being studied. Species distribution data are zero-inflated, spatially autocorrelated and their relationship with environmental parameters are highly nonlinear.

Environmental predictors

The following environmental predictors were included in the diver distribution model:

- *Month*
- *Mean water depth:* Mean water depth of each 1 km grid cell

- *Current*: mean monthly values provided by BSH (Federal Maritime and Hydrographic Agency, Hamburg)
- *Temperature*: mean water temperature as monthly values provided by BSH (Federal Maritime and Hydrographic Agency, Hamburg)
- *Distance to Horns Rev 2 OWF:* minimum distance to Horns Rev 2 OWF
- *Minimum distance to main shipping lines*: as main shipping lines in the area the shipping routes from navigational risk analysis were taken which showed a total number of ships of at least 1,000 ships in 2012 (see report Nr. HR3-TR-007).
- *Distance to land:* minimum distance to land

Analytical methods

A data exploration exercise showed that the datasets contained a large number of zeros and a number of extremely large density values. Such data are difficult to incorporate into standard parametric models. An efficient way to overcome the zero-inflation is to fit models in a hierarchical fashion (e.g., a 'hurdle model'), including a component that estimates the occurrence probability, and a subsequent component that estimates the number of individuals given that the species is present (Millar, 2009; Potts and Elith, 2006; Wenger and Freeman, 2008). We adopted that strategy by constructing two separate sets of models, one to predict the presence of divers, and one to predict the density of divers.

The Random Forest algorithm was used to model the occurrence (presence/absence) and the density (positive part) of divers. Random Forest algorithm was used because of its robustness to outliers. This algorithm is based on the well-known methodology of classification or regression trees (Breiman et al. 1984). In brief, a classification or regression tree is a rule partitioning algorithm, which classifies the data by recursively splitting the dataset into subsets which are as homogenous as possible in terms of the response variable (Breiman et al. 1984). The use of such a procedure is very desirable, as classification trees are non-parametric, are able to handle non-linear relationships, and can deal easily with complex interactions.

Random Forests uses a collection (termed ensemble) of classification or regression trees for prediction. This is achieved by constructing the model using a particularly efficient strategy aiming to increase the diversity between the trees of the forest random. Forests is built using randomly selected subsets of the observations and a random subset of the predictor variables. At first, many samples of the same size as the original dataset are drawn at random from the data. This sampling is done with replacement, meaning that a particular sample, from the observed data, can be selected more than one time. The resampled datasets are called bootstrap samples. In each of these bootstrap samples, about two-thirds of the observations in the original dataset occur one or more times. The remaining one-third of the observations in the original dataset that do not occur in the bootstrap sample are called out-of-bag (OOB) for that bootstrap sample. Classification or regression trees are then fitted to each bootstrap sample. At each node in each classification tree only a small number (the default is the square root of the number of observations) of variables are available to be split on. This random selection of variables at the different nodes ensures that there is a lot of diversity in the fitted trees, which is needed to obtain high classification accuracy.

Each fitted tree is then used to predict for all observations that are OOB for that tree. The final predicted class or value for an observation is obtained by majority vote of all the predictions from the trees for which the observation is OOB. Several characteristics of Random Forests make it ideal for data sets that are noisy and highly dimensional datasets. These include its remarkable resistance to overfitting and its immunity to multicollinearity among predictor. The output of Random Forests depends primarily on the number of predictors selected randomly for the construction of each tree. After trying several values we decided to use a value of two. We made this choice as we did not notice any decrease in the out-of-bag error estimate or increase in the variance explained after trying several values.

In order to measure the importance of each variable, we used measure of importance provided by Random Forests, based on the mean decrease in the prediction accuracy (Breiman 2001). The mean decrease in the prediction accuracy is calculated as follows: Random Forests estimates the importance of a predictive variable by looking at how much the OOB error increases when OOB observations for that variable are permuted (randomly reshuffled) while all other variables are left unchanged. The increase in OOB error is proportional to the predictive variable importance. The importance of all the variables of the model is obtained when the aforementioned process is carried out for each predictor variable (Liaw and Wiener 2002). All the analyses were carried out using the Random Forests package in R (Liaw and Wiener 2002).

Modelling evaluation and predictions

In order to evaluate the predictive performance of the models, the original dataset was randomly split into model training (70%) and model evaluation data sets (30%). The training dataset was used for the construction of the model whereas the evaluation dataset was used to test the predictive abilities of the model. The following measures of model performance were computed: the Pearson correlation coefficient for the positive part of the model, and the AUC (Fielding and Bell 1997) for the presence/absence part.

The Pearson correlation coefficient was used to relate the observed and the predicted densities. The AUC relates relative proportions of correctly classified (true positive proportion) and incorrectly classified (false positive proportion) cells over a wide and continuous range of threshold levels. The AUC ranges generally from 0.5 for models with no discrimination ability to 1.0 for models with perfect discrimination. AUC values of less than 0.5 indicate that the model tends to predict presence at sites at which the species is, in fact, absent (Elith and Burgman 2002). It must, however, be considered that the above-mentioned classification is only a guideline and this measure of model performance needs to be interpreted with caution (see Lobo et. al 2008 for criticisms). Most importantly, a true evaluation of the predictive performance of a model can only be carried out using a spatially and temporally independent dataset, which is not possible in most cases for ecological datasets.

3.1.3 Assessment of importance

The importance of the Horns Rev area to resting birds was determined on the species level by accounting both for the conservation status of a species and the numerical abundance of a species in the area in relation to its biogeographic population. This approach was also used for assessing the importance of the number of birds affected by a pressure in a particular impact area.

The population size and corresponding 1% value of the relevant biogeographic population of a species were taken from Wetlands International (2013). For seabird species, which are not listed in Wetlands International (2013), winter population estimates from BirdLife International (2004) were taken. For the 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 3 (as suggested in BirdLife International 2013).

Table 3.2 Scheme of determination of the importance of the Horns Rev 3 area to a bird species: the importance level is the result of the combination of the species' abundance in relation to its biogeographic reference population and the species' protection/conservation status. For explanation on how abundance criteria and protection/conservation status are defined see Table 3.3 and Table 3.4.

		Protection/conservation status			
		Very high	**High**	**Medium**	**Low**
Abundance in% of the biogeographic reference population	**Very high**	very high	very high	very high	very high
	High	very high	high	medium	medium
	Medium	high	high	medium	low
	Low	low	low	low	low

The abundance criteria for the determination of importance levels are based on the proportion of the respective biogeographic reference population registered in the area (Table 3.3).

Table 3.3 Classification based on species abundance in relation to its biogeographic reference population.

Criterion	Description
Very high	≥1% of the biogeographic reference population, or ≥20,000 individuals of a waterbird species*
High	≥0.5%, but <1% of the biogeographic reference population
Medium	≥0.1%, but <0.5% of the biogeographic reference population
Low	<0.1% of the biogeographic reference population

* For populations over 2 million birds, Ramsar Convention criterion 5 (20,000 or more waterbirds) applies. This criterion only applies for non-breeding waterbirds.

Two international conservation statuses were chosen for classification of a species importance based on its protection and conservation status: whether a species is listed in the Annex I of the EU Birds Directive or not, and the SPEC status according to BirdLife International (2004) (Table 3.4). If a species is listed in Annex I of the EU Birds Directive, but is classified to a lower SPEC status, the higher classification applies (i.e. very high).

Table 3.4 Classification based on the protection/conservation status of the species according to the EU Birds Directive and the SPEC status of a species according to BirdLife International (2004).

Criterion	EU Birds Directive	SPEC Status
Very high	Listed in Annex I	SPEC 1 or 2
High		SPEC 3
Medium		Non-SPEC^E
Low		Non-SPEC

Explanations to Table 4.7 (BirdLife International 2004):

SPEC 1 European species of global conservation concern, i.e. classified as Critically Endangered, Endangered, Vulnerable, Near Threatened or Data Deficient under the IUCN Red List Criteria at a global level (BirdLife International 2004, IUCN 2004).

SPEC 2 Species whose global populations are concentrated in Europe, and which have an Unfavourable Conservation Status in Europe.

SPEC 3 Species whose global populations are not concentrated in Europe, but which have an Unfavourable conservation status in Europe.

Non-SPEC^E Species whose global populations are concentrated in Europe, but which have a Favourable conservation status in Europe

Non-SPEC Species whose global populations are not concentrated in Europe, and which have a Favourable conservation status in Europe.

3.2. Abundance and distribution

In this chapter all waterbird species are described which were considered as relevant for the Environmental Impact Assessment in the marine areas of Horns Rev 3. Species were selected based on their conservation status and their abundance in the study area. A complete list of bird species and numbers observed during the aerial surveys is given in the Appendix (Table 0.2; p. 142).

3.2.1 Red-throated Diver / Black-throated Diver

Red-throated Diver – *Gavia stellata*	**DK: Rødstrubet Lom**
Biogeographic population: NW Europe (win)	
Breeding range: Arctic and boreal W Eurasia, Greenland	
Non-breeding range: NW Europe	
Population size: 150,000 – 450,000	
1% value: 2,600	
Conservation status:	EU Birds Directive, Annex I: listed EU SPEC Category: SPEC 3 EU Threat Status: (depleted) IUCN Red List Category: Least Concern
Trend: STA	Trend quality: Poor
Key food: fish	
Black-throated Diver – *Gavia* arctica	**DK: Sortstrubet Lom**
Biogeographic population: *G. a. arctica*	
Breeding range: N Europe and W Siberia	
Non-breeding range: Coastal NW Europe, Mediterranean, Black and Caspian Seas	
Population size: 250,000 – 500,000	
1% value: 3,500	
Conservation status:	EU Birds Directive, Annex I: listed EU SPEC Category: SPEC 3 EU Threat Status: (Vulnerable) IUCN Red List Category: Least Concern
Trend: DEC	Trend quality: Poor
Key food: fish	

3.2.1.1. Abundance of divers in the Horns Rev 3 area

The two diver species, Red-throated Diver and Black-throated Diver, are treated together, as only a small proportion of diver observations from airplane can be determined to species level. Both species are known to regularly occur in the area, but the Red-throated Diver is much more abundant in the area (e.g. Christensen et al. 2006, Petersen and Fox 2007).

The abundance of divers in the Horns Rev 3 area was estimated by applying Distance analysis (Thomas et al. 2010) on the monthly aerial survey data. The effective strip width (ESW) for Red-throated and Black-throated Diver during aerial surveys, calculated using the entire dataset, was 201 m (95% CI 180 m – 224 m). The limited access to military areas prevented a full coverage of the entire study area during some aerial surveys. As numbers of divers have only been estimated for the area actually surveyed, monthly bird numbers should be regarded as minimum estimates for the respective surveys. The highest estimate of 5,337 divers was obtained for the late-spring survey of 07-05-2013 (Table 3.5).

Table 3.5 Numbers of observed Divers during monthly aerial surveys and results of Distance analysis. ‘Effort’ represents the coverage of the study area in one- or two-sided valid conditions during the particular survey, ‘N birds’ the actual number of birds counted within transects, ‘Density’ the number of birds per km^2. ‘D LCI’ represents the lower 95% confidence interval, ‘D UCI’ the upper 95% confidence interval of the density; Total estimate represents the total number of birds estimated for the area surveyed during a particular survey.

Survey	Effort	N birds	Density	D LCI	D UCI	Total estimate
16-01-13	76%	80	0.43	0.39	0.48	883
13-02-13	100%	44	0.16	0.14	0.18	426
04-03-13	94%	119	0.63	0.57	0.71	1,583
01-04-13	100%	257	1.35	1.21	1.51	3,597
07-05-13	90%	370	2.24	2.01	2.50	5,337
05-06-13	97%	0	0	0	0	0
06-07-13	100%	2	0.01	0.01	0.01	29
22-08-13	99%	13	0.06	0.05	0.06	146
13-09-13	92%	28	0.14	0.13	0.16	352
17-11-13	100%	109	0.47	0.42	0.52	1,253

Month-to-month comparison of density estimates show the species occurring in the Horns Rev area mostly in spring with lower number in winter and autumn. In summer between June and August the species was rarely observed in the area (Table 3.5, Figure 3.4).

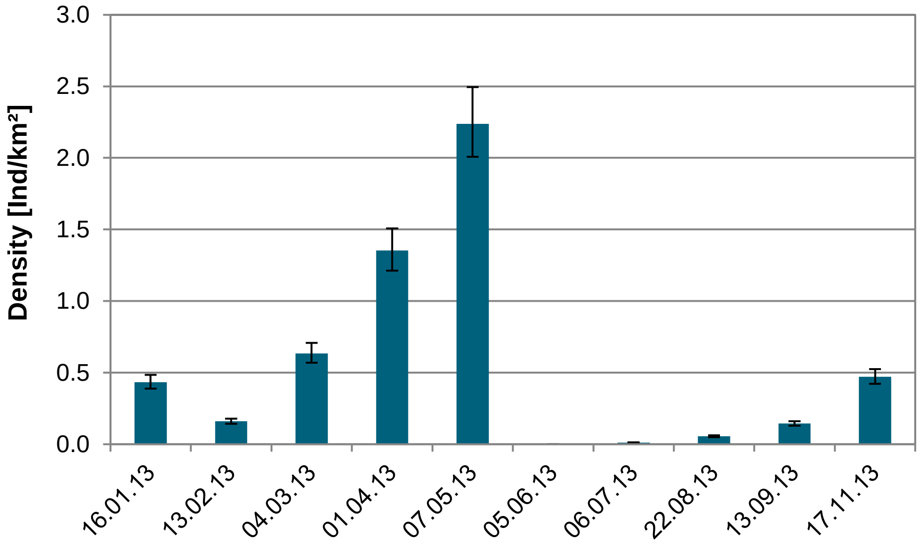


Figure 3.4 Mean density estimates and 95% confidence intervals of divers (Red-throated Diver and Black-throated Diver) estimated for aerial surveys undertaken between January 2013 and November 2013.

Corresponding to monthly results the highest seasonal density was calculated for the spring season (March to May), which corresponds to a seasonal estimate of 3,750 Red- and Black-throated Divers using the Horns Rev 3 study area in spring (Table 3.6).

Table 3.6 Mean seasonal densities and abundance estimates for divers in the Horns Rev 3 study area (2,663 km²).

Survey	Surveys represented	Mean density	Seasonal estimate
Spring	Mar-May	1.41	3,750
Summer	Jun-Aug	0.02	59
Autumn	Sep	0.14	385
Winter	Jan-Feb, Nov	0.35	945

3.2.1.2. Distribution of divers in the Horns Rev 3 area

Distribution based on spatial modelling approach

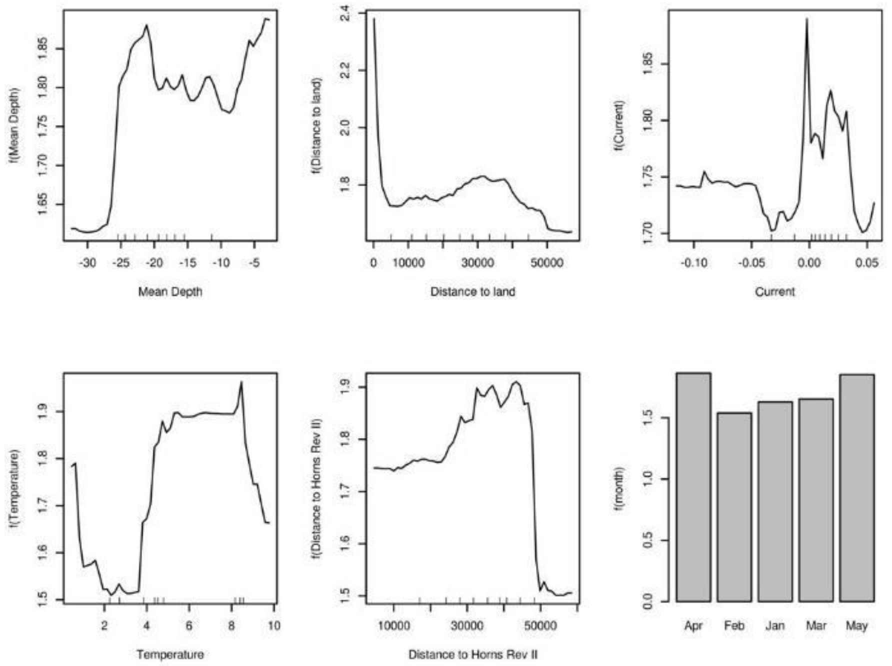
A Random Forest model was fitted to data collected during the five aerial surveys conducted between January and May 2013. Distance to land was the most important predictor in the presence-absence part of the model, followed by water temperature and distance to the existing offshore wind farm Horns Rev 2 (Table 3.7). In a similar manner, temperature and distance to Horns Rev 2 ranked quite high for the positive part of the model, being the two most important variables. The third most important variable for the positive part was Mean Water Depth. Response curves for predictor variables indicated that divers occurred at higher densities in coastal areas and were negatively associated with areas closer to the Horns Rev 2 wind farm. In general the species showed a complex response to the environmental variables with high non-linearity in the relationships.

Table 3.7 Relative importance of the environmental predictors for the presence/absence and the positive parts of the model. The importance of a particular predictor is expressed as the decline in the predictive performance when that particular variable was not included in the model. Evaluation results are presented as area under receiver operator curve (AUC) and Pearson's correlation coefficient respectively. Values for both stages (presence/absence and positive part) of the model are presented on separate panels.

Variable	Presence / absence	Positive part
Month	0.028	0.107
Mean depth	0.026	0.076
Current	0.024	0.078
Temperature	0.054	0.189
Distance to OWF HR 2	0.043	0.116
Minimum distance to shipping lines	0.042	0.074
Distance to land	0.057	0.089
Model performance		
AUC Pearson's correlation coefficient	**0.64**	0.50

The positive part of the model showed a modest predictive ability, as indicated by the Pearson correlation coefficient (Table 3.7). Similarly the accuracy of the predictions of the presence/absence part according to the AUC equalled 0.64, indicating a modest ability to predict the occurrence of the species. A number of factors could have contributed to the observed performance in the model, notably the absence of key predictors (e.g. biotic factors), and the assumption of equilibrium between the distribution of the species and the environmental factors considered. Although month was explicitly incorporated into the models as a categorical variable, one should view the correlative modelling approach used here as a static one. A static modelling approach is unable to fully capture the processes that determine the distribution of highly mobile species living in dynamic environments. According to Moran's I no significant spatial autocorrelation was found in the residuals of the presence / absence part nor in the positive part of the model (see Appendix p 140ff).

a)



b)

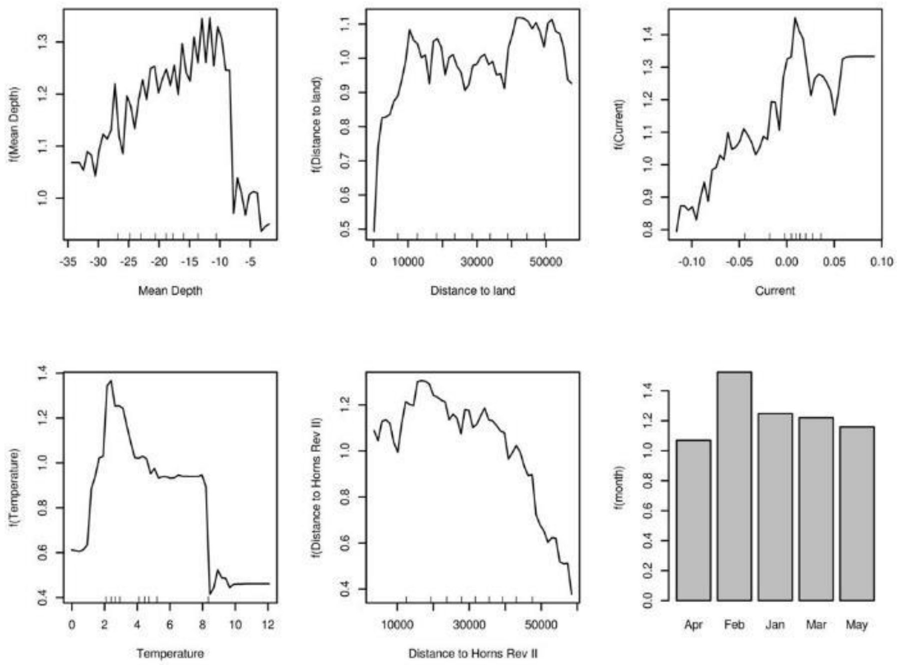


Figure 3.5 Fitted functions for the two-part random forest model representing the relationship between the predictor variables, the positive (a) and presence absence (b) parts for the Diver model. The values of the environmental predictor are shown on the X-axis and the Y-axis shows the density (for the positive part) and the probability of occurrence (for the presence and absence part).

The model predicts divers being widely distributed in the study area with high densities occurring in the coastal areas and generally in the central and northern part of the study area (Figure 3.6). Relatively low densities are predicted for the reef area south of the Horns Rev 3 project area between areas west of Blåvands Huk, the existing wind farm Horns Rev 2 and areas west of it (Figure 3.6).

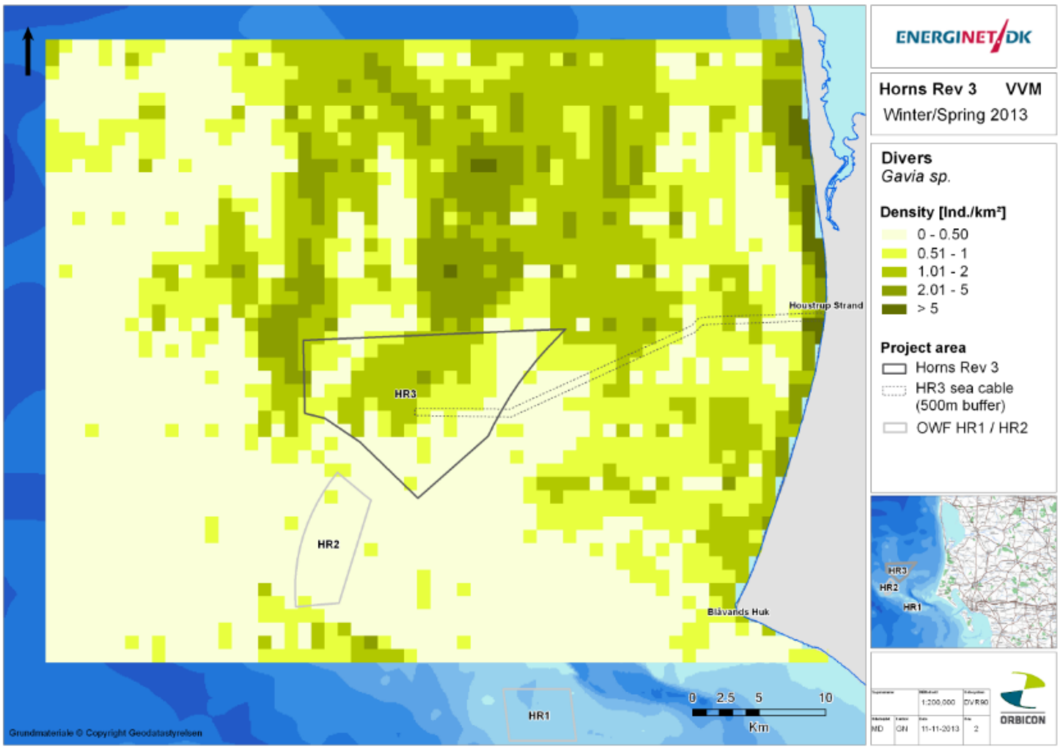


Figure 3.6 Modelled spatial distribution of divers (Red-throated and Black-throated Diver) in the study area based on aerial surveys undertaken between January and May 2013. The densities are modelled for 1 km squares.

Distribution based on seasonal density estimates

Monthly distributions of divers were found being highly variable between the different surveys (for monthly distribution maps see Appendix p. 145ff). Divers forage mainly on pelagic fish species, thus the distribution of the species is expected to vary with prey fish abundance, which can explain part of the observed variation. In spring, the season with highest diver densities in the area, birds were found widely distributed in the study area with high densities close to shore and in the offshore areas north of the Horns Rev 3 project area (Figure 3.7). In the southern part of the study area, west of Blåvands Huk, the reef area including the area around the existing wind farm Horns Rev 2, low diver densities were observed (Figure 3.7). The distribution pattern in autumn shows divers occurring mostly in coastal areas, while the winter distribution was similar to the one observed in spring (Figure 3.7).

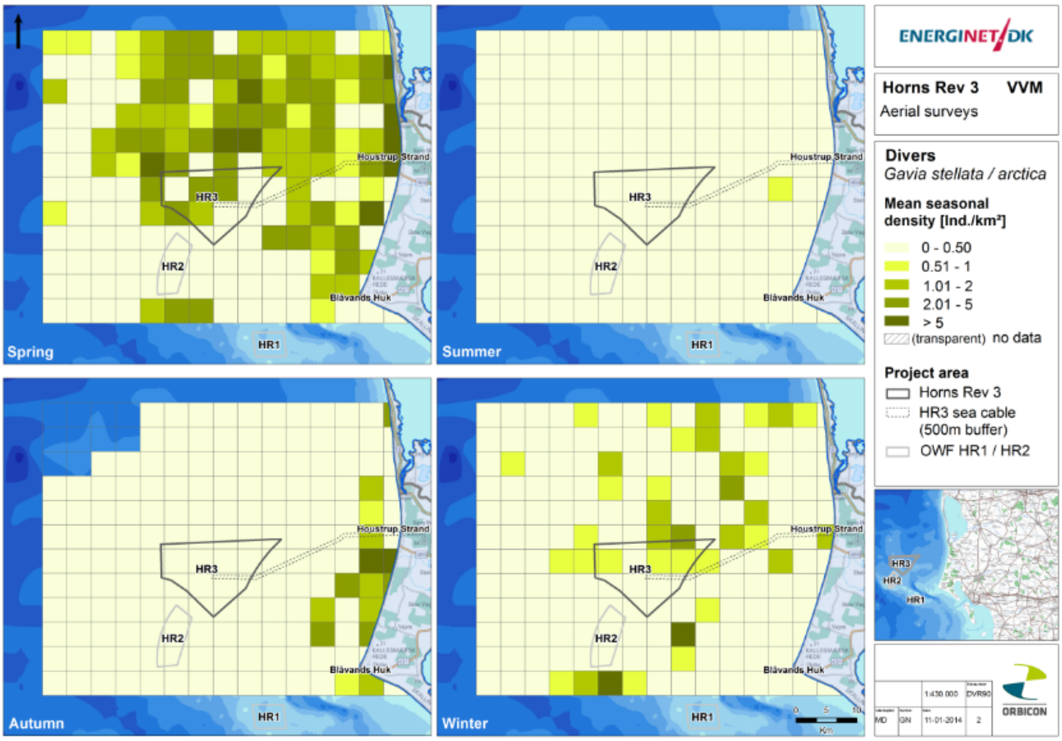


Figure 3.7 Mean seasonal distributions of divers (Red-throated Diver and Black-throated Diver) from aerial survey data recorded between January 2013 and November 2013. Surveys were assigned to the different seasons as follows: Spring: March-May, summer: June-August, autumn: September and winter: January, February and November. The densities are shown in 4 km squares.

3.2.1.3. Abundance and distribution according to other studies

Christensen et al. (2003) recorded divers as the 6th most abundant species/group during the baseline observations in the Horns Rev 1 study area, which is situated further south than the Horns Rev 3 study area with some overlap between the two. Divers were recorded at all 14 survey flights adding to a total of 1,279 birds. Unfortunately no survey flights were conducted in May, the peak month of occurrence in the present study. The phenology was consistent over the period of baseline observations with highest counts in the months of February-April. Highest densities of divers were recorded close to shore at Blåvands Huk / Skallingen and to the southwest and northwest of Horns Rev 1, the latter area being now the location of Horns Rev 2. The total number of divers recorded in the Horns Rev 1 study area during 34 surveys (including the above) from 1999-2005 was 3,921 birds making them the 5th most abundant species/group (Christensen et al. 2006).

Six survey flights during the baseline observations for Horns Rev 2 were scheduled to coincide with the expected peak of scoter and diver abundance in winter and spring (Skov et al. 2008b). The study area was slightly further south than the Horns Rev 3 study area but covered most of the Horns Rev 3 project area. Divers were recorded during all six survey flights with a total count of 462 birds. Highest counts were made in late March and mid-April resulting in a peak density of 0.81 ind./km^2. The distribution of divers was modelled for the study area and a concentration of divers was predicted for the gradient zone between estuarine waters and mixed North Sea and estuarine waters from the southern German Bight. Divers also favoured shallower areas and areas distant from the shore. High densities were found in the area surrounding the Horns Rev 2 project area. No divers were recorded inside the Horns Rev 2 wind farm.

Red-throated divers are far more common in the North Sea than Black-throated Divers. At Helgoland 98% of migrating divers recorded to species level were Red-throated Divers (Dierschke et al. 2011) and at Blåvands Huk the species is also dominating (Jakobsen 2008).

The large number of resting divers in the eastern North Sea in spring is well documented in the literature (e.g. Mendel et al. 2008, Mendel and Garthe 2010). Peak numbers of migrating divers at Blåvands Huk are also noted from March until early May (Jakobsen 2008).

3.2.1.4. Importance of the Horns Rev area to divers

During the spring season divers use the Horns Rev 3 area in internationally important numbers. The seasonal estimate of 3,750 divers in spring equals 1.4% of the more abundant Red-throated Diver population. This results in the assessment of very high importance of the Horns Rev 3 area to divers.

Importance level	Very high

3.2.2 Red-necked Grebe

Red-necked Grebe – *Podiceps grisegena*	**DK: Gråstrubet lappedykker**
Biogeographic population: *P. g. grisegena*, North-west Europe (win)	
Breeding range: E Europe	
Non-breeding range: Coastal NW Europe	
Population size: 42,000 – 60,000	
1% value: 500	
Conservation status:	EU Birds Directive, Annex I: not listed EU SPEC Category: Non-SPEC EU Threat Status: Secure IUCN Red List Category: Least Concern
Trend: DEC	Trend quality: Poor
Key food: Fish, invertebrates	

During the aerial surveys between January and November 2013 no Red-necked Grebes were observed in the Horns Rev 3 study area. According to Skov et al. (1995) and Laursen et al (1997) reasonable numbers of Red-necked Grebe use the Horns Rev area for wintering. However, during 34 survey flights in the Horns Rev 1 study area in 1999-2005 only 9 Red-necked Grebes were recorded (Christensen et al. 2006) and the species was not recorded during the baseline investigations for Horns Rev 2 (Skov et al. 2008b). These more recent studies do not indicate a special importance of the Horns Rev 3 area to the Red-necked Grebe. The area therefore is assessed to be of low importance to the species.

Importance level	Low

3.2.3 Fulmar

Fulmar – *Fulmarus glacialis*	**DK: Mallemuk**
Biogeographic population: *F. g. glacialis*	
Breeding range: Atlantic	
Wintering / core non-breeding range: NA	
Population size: >1,500,000	
1% value: 15,000	
Conservation status:	EU Birds Directive, Annex I: not listed EU SPEC Category: Non-SPEC EU Threat Status: Secure IUCN Red List Category: -
Trend: -	Trend quality: -
Key food: Fish, macrozooplankton, discard	

3.2.3.1. Abundance of Fulmars in the Horns Rev 3 area

During the aerial surveys between January and November 2013 Fulmars were only rarely recorded in the Horns Rev 3 study area. In total 24 Fulmars were observed, among which all observations fell within the summer and autumn months with a maximum of 11 individuals observed during the survey in November 2013 (Table 3.8). Because of the few sightings of this pelagic offshore seabird no Distance-based density and abundance estimates were possible.

Table 3.8 Numbers of observed Fulmars during monthly aerial surveys. 'Effort' represents the coverage of the study area in one- or two-sided valid conditions during the particular survey, 'N birds' the actual number of birds counted within transects.

Survey	Effort	N birds
16-01-13	76%	0
13-02-13	100%	0
04-03-13	94%	0
01-04-13	100%	0
07-05-13	90%	0
05-06-13	97%	5
06-07-13	100%	4
22-08-13	99%	3
13-09-13	92%	1
17-11-13	100%	11

3.2.3.2. Distribution of Fulmars in the Horns Rev 3 area

During the aerial surveys conducted in the Horns Rev 3 study area Fulmar was only rarely observed. The few observations were concentrated in the western and northern part of the study area (Figure 3.8), but there were also observations closer to shore (for more monthly distribution maps see also Appendix p. 150ff).

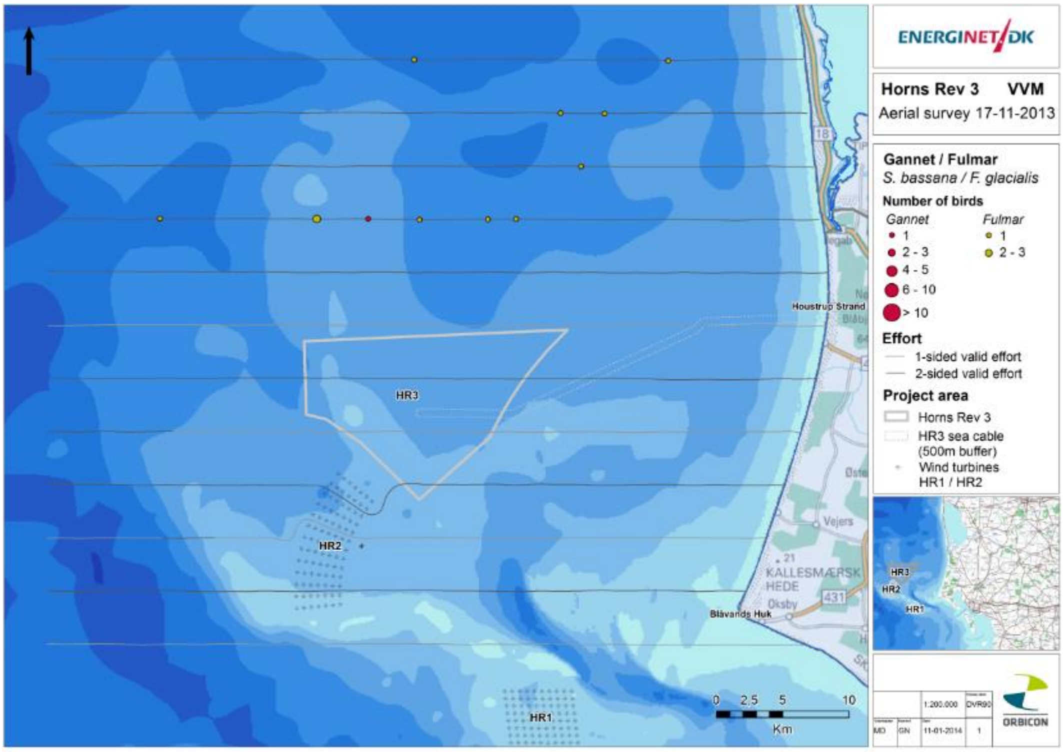


Figure 3.8 Example of the observed Fulmar (and Gannet) distribution in the study area during the aerial surveys on 17/11/2013.

3.2.3.3. Abundance and distribution according to other studies

Christensen et al. (2003) recorded Fulmars in 5 out of 14 survey flights during baseline investigations in the Horns Rev 1 study area, which is situated south of the Horns Rev 3 study area with some overlap between the two. A total of 63 Fulmars were counted during all surveys between August and January. Unfortunately no survey flights were made in June and July, the peak months of occurrence in the present study. Records were scattered throughout the central part of the study area. The total number of Fulmars recorded in the Horns Rev 1 study area during 34 surveys (including the above) from 1999-2005 was 130 birds (Christensen et al. 2006).

Six survey flights during the baseline observations for Horns Rev 2 were scheduled to coincide with the expected peak of scoter and diver abundance in winter and spring and recorded a total of 38 Fulmars (Skov et al. 2008b).

Fulmars are known to avoid coastal waters of the eastern North Sea with their high turbidity. They prefer saline offshore waters with good visibility and are often associated with fishing vessels (Mendel et al. 2008). However passage of Fulmars at Blåvands Huk is noted during strong westerly winds in autumn (Jakobsen 2008). The (small) breeding colony closest to Horns Rev 3 is on the island of Helgoland (Dierschke et al. 2012).

3.2.3.4. Importance of the Horns Rev area to Fulmar

During the aerial surveys at Horns Rev 3 very few Fulmars have been recorded. Thus the area is assessed to be of low importance to the Fulmar.

Importance level	Low

3.2.4 Gannet

Gannet – *Sula bassana*	**DK: Sule**
Biogeographic population: -	
Breeding range: N Atlantic	
Wintering / core non-breeding range: Atlantic	
Population size: 900,000 – 930,000	
1% value: 9,150	
Conservation status:	EU Birds Directive, Annex I: not listed EU SPEC Category: Non-SPEC^E EU Threat Status: Secure IUCN Red List Category: -
Trend: -	Trend quality: -
Key food: Fish	

3.2.4.1. Abundance of Gannets in the Horns Rev 3 area

The abundance of Gannets in the Horns Rev 3 area was estimated by applying Distance analysis (Thomas et al. 2010) on the monthly aerial survey data. The effective strip width (ESW) for the Gannet during aerial surveys, calculated using the entire dataset, was 274 m (95% CI 229 m – 328 m). The limited access to military areas prevented a full coverage of the entire study area during some aerial surveys. As numbers of Gannets have only been estimated for the area actually surveyed, monthly bird numbers should be regarded as minimum estimates for the respective surveys. The highest estimate of 360 Gannets was obtained for the autumn survey of 13-09-2013 (Table 3.9).

Table 3.9 Numbers of observed Gannets during monthly aerial surveys and results of Distance analysis. 'Effort' represents the coverage of the study area in one- or two-sided valid conditions during the particular survey, 'N birds' the actual number of birds counted within transects, 'Density' the number of birds per km^2. 'D LCI' represents the lower 95% confidence interval, 'D UCI' the upper 95% confidence interval of the density; Total estimate represents the total number of birds estimated for the area surveyed during a particular survey.

Survey	Effort	N birds	Density	D LCI	D UCI	Total estimate
16-01-13	76%	1	0.00	0.00	0.00	8
13-02-13	100%	1	0.00	0.00	0.00	7
04-03-13	94%	0	0	0	0	0
01-04-13	100%	11	0.04	0.04	0.05	113
07-05-13	90%	11	0.05	0.04	0.06	116
05-06-13	97%	5	0.02	0.02	0.02	49

Survey	Effort	N birds	Density	D LCI	D UCI	Total estimate
06-07-13	100%	8	0.03	0.03	0.04	85
22-08-13	99%	21	0.07	0.05	0.08	173
13-09-13	92%	39	0.15	0.12	0.18	360
17-11-13	100%	1	0.00	0.00	0.00	8

Month-to-month comparison of density estimates show the species occurring in the Horns Rev area mostly between late spring and autumn. In winter the species was rarely observed in the area (Table 3.9, Figure 3.9).

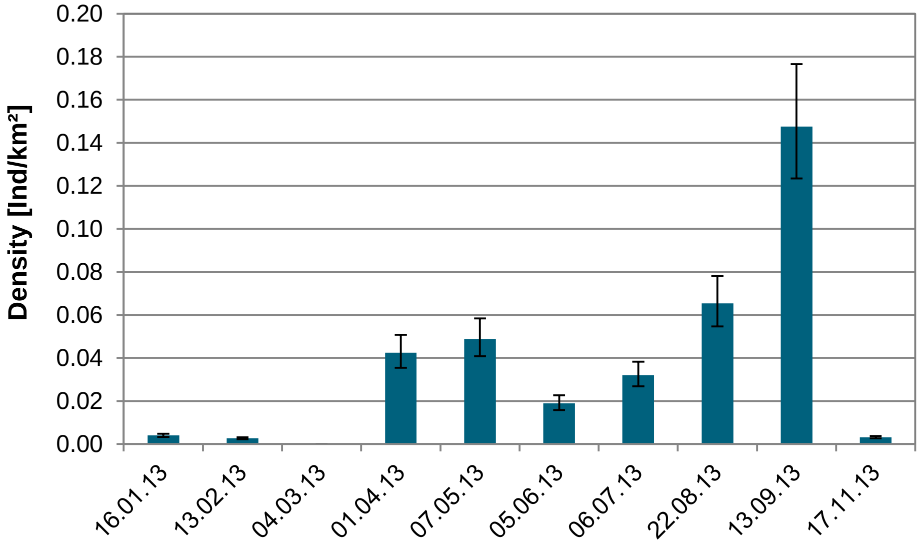


Figure 3.9 Mean density estimates and 95% confidence intervals of the Gannet estimated for aerial surveys undertaken between January 2013 and November 2013.

The highest seasonal density was calculated for the autumn season, which is represented by the September survey. The density of 0.15 ind./km² corresponds to an estimate of 393 Gannets (0.04% of the Gannet population) for the entire Horns Rev 3 study area for the autumn season (Table 3.10).

Table 3.10 Mean seasonal densities and abundance estimates for the Gannet in the Horns Rev 3 study area (2,663 km²).

Survey	Surveys represented	Mean density	Seasonal estimate
Spring	Mar-Apr	0.02	57
Summer	May-Aug	0.04	110
Autumn	Sep	0.15	393
Winter	Jan-Feb, Nov	0.00	9

3.2.4.2. Distribution of Gannets in the Horns Rev 3 area

Distribution of Gannets in the Horns Rev 3 study area was highly variable between surveys and suggests no general habitat associations or preferred areas (Figure 3.10, for monthly distribution maps see also Appendix p. 150ff).

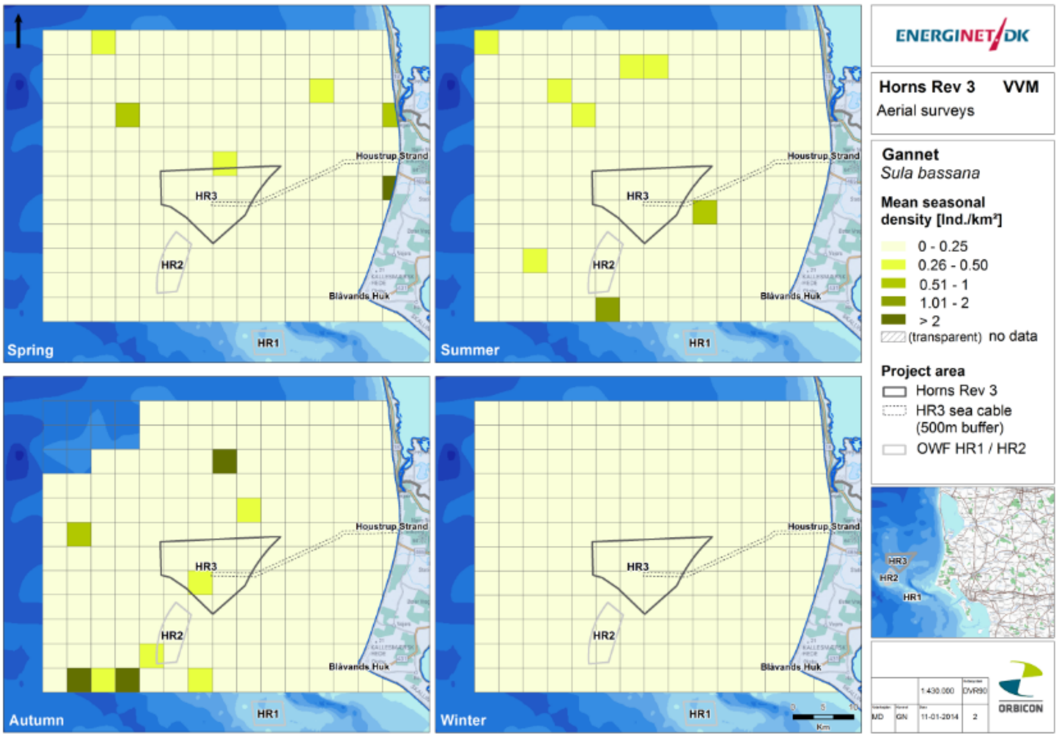


Figure 3.10 Mean seasonal distributions of the Gannet from aerial survey data recorded between January 2013 and November 2013. Species specific seasons were defined according to Garthe et al. (2007). The densities are shown in 4 km squares.

3.2.4.3. Abundance and distribution according to other studies

Christensen et al. (2003) recorded Gannets in 10 out of 14 survey flights during the baseline investigations in the Horns Rev 1 study area, which is situated slightly further south than the Horns Rev 3 study area with some overlap between the two. A total of 505 Gannets were counted making it the 10th most common species/group. Peak counts were during autumn and spring migration. However, there were no survey flights from May-July. Most sightings were made to the west of Horns Rev 1 with the highest densities in the reef area. The total number of Gannets recorded in the Horns Rev 1 study area during 34 surveys (including the above) from 1999-2005 was 1,144 birds (Christensen et al. 2006).

Six survey flights during the baseline observations for Horns Rev 2 were scheduled to coincide with the expected peak of scoter and diver abundance in winter and spring and recorded in total 23 Gannets (Skov et al. 2008b).

Peak numbers of migrating Gannets at Blåvands Huk are noted in September and early October (Jakobsen 2008). In the German Bight the highest abundance is also noted in autumn. Numbers are low in winter and spring (Mendel et al. 2008). The breeding colony closest to Horns Rev 3 is on the island of Helgoland with 489 breeding pairs (Dierschke et al. 2012).

3.2.4.4. Importance of the Horns Rev area to Gannet

Gannets were regularly observed in the Horns Rev 3 study area. However, the species occurred in low densities in the area with maximum estimates equalling less than 0.1% of the biogeographic population. Therefore the Horns Rev 3 area is assessed to be of low importance to the Gannet.

Importance level	Low

3.2.5 Common Eider

Common Eider – *Somateria mollissima*	**DK: Ederfugl**
Biogeographic population: *S. m. mollissima*, Baltic, Wadden Sea	
Breeding range: Baltic and Wadden Sea	
Wintering / core non-breeding range: Atlantic	
Population size: 976,000	
1% value: 9,800	
Conservation status:	EU Birds Directive, Annex I: not listed EU SPEC Category: Non-SPEC^{E} EU Threat Status: Secure IUCN Red List Category: Least Concern
Trend: DEC	Trend quality: Reasonable
Key food: Fish	

3.2.5.1. Abundance of Common Eiders in the Horns Rev 3 area

The abundance of Common Eiders in the Horns Rev 3 area was estimated by applying Distance analysis (Thomas et al. 2010) on the monthly aerial survey data. The effective strip width (ESW) for the Common Eider during aerial surveys, calculated using the entire dataset, was 215 m (95% CI 154 m – 301 m). The limited access to military areas prevented a full coverage of the entire study area during some aerial surveys. As numbers of Common Eiders have only been estimated for the area actually surveyed, monthly bird numbers should be regarded as minimum estimates for the respective surveys. The highest estimate of 8,810 eiders was obtained during the late winter survey of 13-02-2013 (Table 3.11).

Table 3.11 Numbers of observed Common Eiders during monthly aerial surveys and results of Distance analysis. 'Effort' represents the coverage of the study area in one- or two-sided valid conditions during the particular survey, 'N birds' the actual number of birds counted within transects, 'Density' the number of birds per km^2. 'D LCI' represents the lower 95% confidence interval, 'D UCI' the upper 95% confidence interval of the density; Total estimate represents the total number of birds estimated for the area surveyed during a particular survey.

Survey	Effort	N birds	Density	D LCI	D UCI	Total estimate
16-01-13	76%	12	0.06	0.04	0.09	124
13-02-13	100%	973	3.31	2.37	4.63	8,810
04-03-13	94%	323	1.61	1.15	2.26	4,023
01-04-13	100%	4	0.02	0.01	0.03	52
07-05-13	90%	0	0	0	0	0
05-06-13	97%	0	0	0	0	0
06-07-13	100%	22	0.11	0.08	0.16	300
22-08-13	99%	0	0	0	0	0
13-09-13	92%	0	0	0	0	0
17-11-13	100%	1	0.00	0.00	0.01	11

Month-to-month comparison of density estimates show the species occurring in the Horns Rev area mostly in winter and spring. In summer and autumn the species was rarely observed in the area (Table 3.11, Figure 3.11).

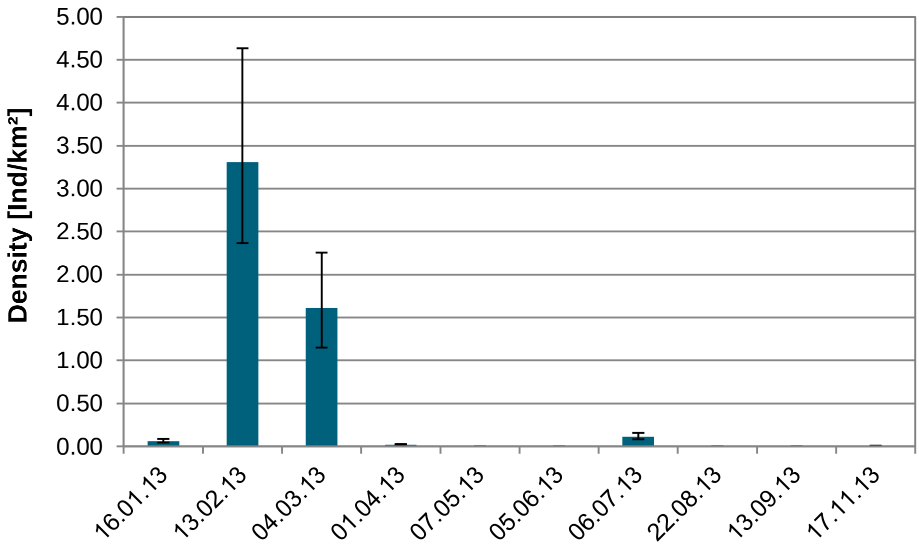


Figure 3.11 Mean density estimates and 95% confidence intervals of the Common Eider estimated for aerial surveys undertaken between January 2013 and November 2013.

The highest seasonal density was calculated for the winter and spring seasons with mean densities of 1.67 ind./km² and 0.82 ind./km² respectively. These correspond to estimates of 4,489 and 2,172 Common Eiders for the entire Horns Rev 3 study area for these seasons (Table 3.12).

Table 3.12 Mean seasonal densities and abundance estimates for the Common Eider in the Horns Rev 3 study area (2,663 km²).

Survey	Surveys represented	Mean density	Seasonal estimate
Spring	Mar-Apr	0.82	2,172
Summer	May-Aug	0.03	70
Autumn	Sep, Nov	0.00	5
Winter	Jan-Feb	1.69	4,489

3.2.5.2. Distribution of Common Eiders in the Horns Rev 3 area

In the Horns Rev 3 study area Common Eiders were highly concentrated along the coast close to Blåvands Huk at the very south-eastern edge of the surveyed area (Figure 3.12; for monthly distribution maps see Appendix p. 153ff).

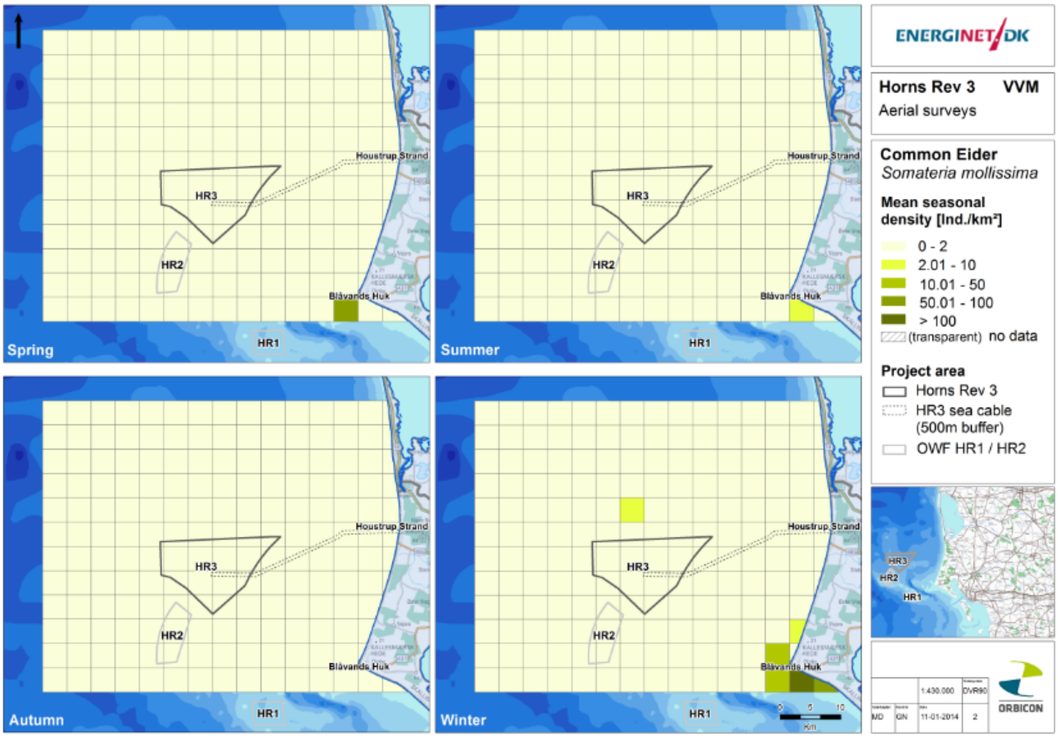


Figure 3.12 Mean seasonal distributions of the Common Eider from aerial survey data recorded between January 2013 and November 2013. Species specific seasons were defined according to Garthe et al. (2007). The densities are shown in 4 km squares.

3.2.5.3. Abundance and distribution according to other studies

Christensen et al. (2003) recorded Common Eiders in all but one of 14 survey flights during the baseline investigations in the Horns Rev 1 study area, which is situated slightly further south than the Horns Rev 3 study area with some overlap between the two. A total of 11,774 birds were counted making it the third most common species. Highest numbers were recorded in mid-winter. Distribution was very consistent over all survey flights with a strong concentration along the coast at Blåvands Huk and Skallingen. The total number of Common Eiders recorded in the Horns Rev 1 study area during 34 surveys (including the above) from 1999-2005 was 21,718 birds making it the 3rd most common species (Christensen et al. 2006). Four survey flights in January-April 2007 found the same distribution of birds with a concentration along the coast (Petersen and Fox 2007).

Six survey flights during the baseline observations for Horns Rev 2 were scheduled to coincide with the expected peak of scoter and diver abundance in winter and spring and recorded 311 Common Eiders (Skov et al. 2008b). This is a small number considering the abundance in the present study.

The restriction of Common Eiders to coastal waters and the Wadden Sea is also described by Mendel et al. (2008). At Blåvands Huk strong migration of Common Eiders is noted in October-November and February-March (Jakobsen 2008).

3.2.5.4. Importance of the Horns Rev area to Common Eider

In winter and spring maximum numbers of about 8,800 Common Eiders were observed in the Horns Rev 3 study area, the maximum seasonal estimate in winter of 4,489 eiders equals 0.45% of the biogeographic population. Therefore, regarding the entire Horns Rev 3 study area, the area is assessed to be of medium importance to the species. However, birds are not equally distributed in the study area and were only rarely observed outside the very south-eastern part of the surveyed area around Blåvands Huk. The Horns Rev 3 project area itself is regarded to be of low importance to the Common Eider.

Importance level	Medium

3.2.6 Common Scoter

Common Scoter – *Melanitta nigra*		**DK: Sortand**
Biogeographic population: *M .n. nigra,* W Siberia & N Europe/W Europe & NW Africa		
Breeding range: W Siberia, Scandinavia, Iceland, Scotland and Ireland		
Wintering / core non-breeding range: Baltic, E Atlantic S to Mauritania		
Population size: 550,000		
1% value: 5,500		
Conservation status:	EU Birds Directive, Annex I: not listed EU SPEC Category: Non-SPEC EU Threat Status: Secure IUCN Red List Category: Least Concern	
Trend: DEC	Trend quality: Poor	
Key food: molluscs, annelids, crustaceans		

3.2.6.1. Abundance of Common Scoters in the Horns Rev 3 area

The abundance of Common Scoters in the Horns Rev 3 area was estimated by applying Distance analysis (Thomas et al. 2010) on the monthly aerial survey data. The effective strip width (ESW) for the Common Scoter during aerial surveys, calculated using the entire dataset, was 271 m (95% CI 259 m – 284 m). The limited access to military areas prevented a full coverage of the entire study area during some aerial surveys. As numbers of scoters have only been estimated for the area actually surveyed, monthly bird numbers should be regarded as minimum estimates for the respective surveys. The highest estimate of 118,340 Common Scoters was obtained for the winter survey on 13-02-2013 (Table 3.13).

Month-to-month comparison of density estimates show the species occurring in the Horns Rev area almost all year with highest numbers occurring in winter and spring. Between May and September the species occurs mostly in shallow coastal waters with overall lower densities (Table 3.13, Figure 3.13). However, monthly estimates indicate also internationally important numbers of Common Scoter using the Horns Rev area during summer.

Table 3.13 Numbers of observed Common Scoters during monthly aerial surveys and results of Distance analysis. 'Effort' represents the coverage of the study area in one- or two-sided valid conditions during the particular survey, 'N birds' the actual number of birds counted within transects, 'Density' the number of birds per km². 'D LCI' represents the lower 95% confidence interval, 'D UCI' the upper 95% confidence interval of the density; Total estimate represents the total number of birds estimated for the area surveyed during a particular survey.

Survey	Effort	N birds	Density	D LCI	D UCI	Total estimate
16-01-13	76%	3,797	15.28	14.57	16.01	31,064
13-02-13	100%	16,498	44.47	42.42	46.61	118,336
04-03-13	94%	5,838	23.07	22.01	24.19	57,599
01-04-13	100%	4,968	19.39	18.49	20.32	51,561
07-05-13	90%	0	0	0	0	0
05-06-13	97%	430	1.64	1.57	1.72	4,260
06-07-13	100%	1,099	4.45	4.24	4.66	11,853
22-08-13	99%	299	0.94	0.90	0.99	2,485
13-09-13	92%	178	0.68	0.65	0.71	1,660
17-11-13	100%	417	1.33	1.27	1.40	3,555

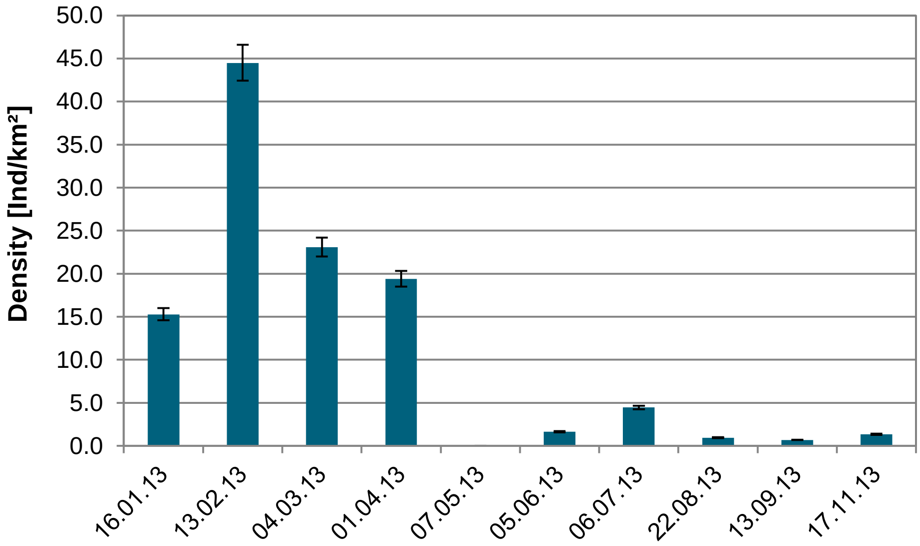


Figure 3.13 Mean density estimates and 95% confidence intervals of the Common Scoter estimated for aerial surveys undertaken between January 2013 and November 2013.

Highest seasonal densities of Common Scoters were calculated for the spring and winter season with densities of 14.15 ind./km² and 29.87 ind./km² respectively. The highest seasonal density of winter corresponds to an abundance estimate of 79,546 Common Scoters using the Horns Rev 3 study area (Table 3.14).

Table 3.14 Mean seasonal densities and abundance estimates for the Common Scoter in the Horns Rev 3 study area (2,663 km²).

Survey	Surveys represented	Mean density	Seasonal estimate
Spring	Mar-May	14.15	37,690
Summer	Jun-Sep	1.93	5,135
Autumn	Nov	1.33	3,555
Winter	Jan-Feb	29.87	79,546

3.2.6.2. Distribution of Common Scoters in the Horns Rev 3 area

During spring and winter Common Scoters are widely distributed in the Horns Rev 3 study area. Distributions observed during spring and winter seasons are similar with highest abundances observed in the southern part of the study area around Blåvands Huk and the reef area of Horns Rev (Figure 3.14). The high density area also includes the existing wind farm Horns Rev 2, where Common Scoters were regularly observed within the wind farm site.

In contrast to spring and winter, summer distribution shows the species to be highly concentrated in coastal areas. Similar to the other seasons, during summer the species was more abundant in the southern part of the study area with areas around Blåvands Huk showing the highest densities of Common Scoters (Figure 3.14). Distribution of Common Scoters in November was found being intermediate between summer and winter distribution patterns.

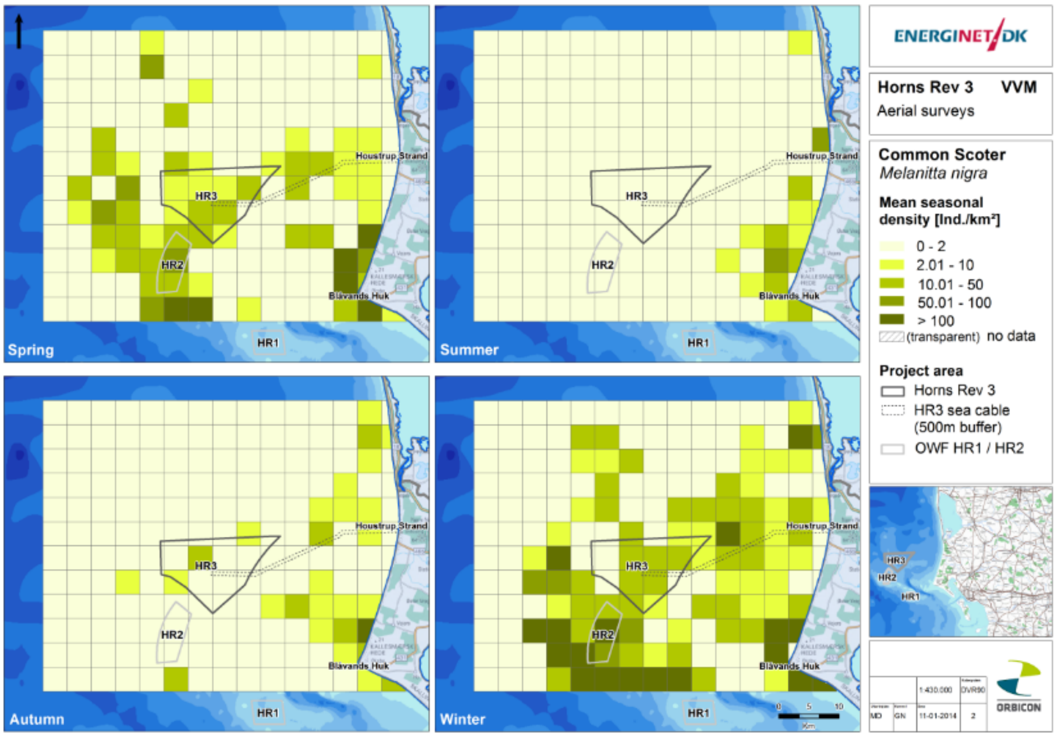


Figure 3.14 Mean seasonal distributions of the Common Scoter from aerial survey data recorded between January 2013 and November 2013. Species specific seasons were defined according to Garthe et al. (2007). The densities are shown in 4 km squares.

Foraging on benthic organisms Common Scoters are limited by water depth. According to the Horns Rev 3 baseline aerial survey data the range of water depth levels used differs between seasons. During spring, autumn and winter Common Scoters were observed being mostly confined to areas with water depths of less than 20 m. During that time of the year only 0.4–8.5% of scoters were observed in water depths greater than 20 m (Figure 3.15). There were no observations from areas of more than 25 m water depth. In summer Common Scoters were observed closer to shore with 78% of the birds using areas of less than 10 m water depth (Figure 3.15).

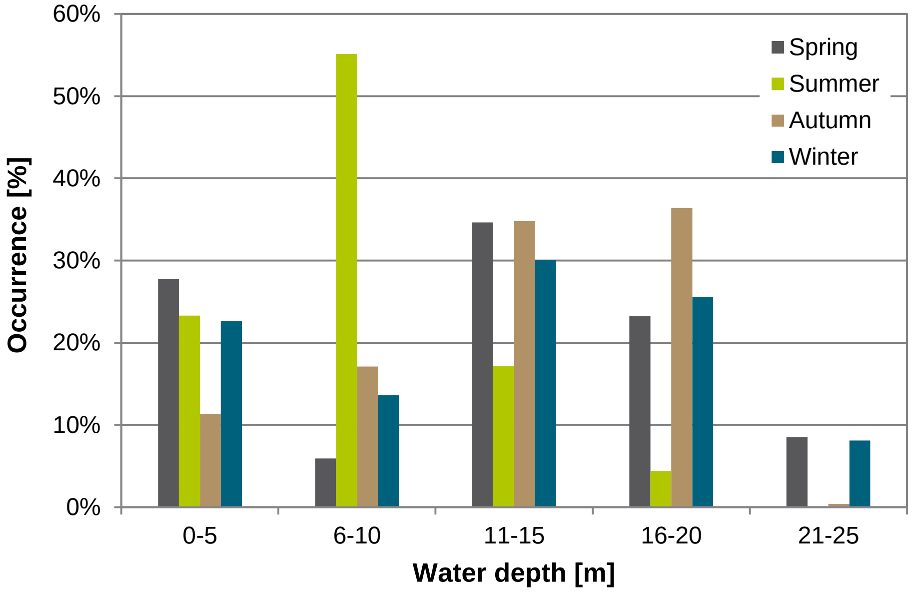


Figure 3.15 Common Scoter occurrence in the Horns Rev 3 study area in relation to water depth. The graph shows percentages of bird numbers observed in different water depth classes during aerial surveys between January and November 2013. Species specific seasons were defined according to Garthe et al. (2007).

3.2.6.3. Abundance and distribution according to other studies

Christensen et al. (2003) recorded Common Scoters during all 14 survey flights during the baseline investigations in the Horns Rev 1 study area, which is situated slightly further south than the Horns Rev 3 study area with some overlap between the two. A total of 93,642 birds were counted making it by far the most common species. Highest numbers were recorded in winter and spring. Common Scoters occurred more offshore than Common Eiders. Areas of high concentrations were along the coast at Blåvands Huk and Skallingen and the waters southeast of Horns Rev 1. Densities were very low in the western half of the study area. In February-March birds were recorded further offshore than in November-January. The total number of Common Scoters recorded in the Horns Rev 1 study area during 34 surveys (including the above) from 1999-2005 was 917,700 birds (Christensen et al. 2006).

Petersen and Fox (2007) investigated the distribution of Common Scoters in the Horns Rev 1 area following reports of helicopter pilots who spotted large numbers within the wind farm Horns Rev 1. During four survey flights following these observations from January-April 2007 a total of 356,635 Common Scoters were recorded with a peak count of 133,262 birds on February 15th alone. Birds shifted to more offshore areas towards April and were recorded inside the wind farm Horns Rev 1 during all flights.

Six survey flights during the baseline observations for Horns Rev 2 were scheduled to coincide with the expected peak of scoter and diver abundance in winter and spring and consequently recorded 120,179 Common Scoters making it by far the most abundant species of that study (Skov et al. 2008b). That study found the same shift of Common

Scoters from coastal waters at Blåvands Huk and Skalling in winter to more offshore areas at Horns Rev and further north in spring, as already described by Christensen et al. (2003). In early April the estimated total was 70,000 birds. A model of the distribution showed a strong correlation of scoter abundance with the habitat of *Spisula subtruncata*. There was less correlation with the suitable habitat for *Ensis americanus.* These two bivalve species are regarded as the most important prey for Common Scoters in the Danish part of the North Sea (Skov et al. 2008a). The shift of Common Scoter distribution to more offshore locations in late winter and early spring may be attributed to a shift in diet from *Spisula subtruncata* to *Ensis americanus* (Skov et al. 2008a, Leonhard and Skov 2012).

At Blåvands Huk the Common Scoter was the most common species during visual observations from 1963-1992 (Jakobsen 2008).

3.2.6.4. Importance of the Horns Rev area to Common Scoter

The Common Scoter is the most abundant waterbird species using the Horns Rev 3 area as resting, wintering, foraging and probably moulting area. With a seasonal estimate of 79,546 birds 14.46% of the biogeographic population of the Common Scoter winters in the Horns Rev 3 area. Also internationally important numbers use the area during spring (6.85% of the biogeographic population). Additionally almost 1% of the biogeographic population are estimated to spend the summer season in area. The international importance of the area to the species during different seasons results in the assessment of very high importance for the Common Scoter.

Importance level	Very high

3.2.7 Velvet Scoter

Velvet Scoter – *Melanitta fusca*	**DK: Fløjlsand**
Biogeographic population: *M .f. fusca,* Western Siberia & Northern Europe/NW Europe	
Breeding range: W Siberia and N Europe	
Wintering / core non-breeding range: Baltic, W Europe	
Population size: 450,000	
1% value: 4,500	
Conservation status:	EU Birds Directive, Annex I: not listed EU SPEC Category: SPEC 3 EU Threat Status: (Declining) IUCN Red List Category: Endangered
Trend: DEC	Trend quality: Poor
Key food: molluscs, crustaceans	

3.2.7.1. Abundance of Velvet Scoters in the Horns Rev 3 area

The abundance of Velvet Scoters in the Horns Rev 3 area was estimated by applying Distance analysis (Thomas et al. 2010) on the monthly aerial survey data. The effective strip width (ESW) for the Velvet Scoter during aerial surveys, calculated using the entire dataset, was 215 m (95% CI 173 m – 266 m). The limited access to military areas prevented a full coverage of the entire study area during some aerial surveys. As numbers of scoters have only been estimated for the area actually surveyed, monthly bird numbers should be regarded as minimum estimates for the respective surveys. The highest estimate of 4,037 Velvet Scoters was obtained for the spring survey of 01-04-2013 (Table 3.15).

Month-to-month comparison of density estimates show the species occurring in the Horns Rev area almost exclusively in spring. In other months the species was only occasionally observed during aerial surveys (Table 3.15, Figure 3.16).

Table 3.15 Numbers of observed Velvet Scoters during monthly aerial surveys and results of Distance analysis. 'Effort' represents the coverage of the study area in one- or two-sided valid conditions during the particular survey, 'N birds' the actual number of birds counted within transects, 'Density' the number of birds per km^2. 'D LCI' represents the lower 95% confidence interval, 'D UCI' the upper 95% confidence interval of the density; Total estimate represents the total number of birds estimated for the area surveyed during a particular survey.

Survey	Effort	N birds	Density	D LCI	D UCI	Total estimate
16-01-13	76%	2	0.01	0.01	0.01	21
13-02-13	100%	0	0	0	0	0
04-03-13	94%	96	0.48	0.39	0.59	1,196
01-04-13	100%	308	1.52	1.23	1.88	4,037
07-05-13	90%	0	0	0	0	0
05-06-13	97%	0	0	0	0	0
06-07-13	100%	0	0	0	0	0
22-08-13	99%	1	0.00	0.00	0.00	10
13-09-13	92%	0	0	0	0	0
17-11-13	100%	2	0.01	0.01	0.01	22

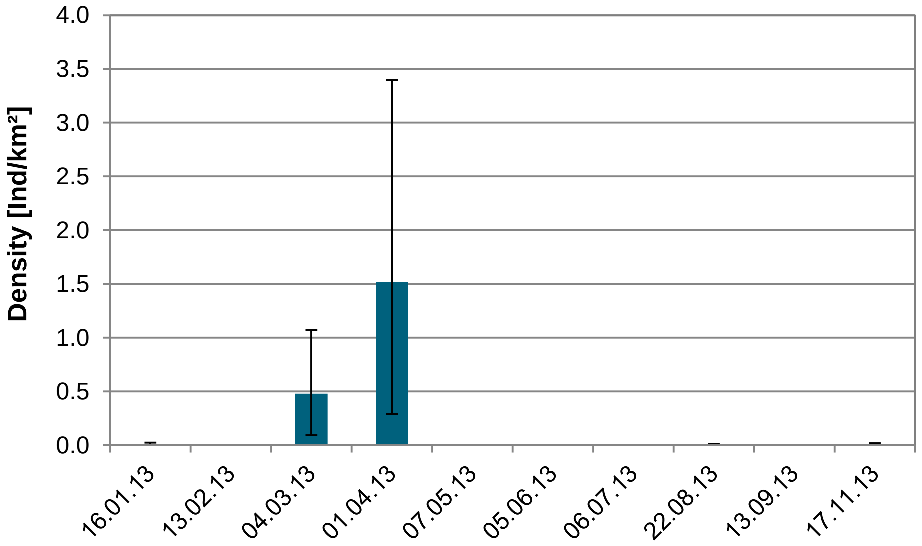


Figure 3.16 Mean density estimates and 95% confidence intervals of the Velvet Scoter estimated for aerial surveys undertaken between January 2013 and November 2013.

Corresponding to monthly results the highest seasonal density was calculated for the spring season (March to May), which corresponds to a seasonal estimate of 1,773 Velvet Scoters (0.39% of the biogeographic population) using the Horns Rev 3 study area in spring (Table 3.16).

Table 3.16 Mean seasonal densities and abundance estimates for the Velvet Scoter in the Horns Rev 3 study area (2,663 km²).

Survey	Surveys represented	Mean density	Seasonal estimate
Spring	Mar-May	0.67	1,773
Summer	Jun-Aug	0.00	3
Autumn	Sep, Nov	0.00	11
Winter	Jan-Feb	0.01	14

3.2.7.2. Distribution of Velvet Scoters in the Horns Rev 3 area

Similar to the Common Eider distribution, Velvet Scoters were highly concentrated along the coast. Higher numbers were only recorded in coastal areas close to Blåvands Huk at the very south-eastern tip of the surveyed area (Figure 3.17; for monthly distribution maps see Appendix p. 156ff).

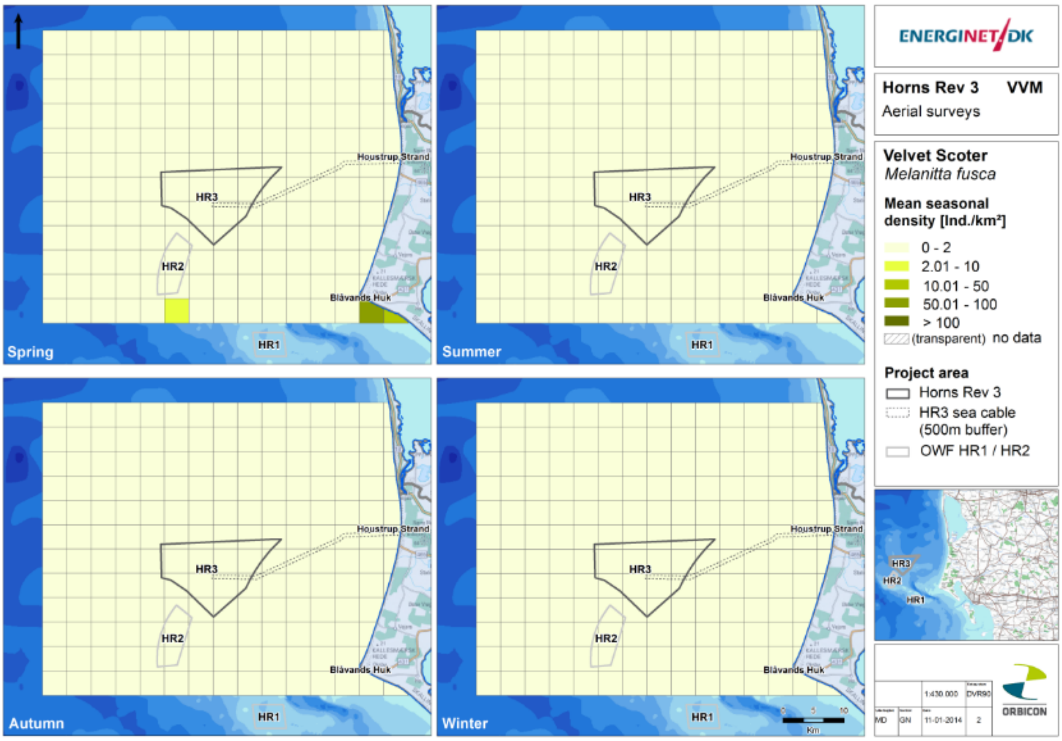


Figure 3.17 Mean seasonal distributions of the Velvet Scoter from aerial survey data recorded between January 2013 and November 2013. Species specific seasons were defined according to Garthe et al. (2007). The densities are shown in 4 km squares.

3.2.7.3. Abundance and distribution according to other studies

Christensen et al. (2003) recorded Velvet Scoters in 8 out of 14 survey flights during the baseline investigations of the Horns Rev 1 study area, which is situated slightly further south than the Horns Rev 3 study area with some overlap between the two. The species is notoriously difficult to separate from Common Scoter during aerial surveys and does occur in mixed flocks with the later so the species might have been overlooked in flocks of Common Scoters during the other surveys. A total of 614 birds were counted making it the 8th most common species. The total number of Velvet Scoters recorded in the Horns Rev 1 study area during 34 surveys (including the above) from 1999-2005 was 1,426 birds (Christensen et al. 2006).

Six survey flights during the baseline observations for Horns Rev 2 were scheduled to coincide with the expected peak of scoter and diver abundance in winter and spring and also recorded a total of 132 Velvet Scoters during five out of six flights (Skov et al. 2008b).

At Blåvands Huk Velvet Scoters are also far less abundant than Common Scoters with highest numbers passing in October-February (Jakobsen 2008). The winter population of the Velvet Scoter is at the southern limit of its distribution in the North Sea, further south along the coast of Germany the species becomes fairly rare with a maximum total of 480 birds in spring for the entire German sector of the North Sea (Mendel et al. 2008).

3.2.7.4. Importance of the Horns Rev area to Velvet Scoter

In spring maximum numbers of more than 4,000 Velvet Scoters were estimated for the Horns Rev 3 study area, the maximum seasonal estimate in spring of 1,773 Velvet Scoters equals 0.39% of the biogeographic population. Therefore, and due to the high conservation status of the species, the Horns Rev 3 study area is assessed to be of high importance to the species. However, birds were observed not being equally distributed in the study area, but were only rarely observed outside the very southern and south-eastern part of the surveyed area. The Horns Rev 3 project area itself is regarded to be of low importance to the Velvet Scoter.

Importance level	High

3.2.8 Little Gull

Little Gull – *Larus minutus*	**DK: Dværgmåge**
Biogeographic population: Central & E Europe/SW Europe & W Mediterranean	
Breeding range: N Scandinavia, Baltic States, W Russia, Belarus and Ukraine	
Wintering / core non-breeding range: W Europe and NW Africa	
Population size: 72,000 – 174,000	
1% value: 1,100	
Conservation status:	EU Birds Directive, Annex I: listed EU SPEC Category: SPEC 3 EU Threat Status: (Depleted) IUCN Red List Category: Least Concern
Trend: INC	Trend quality: Poor
Key food: insects (breeding, migration); marine invertebrates, fish (wintering)	

3.2.8.1. Abundance of Little Gull in the Horns Rev 3 area

The abundance of Little Gulls in the Horns Rev 3 area was estimated by applying Distance analysis (Thomas et al. 2010) on the monthly aerial survey data. The effective strip width (ESW) for the Little Gull during aerial surveys, calculated using the entire dataset, was 256 m (95% CI 214 m – 307 m). The limited access to military areas prevented a full coverage of the entire study area during some aerial surveys. As numbers of Little Gulls have only been estimated for the area actually surveyed, monthly bird numbers should be regarded as minimum estimates for the respective surveys. The highest estimate of 470 Little Gulls was obtained in early spring during the survey on 04-03-2013 (Table 3.17).

Month-to-month comparison of density estimates show the species occurring in the Horns Rev area almost throughout the year with highest numbers occurring during spring migration period (Table 3.17, Figure 3.18).

Table 3.17 Numbers of observed Little Gulls during monthly aerial surveys and results of Distance analysis. 'Effort' represents the coverage of the study area in one- or two-sided valid conditions during the particular survey, 'N birds' the actual number of birds counted within transects, 'Density' the number of birds per km^2. 'D LCI' represents the lower 95% confidence interval, 'D UCI' the upper 95% confidence interval of the density; 'Total estimate' represents the total number of birds estimated for the area surveyed during a particular survey.

Survey	Effort	N birds	Density	D LCI	D UCI	Total estimate
16-01-13	76%	15	0.06	0.05	0.08	130
13-02-13	100%	25	0.07	0.06	0.09	190
04-03-13	94%	45	0.19	0.16	0.23	470
01-04-13	100%	12	0.05	0.04	0.06	132
07-05-13	90%	9	0.04	0.04	0.05	102
05-06-13	97%	1	0.00	0.00	0.00	10
06-07-13	100%	20	0.09	0.07	0.10	228
22-08-13	99%	12	0.04	0.03	0.05	106
13-09-13	92%	0	0	0	0	0
17-11-13	100%	18	0.06	0.05	0.07	163

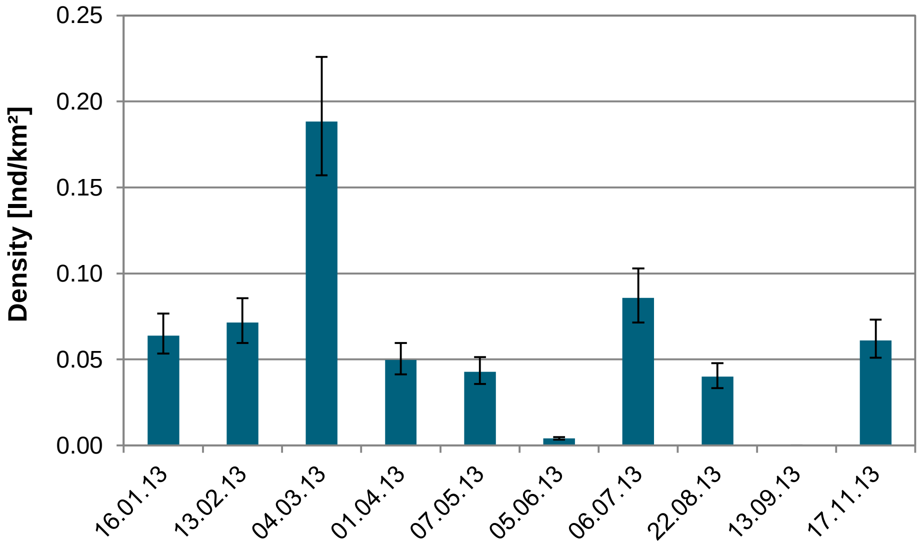


Figure 3.18 Mean density estimates and 95% confidence intervals of the Little Gull estimated for aerial surveys undertaken between January 2013 and November 2013.

Corresponding to monthly results the highest seasonal density was calculated for the spring season (March to May), which corresponds to a seasonal estimate of 249 Little Gulls (0.23% of the biogeographic population) using the Horns Rev 3 study area in spring (Table 3.18).

Table 3.18 Mean seasonal densities and abundance estimates for the Little Gull in the Horns Rev 3 study area (2,663 km²).

Survey	Surveys represented	Mean density	Seasonal estimate
Spring	Mar-May	0.09	249
Summer	Jun-Jul	0.04	120
Autumn	Aug-Sep	0.02	53
Winter	Jan-Feb, Nov	0.07	174

3.2.8.2. Distribution of Little Gull in the Horns Rev 3 area

Distribution of Little Gulls in the Horns Rev 3 study area was highly variable between surveys and suggests no general habitat associations or preferred areas (Figure 3.19, for monthly distribution maps see also Appendix p. 160ff). However, except for the autumn and winter seasons, when Little Gulls were also observed close to shore, the species was mostly observed further offshore (Figure 3.19).

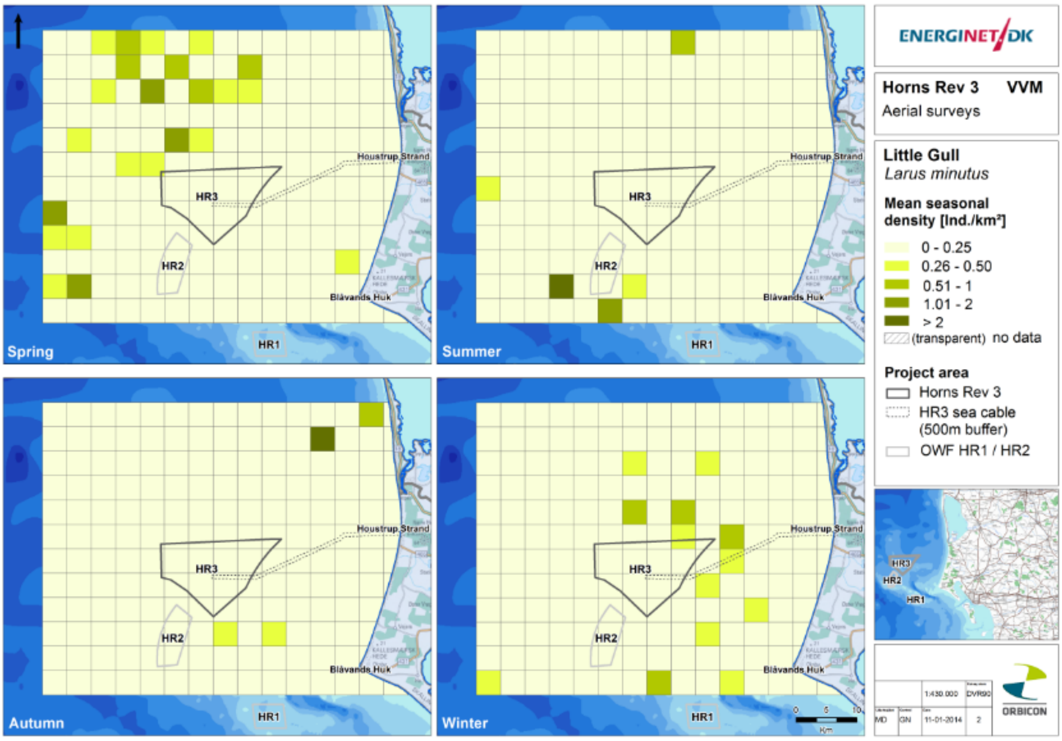


Figure 3.19 Mean seasonal distributions of Little Gulls from aerial survey data recorded between January 2013 and November 2013. Species specific seasons were defined according to Garthe et al. (2007). The densities are shown in 4 km squares.

3.2.8.3. Abundance and distribution according to other studies

Christensen et al. (2003) recorded Little Gulls during 6 out of 14 survey flights during the baseline investigations in the Horns Rev 1 study area, which is situated slightly further south than the Horns Rev 3 study area with some overlap between the two. A total of 50 birds were counted. Highest numbers were recorded in February-March. Most birds were recorded north/northwest and south/southeast of Horns Rev 1. The total number of Little Gulls recorded in the Horns Rev 1 study area during 34 surveys (including the above) from 1999-2005 was 1,451 birds (Christensen et al. 2006). Surveys during these studies likely underestimate Little Gull numbers occurring in the area over the year due to the timing of the surveys.

Six survey flights during the baseline observations for Horns Rev 2 were scheduled to coincide with the expected peak of scoter and diver abundance in winter and spring and also recorded a total of 75 Little Gulls during the last two flights in April (Skov et al. 2008b). In the southern part of the German Bight a strong passage of Little Gulls is noted in April (Dierschke et al. 2011). Mendel et al. (2008) calculated a total of 4,600 birds in spring for the German sector of the North Sea with most birds in territorial waters. At Blåvands Huk Little Gulls are more commonly seen in autumn with the peak of migration in October and early November (Jakobsen 2008).

3.2.8.4. Importance of the Horns Rev area to Little Gull

In March a maximum number of 470 Little Gulls was estimated for the Horns Rev 3 study area. The maximum seasonal estimate in spring of 249 birds equals 0.23% of the biogeographic population. Densities equalling more than 0.1% of the biogeographic population were also estimated for the winter and summer seasons. Therefore, and due to the very high conservation status of the species (Little Gull is listed in Annex I of the EU Birds Directive) the Horns Rev 3 study area is assessed to be of high importance to the Little Gull.

Importance level	High

3.2.9 Black-headed Gull

Black-headed Gull – *Larus ridibundus*	**DK: Hættemåge**
Biogeographic population: W Europe/W Europe W Mediterranean West Africa	
Breeding range: N & W Europe and S Greenland	
Non-breeding range: S & W Europe	
Population size: 3,400,000 – 4,800,000	
1% value: 42,100*	
Conservation status:	EU Birds Directive, Annex I: not listed EU SPEC Category: Non-SPEC[E] EU Threat Status: (Secure) IUCN Red List Category: Least Concern
Trend: STA	Trend quality: good
Key food: variable; aquatic and terrestrial invertebrates	

* For populations over 2 million birds, Ramsar Convention criterion 5 (20,000 or more waterbirds) applies.

3.2.9.1. Abundance of Black-headed Gulls in the Horns Rev 3 area

Abundance estimates of the Black-headed Gull have to be regarded as minimum estimates due to approximately 30% of all gull observations not identified to the species level, which is not accounted for in the density estimates.

Gulls observed in larger distance to the observer or observed in large flocks associated with fishing vessels often cannot be identified to the species level. Therefore Distance analysis (Thomas et al. 2010) could not be applied for the gull species except the Little Gull. The abundance of Black-headed Gulls in the Horns Rev 3 area was estimated by estimating bird densities from observed numbers within the distance bands A1 and A2 (band-A; BSH 2007), assuming a high detection probability close to 100% within these distance bands. This approach was chosen since most unidentified gulls have been recorded in more distant bands of the transect, thus density estimation using data from band-A only was regarded to be the most reliable method. Bird densities estimated by applying both methods (band-A and Distance analysis) were found to correspond closely for several species (see Appendix, p. 144), thus density estimation using the band-A approach according to BSH (2007) is regarded being appropriate.

The limited access to military areas prevented a full coverage of the entire study area during some aerial surveys. As numbers of Black-headed Gulls have only been estimated for the area actually surveyed, monthly bird numbers should be regarded as minimum estimates for the respective surveys. The highest estimate of 5,210 Black-headed Gulls was obtained for the survey on 13-09-2013 (Table 3.19).

Table 3.19 Numbers of observed Black-headed Gulls during monthly aerial surveys. 'Effort' represents the coverage of the study area in one- or two-sided valid conditions during the particular survey, 'N birds' the actual number of birds counted within transects, 'N birds band-A' the actual number of birds counted within transect bands A1 and A2, 'Density band-A' is calculated density based on bird numbers observed in band-A1 and A2, 'Total estimate' represents the total number of birds estimated for the area surveyed during a particular survey.

Survey	Effort	N birds	N birds band-A	Density band-A	Total estimate
16-01-13	76%	0	0	0	0
13-02-13	100%	1	0	0	0
04-03-13	94%	4	2	0.02	45
01-04-13	100%	7	5	0.04	118
07-05-13	90%	37	30	0.31	732
05-06-13	97%	1	1	0.01	23
06-07-13	100%	7	1	0.01	25
22-08-13	99%	5	2	0.01	38
13-09-13	92%	521	245	2.14	5,210
17-11-13	100%	100	92	0.67	1,788

Month-to-month comparison of density estimates show the species being present in the Horns Rev area between spring and autumn, but during most surveys only single individuals were observed (Table 3.19, Figure 3.20). There were no Black-headed Gull observations in January and February. Highest densities were observed in late autumn during the survey on 13-09-2013 and early winter on 17-11-2013.

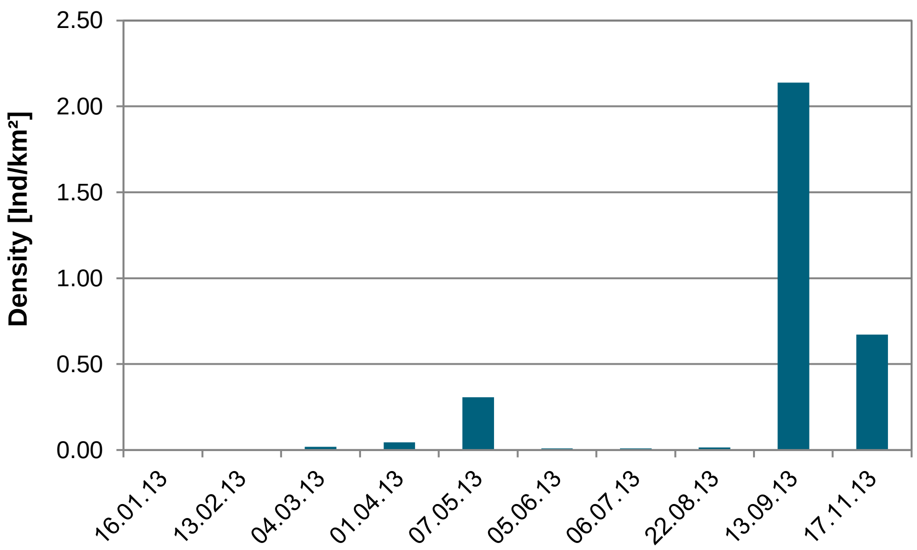


Figure 3.20 Mean density estimates of the Black-headed Gull estimated for aerial surveys undertaken between January 2013 and November 2013. Densities are estimated from bird observations in band-A, thus no confidence interval can be given.

Corresponding to monthly results the highest seasonal density was calculated for the autumn season (July to September), which corresponds to a seasonal estimate of 1,918 Black-headed Gulls (0.05% of the biogeographic population) using the Horns Rev 3 study area in autumn (Table 3.20).

Table 3.20 Mean seasonal densities and abundance estimates for the Black-headed Gull in the Horns Rev 3 study area (2,663 km²).

Survey	Surveys represented	Mean density	Seasonal estimate
Spring	Mar-Apr	0.03	83
Summer	May-Jun	0.16	420
Autumn	Jul-Sep	0.72	1,918
Winter	Jan-Feb, Nov	0.22	596

3.2.9.2. Distribution of Black-headed Gulls in the Horns Rev 3 area

Distribution of Black-headed Gulls in the Horns Rev 3 study area was highly variable between surveys and suggests no general habitat associations or preferred areas (Figure 3.21, for monthly distribution maps see also Appendix p. 164ff). Black-headed Gulls were observed close to the coast as well as in the offshore areas of the study area. The higher autumn numbers were observed close to the coast in the northeast of the surveyed area (Figure 3.21).

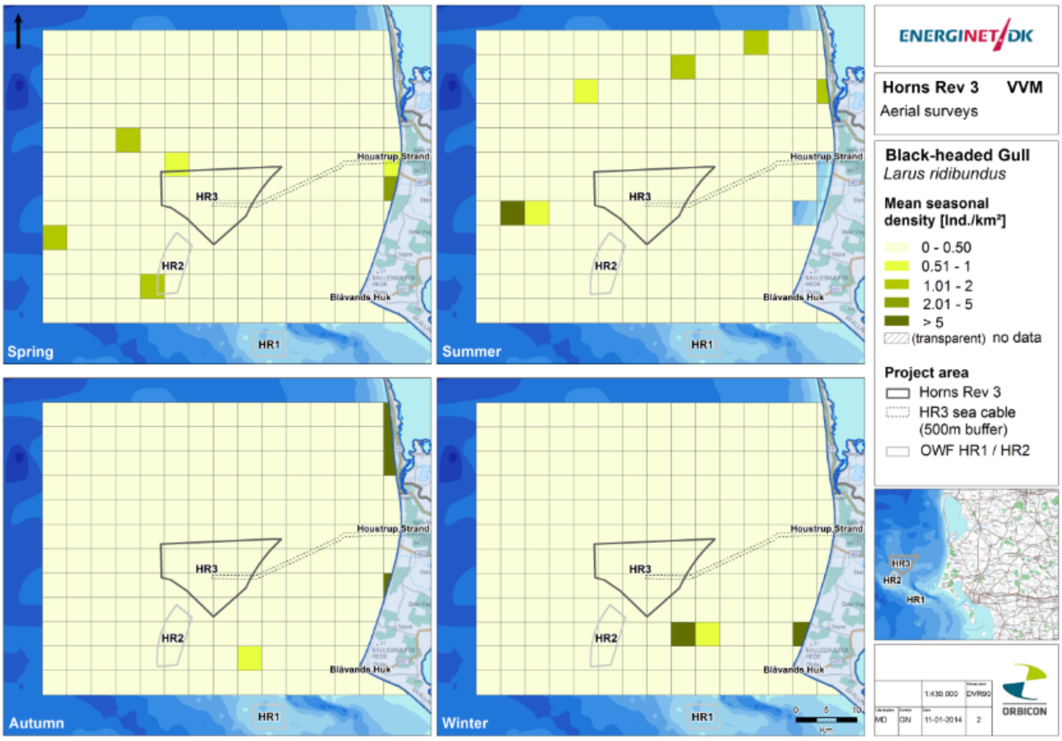


Figure 3.21 Mean seasonal distributions of the Black-headed Gull from aerial survey data recorded between January 2013 and November 2013. Species specific seasons were defined according to Garthe et al. (2007). The densities are shown in 4 km squares.

3.2.9.3. Abundance and distribution according to other studies

Christensen et al. (2003) recorded Black-headed Gulls during 10 out of 14 survey flights during the baseline investigations in the Horns Rev 1 study area. A total of 527 birds were counted making it the 9th most common species/group in the area. Highest counts were from April and August. Black-headed Gulls were concentrated near the coast. The total number of Black-headed Gulls recorded in the Horns Rev 1 study area during 34 surveys (including the above) from 1999-2005 was 675 birds (Christensen et al. 2006).

Six survey flights during the baseline observations for Horns Rev 2 were scheduled to coincide with the expected peak of scoter and diver abundance in winter and spring and also recorded a total of 123 Black-headed Gulls during five out of six flights (Skov et al. 2008b). At Blåvands Huk the passage of Black-headed Gulls is noted in March (adults), May-June (2nd year birds), August (juveniles) and October-November (adults) (Jakobsen 2008). SAS transects in the German Bight record most Black-headed Gulls close to the coast. In offshore areas they seem to be chiefly migrants passing through (Mendel et al. 2008).

3.2.9.4. Importance of the Horns Rev area to Black-headed Gull

In September a maximum number of 5,210 Black-headed Gulls were estimated for the Horns Rev 3 study area. The maximum seasonal estimate in autumn of 1,918 birds equals 0.05% of the biogeographic Black-headed Gull population. Therefore the Horns Rev 3 study area is assessed to be of low importance to the Black-headed Gull.

Importance level	Low

3.2.10 Common Gull

Common Gull – *Larus canus*	**DK: Stormmåge**
Biogeographic population: NW & Cent. Europe/Atlantic coast & Mediterranean	
Breeding range: Iceland, Ireland, Britain, E to White Sea	
Non-breeding range: Europe to N Africa	
Population size: 1,200,000 – 2,250,000	
1% value: 16,400	
Conservation status:	EU Birds Directive, Annex I: not listed EU SPEC Category: SPEC 2 EU Threat Status: (Depleted) IUCN Red List Category: Least Concern
Trend: DEC?	Trend quality: -
Key food: terrestrial and aquatic invertebrates, fish	

3.2.10.1. Abundance of Common Gulls in the Horns Rev 3 area

Abundance estimates of the Common Gull have to be regarded as minimum estimates due to approximately 30% of all gull observations not identified to the species level, which is not accounted for in the density estimates.

For the same reasons as described above in the paragraph on Black-headed Gulls (see chapter 3.2.9.1) the abundance of Common Gulls in the Horns Rev 3 area was estimated by estimating bird densities from observed numbers within the distance bands A1 and A2 (band-A; BSH 2007).

The limited access to military areas prevented a full coverage of the entire study area during some aerial surveys. As numbers of Common Gulls have only been estimated for the area actually surveyed, monthly bird numbers should be regarded as minimum estimates for the respective surveys. The highest estimate of 1,963 Common Gulls was calculated for the early-winter survey on 17-11-2013 (Table 3.21, Figure 3.22).

Month-to-month comparison of density estimates show the species occurring in the Horns Rev area all year with numbers highly fluctuating between surveys. Between late spring and early autumn there were three (summer) aerial surveys with very low densities of Common Gulls observed in the area (Table 3.21, Figure 3.22).

Table 3.21 Numbers of observed Common Gulls during monthly aerial surveys. 'Effort' represents the coverage of the study area in one- or two-sided valid conditions during the particular survey, 'N birds' the actual number of birds counted within transects, 'N birds band-A' the actual number of birds counted within transect bands A1 and A2, 'Density band-A' is calculated density based on bird numbers observed in band-A1 and A2, 'Total estimate' represents the total number of birds estimated for the area surveyed during a particular survey.

Survey	Effort	N birds	N birds band-A	Density band-A	Total estimate
16-01-13	76%	25	19	0.17	354
13-02-13	100%	78	50	0.31	818
04-03-13	94%	29	20	0.18	450
01-04-13	100%	18	11	0.10	260
07-05-13	90%	5	2	0.02	49
05-06-13	97%	27	21	0.18	474
06-07-13	100%	2	0	0.00	0
22-08-13	99%	5	4	0.03	76
13-09-13	92%	67	30	0.26	638
17-11-13	100%	114	101	0.74	1,963

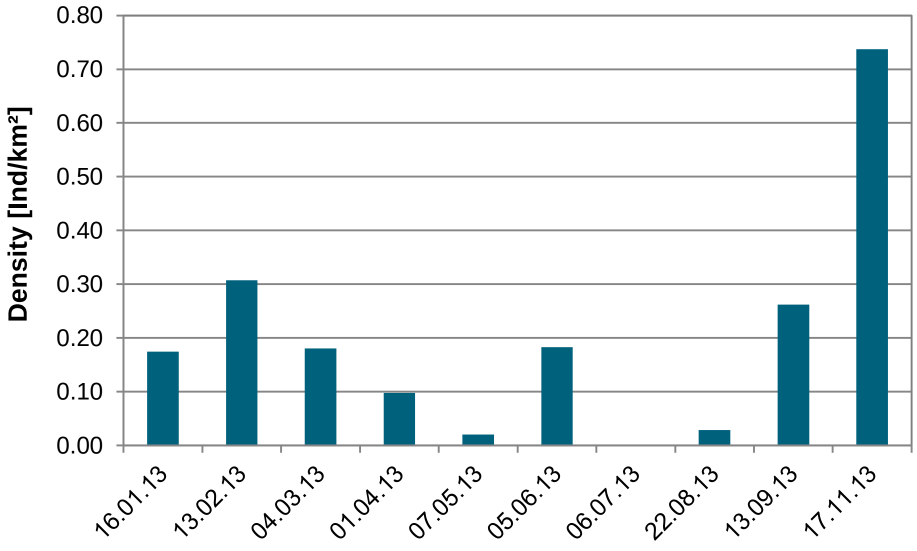


Figure 3.22 Mean density estimates of the Common Gull estimated for aerial surveys undertaken between January 2013 and November 2013. Densities are estimated from bird observations in band-A, thus no confidence interval can be given.

Seasonal densities of Common Gulls for the Horns Rev 3 study area varied between 0.09 ind./km² in summer and 0.41 ind./km² in winter (Table 3.22). The highest density for the winter season (represented by January, February and November surveys) corresponds to a seasonal estimate of 1,082 Common Gulls (0.07% of the biogeographic population) using the Horns Rev 3 study area in winter time (Table 3.22).

Table 3.22 Mean seasonal densities and abundance estimates for the Common Gull in the Horns Rev 3 study area (2,663 km²).

Survey	Surveys represented	Mean density	Seasonal estimate
Spring	Mar-May	0.10	265
Summer	Jun-Jul	0.09	244
Autumn	Aug-Sep	0.15	387
Winter	Jan-Feb, Nov	0.41	1,082

3.2.10.2. Distribution of Common Gulls in the Horns Rev 3 area

Common Gulls are frequently observed associated with fishing vessels scavenging for fish discards (e.g. Garthe and Scherp 2003), thus the distribution of Common Gulls is expected to be affected by fishing activities in the study area. Common Gulls were observed being widely distributed in the study area with the distribution patterns varying between seasons (Figure 3.23, for monthly distribution maps see also Appendix p.168ff). During spring and summer Common Gulls were mostly recorded in the southern part of the study area, in autumn the species was observed mostly close to the coast line. In winter Common Gulls were widely distributed in the area and distribution patterns suggest no clear habitat associations or preferred areas (Figure 3.23).

Figure 3.23 Mean seasonal distributions of the Common Gull from aerial survey data recorded between January 2013 and November 2013. Species specific seasons were defined according to Garthe et al. (2007). The densities are shown in 4 km squares.

3.2.10.3. Abundance and distribution according to other studies

Christensen et al. (2003) recorded Common Gulls during all but two out of 14 survey flights during the baseline investigations in the Horns Rev 1 study area. A total of 267 birds were counted. The highest count was in August, but there was no consistent phenology over the two years of baseline investigations. Most birds were recorded in coastal parts of the study area of Blåvands Huk and Skallingen. The total number of Common Gulls recorded in the Horns Rev 1 study area during 34 surveys (including the above) from 1999-2005 was 593 birds (Christensen et al. 2006).

Six survey flights during the baseline observations for Horns Rev 2 were scheduled to coincide with the expected peak of scoter and diver abundance in winter and spring and also recorded a total of 3,136 Common Gulls. The species was recorded on all flights and was the third most common species (Skov et al. 2008b). The distribution of the species was strongly influenced by the presence of fishing vessels.

In the German Bight the peak of occurrence is in winter with high densities in all areas up to a water depth of 20 m. Further offshore the species becomes less abundant. Common Gulls were found being especially associated with shrimp fishery (Mendel et al. 2008). At Blåvands Huk the passage of Common Gulls is noted in March-April, July and October-November (Jakobsen 2008).

3.2.10.4. Importance of the Horns Rev area to Common Gull

Common Gulls occur in the Horns Rev 3 study area all year with highest numbers being observed in winter. The winter estimate of 1,082 Common Gulls equals 0.07% of the biogeographic population. Therefore the Horns Rev 3 area is assessed to be of low importance to the Common Gull.

Importance level	Low

3.2.11 Lesser Black-backed Gull

Lesser Black-backed Gull – *Larus fuscus*	**DK: Sildemåge**
Biogeographic population: *L. f. intermedius*, S Scandinavia Netherlands Ebro Delta Spain	
Breeding range: N Norway, E Sweden, E Denmark, Finland, Estonia, W Russia E to White Sea	
Non-breeding range: W Europe to W Africa	
Population size: 325,000 – 440,000	
1% value: 3,800	
Conservation status:	EU Birds Directive, Annex I: not listed EU SPEC Category: Non-SPEC^{E} EU Threat Status: Secure IUCN Red List Category: Least Concern
Trend: INC	Trend quality: Poor
Key food: various different food	

3.2.11.1. Abundance of Lesser Black-backed Gulls in the Horns Rev 3 area

Abundance estimates of the Lesser Black-backed Gull have to be regarded as minimum estimates due to approximately 30% of all gull observations not identified to the species level, which is not accounted for in the density estimates.

For the same reasons as described above in the paragraph on Black-headed Gulls (see chapter 3.2.9.1) the abundance of Lesser Black-backed Gulls in the Horns Rev 3 area was estimated by estimating bird densities from observed numbers within the distance bands A1 and A2 (band-A; BSH 2007).

The limited access to military areas prevented a full coverage of the entire study area during some aerial surveys. As numbers of Lesser Black-backed Gulls have only been estimated for the area actually surveyed, monthly bird numbers should be regarded as minimum estimates for the respective surveys. Month-to-month comparison of density estimates show the species occurring in the Horns Rev area mainly during the summer period. The highest estimate of 3,123 Lesser Black-backed Gulls was obtained for the summer survey on 06-07-2013 (Table 3.23, Figure 3.24). In winter the species is almost absent from the study area.

Table 3.23 Numbers of observed Lesser Black-backed Gulls during monthly aerial surveys. 'Effort' represents the coverage of the study area in one- or two-sided valid conditions during the particular survey, 'N birds' the actual number of birds counted within transects, 'N birds band-A' the actual number of birds counted within transect bands A1 and A2, 'Density band-A' is calculated density based on bird numbers observed in band-A1 and A2, 'Total estimate' represents the total number of birds estimated for the area surveyed during a particular survey.

Survey	Effort	N birds	N birds band-A	Density band-A	Total estimate
16-01-13	76%	0	0	0	0
13-02-13	100%	0	0	0	0
04-03-13	94%	6	3	0.03	67
01-04-13	100%	2	2	0.02	47
07-05-13	90%	11	5	0.05	122
05-06-13	97%	75	29	0.25	655
06-07-13	100%	425	127	1.17	3,123
22-08-13	99%	35	25	0.18	474
13-09-13	92%	16	8	0.07	170
17-11-13	100%	0	0	0	0

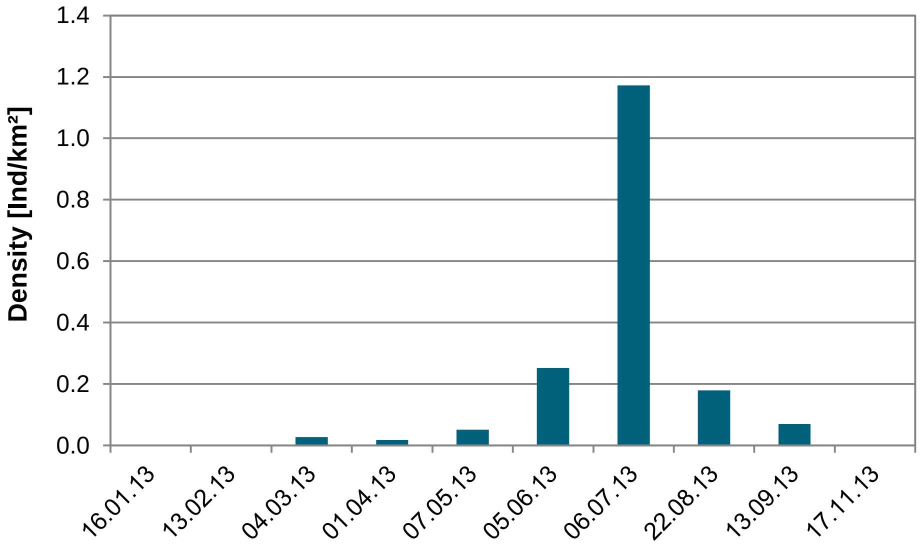


Figure 3.24 Mean density estimates of the Lesser Black-backed Gull estimated for aerial surveys undertaken between January 2013 and November 2013. Densities are estimated from bird observations in band-A, thus no confidence interval can be given.

The highest seasonal density of Lesser Black-backed Gulls was calculated for the summer season with 0.71 ind./km². This density corresponds to an abundance estimate of almost 1,900 Lesser Black-backed Gulls using the Horns Rev 3 study area during summer, equalling 0.50% of the biogeographic population (Table 3.24).

Table 3.24 Mean seasonal densities and abundance estimates for the Lesser Black-backed Gull in the Horns Rev 3 study area (2,663 km²).

Survey	Surveys represented	Mean density	Seasonal estimate
Spring	Apr-May	0.03	92
Summer	Jun-Jul	0.71	1,897
Autumn	Aug-Sep	0.12	332
Winter	Jan-Mar, Nov	0.01	18

3.2.11.2. Distribution of Lesser Black-backed Gulls in the Horns Rev 3 area

As other gull species Lesser Black-backed Gulls are frequently observed associated with fishing vessels scavenging for fish discards (e.g. Garthe and Hüppop 1994, Schwemmer and Garthe 2005), thus the distribution of the species is expected to be affected by fishing activities in the study area. Lesser Black-backed Gulls were observed being widely distributed in the study area with the distribution patterns varying between surveys (Figure 3.23, for monthly distribution maps see also Appendix p.173ff). Distribution patterns suggest no clear habitat associations or preferred areas (Figure 3.25).

Figure 3.25 Mean seasonal distributions of the Lesser Black-backed Gull from aerial survey data recorded between January 2013 and November 2013. Species specific seasons were defined according to Garthe et al. (2007). The densities are shown in 4 km squares.

3.2.11.3. Abundance and distribution according to other studies

Christensen et al. (2003) recorded Lesser Black-backed Gulls in 8 out of 14 survey flights during the baseline investigations of the Horns Rev 1 study area, which is situated slightly further south than the Horns Rev 3 study area with some overlap between the two. A total of 86 birds were counted. Unfortunately no surveys were carried out during the months of June and July, the peak of occurrence in the present study. The total number of Lesser Black-backed Gulls recorded in the Horns Rev 1 study area during 34 surveys (including the above) from 1999-2005 was 143 birds (Christensen et al. 2006).

Six survey flights during the baseline observations for Horns Rev 2 were scheduled to coincide with the expected peak of scoter and diver abundance in winter and spring and also recorded a total of 407 Lesser Black-backed Gulls, the low number surely being attributed to the focus of the study on winter and early spring (Skov et al. 2008b). The distribution was less correlated with fishing activities than that of Common Gull and Herring Gull.

At Blåvands Huk the species is noted from late February to early November with large numbers passing in July and August (Jakobsen 2008). In the German Bight the peak of occurrence is also noted in summer with a total of 76,000 birds calculated for the German sector of the North Sea. Lesser Black-backed Gulls are associated with fishing activities but are also successfully finding prey by themselves (Mendel et al. 2008).

3.2.11.4. Importance of the Horns Rev area to Lesser Black-backed Gull

During the summer season Lesser Black-backed Gulls use the Horns Rev 3 area in internationally important numbers. The seasonal estimate of almost 1,900 Lesser Black-backed Gulls in summer equals 0.50% of the biogeographic population. This results in the assessment of medium importance of the Horns Rev 3 area to Lesser Black-backed Gulls.

Importance level	medium

3.2.12 Herring Gull

Herring Gull – *Larus argentatus*	**DK: Sølvmåge**
Biogeographic population: *argentatus*, North & North-west Europe*	
Breeding range: Denmark & Fenno-Scandia to E Kola Peninsula	
Non-breeding range: N & W Europe	
Population size: 1,300,000 – 3,100,000	
1% value: 20,100**	
Conservation status:	EU Birds Directive, Annex I: not listed EU SPEC Category: Non-SPEC[E] EU Threat Status: Secure IUCN Red List Category: Least Concern
Trend: STA	Trend quality: Poor
Key food: various different food	

* Population *L.a.argenteus* (Iceland & Western Europe), NW Europe S to N Iberia (non-br) occurs, too. However, following Meininger et al. (1995) and Wahl et al. (2007) numbers of the larger population (*L. a. argentatus*) apply.
** For populations over 2 million birds, Ramsar Convention criterion 5 (20,000 or more waterbirds) applies.

3.2.12.1. Abundance of Herring Gulls in the Horns Rev 3 area

Abundance estimates of the Herring Gull have to be regarded as minimum estimates due to approximately 30% not to the species level identified gulls in all observations not accounted for in density estimates.

For the same reasons as described above in the paragraph on Black-headed Gulls (see chapter 3.2.9.1) the abundance of Herring Gulls in the Horns Rev 3 area was estimated by estimating bird densities from observed numbers within the distance bands A1 and A2 (band-A; BSH 2007).

The limited access to military areas prevented a full coverage of the entire study area during some aerial surveys. As numbers of Herring Gulls have only been estimated for the area actually surveyed, monthly bird numbers should be regarded as minimum estimates for the respective surveys. Month-to-month comparison of density estimates show the species occurring in the Horns Rev area all year. The highest estimate of 8,124 Herring Gulls was obtained for the winter survey on 17-11-2013 (Table 3.25, Figure 3.26).

Table 3.25 Numbers of observed Herring Gulls during monthly aerial surveys. 'Effort' represents the coverage of the study area in one- or two-sided valid conditions during the particular survey, 'N birds' the actual number of birds counted within transects, 'N birds band-A' the actual number of birds counted within transect bands A1 and A2, 'Density band-A' is calculated density based on bird numbers observed in band-A1 and A2, 'Total estimate' represents the total number of birds estimated for the area surveyed during a particular survey.

Survey	Effort	N birds	N birds band-A	Density band-A	Total estimate
16-01-13	76%	46	27	0.25	504
13-02-13	100%	33	18	0.11	294
04-03-13	94%	17	11	0.10	247
01-04-13	100%	26	13	0.12	308
07-05-13	90%	48	24	0.25	585
05-06-13	97%	27	2	0.02	45
06-07-13	100%	23	17	0.16	418
22-08-13	99%	120	80	0.57	1,516
13-09-13	92%	513	213	1.86	4,530
17-11-13	100%	601	418	3.05	8,124

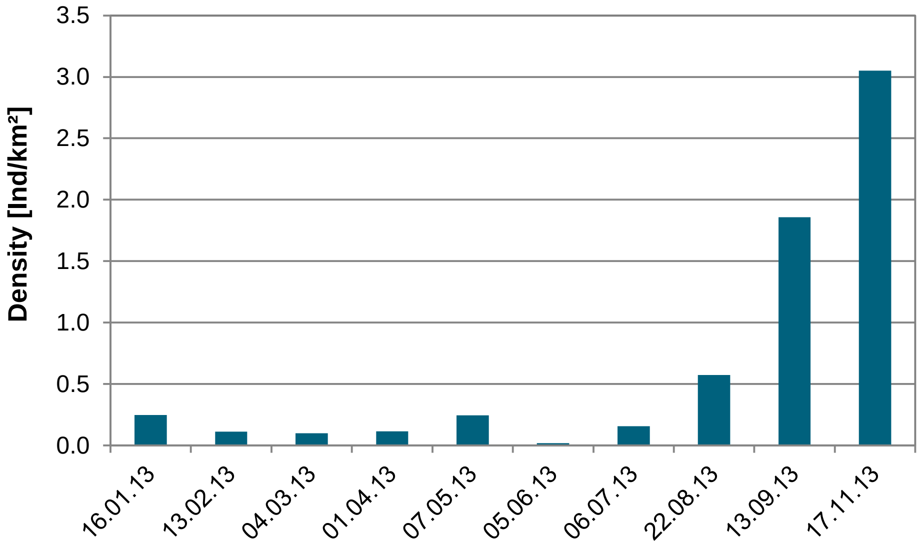


Figure 3.26 Mean density estimates of the Herring Gull estimated for aerial surveys undertaken between January 2013 and November 2013. Densities are estimated from bird observations in band-A, thus no confidence interval can be given.

The highest seasonal density of Herring Gulls was calculated for the autumn season with 1.22 ind./km². This density corresponds to an abundance estimate of 3,238 Herring Gulls using the Horns Rev 3 study area during autumn, equalling 0.16% of the biogeographic population (Table 3.26).

Table 3.26 Mean seasonal densities and abundance estimates for the Herring Gull in the Horns Rev 3 study area (2,663 km²).

Survey	Surveys represented	Mean density	Seasonal estimate
Spring	Mar-May	0.15	409
Summer	Jun-Jul	0.09	232
Autumn	Aug-Sep	1.22	3,238
Winter	Jan-Feb, Nov	1.14	3,026

3.2.12.2. Distribution of Herring Gulls in the Horns Rev 3 area

Herring Gulls are frequently observed associated with fishing vessels scavenging for discards (e.g. Garthe and Hüppop 1998), thus the distribution of Herring Gulls is expected to be affected by fishing activities in the study area. Herring Gulls were observed being widely distributed in the study area with the distribution patterns varying between seasons (Figure 3.27, for monthly distribution maps see also Appendix p.168ff). Between spring and autumn Herring Gulls were recorded in higher densities in the coastal areas. In winter Herring Gulls were found widely distributed in the area and distribution patterns suggest no clear habitat associations or preferred areas (Figure 3.27).

Figure 3.27 Mean seasonal distributions of the Herring Gull from aerial survey data recorded between January 2013 and November 2013. Species specific seasons were defined according to Garthe et al. (2007). The densities are shown in 4 km squares.

3.2.12.3. Abundance and distribution according to other studies

Christensen et al. (2003) recorded Herring Gulls during all 14 survey flights during the baseline investigations in the Horns Rev 1 study area. A total of 16,237 birds were counted making it the second most common species and by far the most common gull species in the area. Highest numbers were recorded in February-April. Densities were highest along the coast, but Herring Gulls occurred throughout the study area and showed concentrations around fishing vessels in the offshore parts. The total number of Herring Gulls recorded in the Horns Rev 1 study area during 34 surveys (including the above) from 1999-2005 was 45,974 birds (Christensen et al. 2006).

Six survey flights during the baseline observations for Horns Rev 2 were scheduled to coincide with the expected peak of scoter and diver abundance in winter and spring and also recorded a total of 6,668 Herring Gulls making it the second most common species of that study (Skov et al. 2008b). Herring Gulls were strongly associated with fishing activities offshore.

In agreement with the offshore surveys Herring Gulls are very common at Blåvands Huk from October-January (Jakobsen 2008). In the German Bight the peak of occurrence in offshore areas is noted in winter while at the coast the species is most common in summer. Herring Gulls in the German Bight are also strongly associated with fishing vessels particularly in offshore areas (Mendel et al. 2008).

3.2.12.4. Importance of the Horns Rev area to Herring Gull

In autumn maximum numbers of 4,530 Herring Gulls were observed in the Horns Rev 3 study area, the maximum seasonal estimate in autumn of 3,238 Herring Gulls equals 0.16% of the biogeographic population. Therefore, and due to the medium conservation/protection status of the species (SPEC status: Non-SPEC^{E}), the Horns Rev 3 study area is assessed to be of medium importance to the species.

Importance level	Medium

3.2.13 Great Black-backed Gull

Great Black-backed Gull – *Larus marinus*	**DK: Svartbag**
Biogeographic population: North & West Europe	
Breeding range: Coasts NW France, Ireland, Britain, Iceland E to Scandinavia, White Sea	
Non-breeding range: E Atlantic coast S to Iberia	
Population size: 330,000 – 540,000	
1% value: 4,200	
Conservation status:	EU Birds Directive, Annex I: not listed EU SPEC Category: Non-SPEC[E] EU Threat Status: Secure IUCN Red List Category: Least Concern
Trend: INC	Trend quality: Reasonable
Key food: various different food	

3.2.13.1. Abundance of Great Black-backed Gulls in the Horns Rev 3 area

During the aerial surveys between January and November 2013 Great Black-backed Gulls were only rarely observed in the Horns Rev 3 study area. In total 39 Great Black-backed Gulls were recorded with a maximum of 17 individuals observed during the survey in November 2013 (Table 3.27). Because of the few sightings of this species no density and abundance estimates were possible. Numbers of the Great Black-backed Gull have to be regarded as minimum numbers due to approximately 30% not to the species level identified gulls in all observations.

Table 3.27 Numbers of observed Great Black-backed Gulls during monthly aerial surveys. 'Effort' represents the coverage of the study area in one- or two-sided valid conditions during the particular survey, 'N birds' the actual number of birds counted within transects.

Survey	Effort	N birds
16-01-13	76%	2
13-02-13	100%	0
04-03-13	94%	3
01-04-13	100%	1
07-05-13	90%	0
05-06-13	97%	4
06-07-13	100%	1
22-08-13	99%	2
13-09-13	92%	9

Survey	Effort	N birds
17-11-13	100%	17

3.2.13.2. Distribution of Great Black-backed Gulls in the Horns Rev 3 area

During the aerial surveys conducted in the Horns Rev 3 study area the Great Black-backed Gull was only rarely observed. The few observations were distributed in different parts of the study area (Figure 3.28, for more monthly distribution maps see also Appendix p. 173ff). Thus, surveys suggest no general habitat associations or preferred areas for the Great Black-backed Gull in the Horn Rev 3 study area.

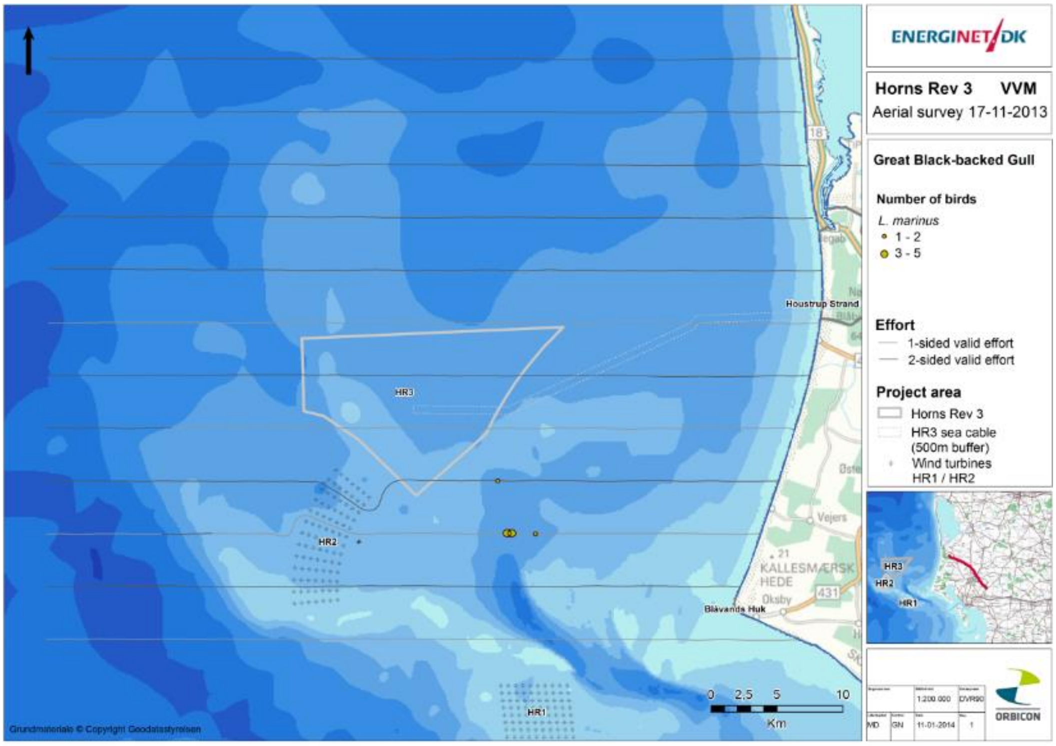


Figure 3.28 Example of the observed Great Black-backed Gull (and Lesser Black-backed Gull) distribution in the study area during the aerial surveys on 17/11/2013.

3.2.13.3. Abundance and distribution according to other studies

Christensen et al. (2003) recorded Great Black-backed Gulls during all 14 survey flights during the baseline investigations of the Horns Rev 1 study area. A total of 471 birds were counted. Highest numbers were recorded in August/September and April. A pattern that was consistent during the two years of the baseline study. There was no consistent distribution pattern between flights. In general the Great Black-backed Gull was distributed more offshore than Herring and Common Gulls and showed a concentration in the eastern half of the study area. The total number of Great Black-backed Gulls recorded in the Horns Rev 1 study area during 34 surveys (including the above) from 1999-2005 was 1,125 birds (Christensen et al. 2006).

Six survey flights during the baseline observations for Horns Rev 2 were scheduled to coincide with the expected peak of scoter and diver abundance in winter and spring and only recorded 25 Great Black-backed Gulls (Skov et al. 2008b).

At Blåvands Huk the species is common on passage in late summer and autumn (Jakobsen 2008). In the German Bight the peak of occurrence in offshore areas is noted in autumn and winter and its distribution is correlated with fishing activities (Mendel et al. 2008).

3.2.13.4. Importance of the Horns Rev area to Great Black-backed Gull

During the aerial surveys at Horns Rev 3 only single Great Black-backed Gulls have been recorded. Therefore the area is assessed to be of low importance to the Great Black-backed Gull.

Importance level	Low

3.2.14 Kittiwake

Kittiwake – *Rissa tridactyla*	**DK: Ride**
Biogeographic population: *R. t. trydactyla*, East Atlantic (br)	
Breeding range: Coastal N & W Europe E to Taymyr Peninsula	
Non-breeding range: E North Atlantic & North Sea	
Population size: 6,600,000	
1% value: 66,000*	
Conservation status:	EU Birds Directive, Annex I: not listed EU SPEC Category: Non-SPEC EU Threat Status: (Secure) IUCN Red List Category: Least Concern
Trend: DEC	Trend quality: Reasonable
Key food: fish and marine invertebrates	

* For populations over 2 million birds, Ramsar Convention criterion 5 (20,000 or more waterbirds) applies.

3.2.14.1. Abundance of Kittiwakes in the Horns Rev 3 area

Abundance estimates of the Kittiwake have to be regarded as minimum estimates due to approximately 30% not to the species level identified gulls in all observations not accounted for in density estimates.

For the same reasons as described above in the paragraph on Black-headed Gulls (see chapter 3.2.9.1) the abundance of Kittiwakes in the Horns Rev 3 area was estimated by estimating bird densities from observed numbers within the distance bands A1 and A2 (band-A; BSH 2007).

The limited access to military areas prevented a full coverage of the entire study area during some aerial surveys. As numbers of Kittiwakes have only been estimated for the area actually surveyed, monthly bird numbers should be regarded as minimum estimates for the respective surveys. Month-to-month comparison of density estimates show the species occurring in the Horns Rev area almost all year. The highest estimate of 408 Kittiwakes was obtained for the winter survey on 17-11-2013 (Table 3.28, Figure 3.29).

Table 3.28 Numbers of observed Kittiwakes during monthly aerial surveys. 'Effort' represents the coverage of the study area in one- or two-sided valid conditions during the particular survey, 'N birds' the actual number of birds counted within transects, 'N birds band-A' the actual number of birds counted within transect bands A1 and A2, 'Density band-A' is calculated density based on bird numbers observed in band-A1 and A2, 'Total estimate' represents the total number of birds estimated for the area surveyed during a particular survey.

Survey	Effort	N birds	N birds band-A	Density band-A	Total estimate
16-01-13	76%	25	17	0.16	317
13-02-13	100%	3	1	0.01	16
04-03-13	94%	7	4	0.04	90
01-04-13	100%	0	0	0	0
07-05-13	90%	1	1	0.01	24
05-06-13	97%	7	4	0.03	90
06-07-13	100%	14	4	0.04	98
22-08-13	99%	1	1	0.01	19
13-09-13	92%	2	0	0	0
17-11-13	100%	31	21	0.15	408

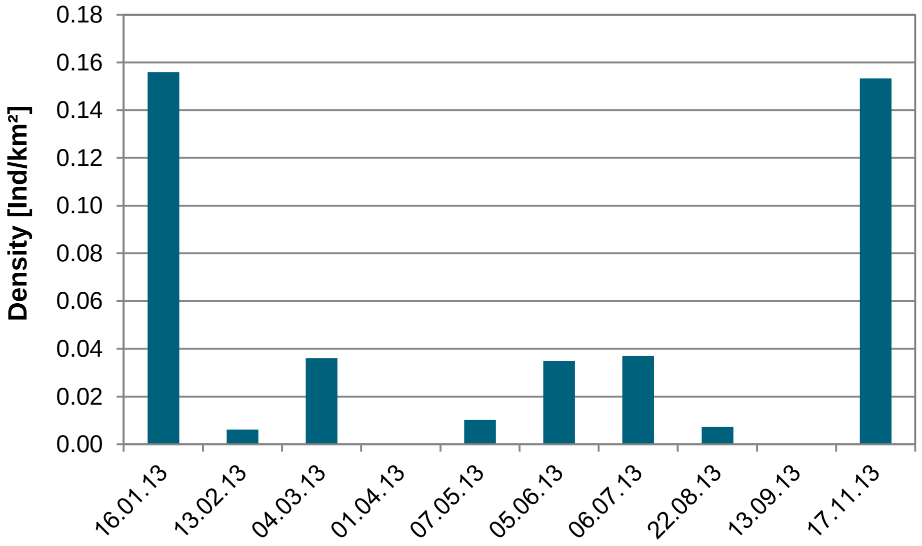


Figure 3.29 Mean density estimates of the Kittiwake estimated for aerial surveys undertaken between January 2013 and November 2013. Densities are estimated from bird observations in band-A, thus no confidence interval can be given.

Seasonal densities of Kittiwakes for the Horns Rev 3 study area were relatively low over all seasons (Table 3.29). The highest density of 0.11 ind./km² for the winter season (represented by January, February and November surveys) corresponds to a seasonal estimate of 280 Kittiwakes (0.004% of the biogeographic population) using the Horns Rev 3 study area in winter time (Table 3.29).

Table 3.29 Mean seasonal densities and abundance estimates for the Kittiwake in the Horns Rev 3 study area (2,663 km²).

Survey	Surveys represented	Mean density	Seasonal estimate
Spring	Mar-May	0.02	41
Summer	Jun-Jul	0.04	96
Autumn	Aug-Sep	0.00	10
Winter	Jan-Feb, Nov	0.11	280

3.2.14.2. Distribution of Kittiwakes in the Horns Rev 3 area

During the aerial surveys conducted in the Horns Rev 3 study area Kittiwakes were observed during most surveys, but usually in low densities. The observations were distributed mostly in the western part of the study area (Figure 3.30; for monthly distribution maps see also Appendix p. 182ff).

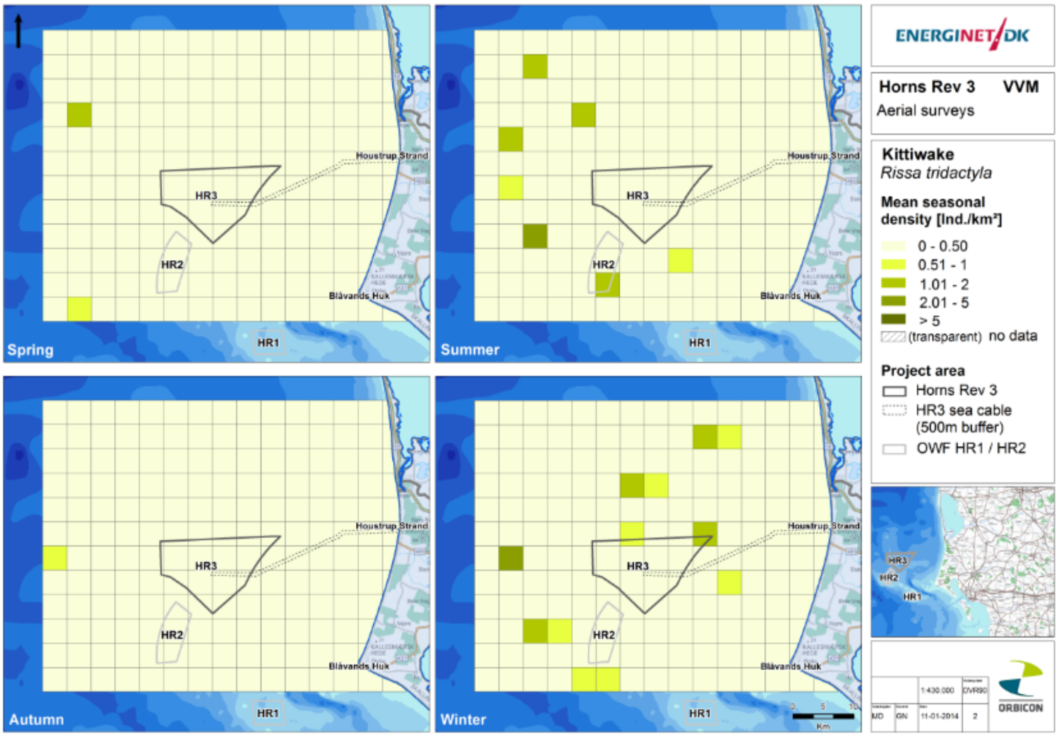


Figure 3.30 Mean seasonal distributions of the Kittiwake from aerial survey data recorded between January 2013 and November 2013. Species specific seasons were defined according to Garthe et al. (2007). The densities are shown in 4 km squares.

3.2.14.3. Abundance and distribution according to other studies

Christensen et al. (2003) recorded Kittiwakes during all 14 survey flights during the baseline investigations in the Horns Rev 1 study area. A total of 2,127 birds were counted making it the 5th most common species/group of this study. Most observations were from August-November. The species occurred throughout the study area with lowest numbers in the south-eastern part and concentrations in the north-western and northern part. The total number of Kittiwakes recorded in the Horns Rev 1 study area during 34 surveys (including the above) from 1999-2005 was 3,518 birds (Christensen et al. 2006).

Six survey flights during the baseline observations for Horns Rev 2 were scheduled to coincide with the expected peak of scoter and diver abundance in winter and spring and recorded 710 Kittiwakes with the highest daily count in December (Skov et al. 2008b). Kittiwakes were noted throughout the study area with highest densities in areas with high fishing activity to the southeast and northwest of Horns Rev.

At Blåvands Huk the species is common on passage from June to September (Jakobsen 2008); its phenology along the coast seems to be quite different from that at offshore locations. In the German Bight the peak of occurrence in offshore areas is noted in autumn and winter and its distribution is correlated with fishing activities (Mendel et al. 2008).

3.2.14.4. Importance of the Horns Rev area to Kittiwake

Kittiwakes occur in the Horns Rev 3 study area almost all year with relatively low densities. During baseline investigations in 2013 highest numbers were observed in winter with a total abundance estimate of 280 Kittiwakes. This number equals 0.004% of the biogeographic Kittiwake population. Therefore the Horns Rev 3 area is assessed to be of low importance to the Kittiwake.

Importance level	Low

3.2.15 Sandwich Tern

Sandwich Tern – *Sterna sandvicensis*	**DK: Splitterne**
Biogeographic population: Western Europe/West Africa	
Breeding range: Coasts of W & N Europe	
Non-breeding range: Mostly W & NW African coasts S to South Africa	
Population size: 166,000 – 171,000	
1% value: 1,700	
Conservation status:	EU Birds Directive, Annex I: listed EU SPEC Category: SPEC 2 EU Threat Status: Depleted IUCN Red List Category: Least Concern
Trend: STA	Trend quality: Poor
Key food: fish	

3.2.15.1. Abundance of Sandwich Terns in the Horns Rev 3 area

Abundance estimates of the Sandwich Tern have to be regarded as minimum estimates due to approximately 42% unidentified terns in all observations not accounted for in the density estimates.

Terns observed in larger distance to the observer or observed in large flocks often cannot be identified to the species level during aerial surveys. Therefore Distance analysis (Thomas et al. 2010) could not be applied for the tern species. The abundance of Sandwich Terns in the Horns Rev 3 area was estimated by estimating bird densities from observed numbers within the distance bands A1 and A2 (band-A; BSH 2007), assuming no detection bias for the data within these distance bands closest to the observers. This approach was chosen since most unidentified terns have been recorded in more distant bands of the transect, thus density estimation using data from band-A only was regarded to be the most reliable method. Bird densities estimated by applying both methods (band-

A and Distance analysis) were found to correspond closely for several species (see Appendix, p. 144), thus density estimation using the band-A approach according to BSH (2007) is regarded being appropriate.

The limited access to military areas prevented a full coverage of the entire study area during some aerial surveys. As numbers of Sandwich Terns have only been estimated for the area actually surveyed, monthly bird numbers should be regarded as minimum estimates for the respective surveys. The highest estimate of 369 Sandwich Terns was obtained for the survey on 06-07-2013 (Table 3.30).

Table 3.30 Numbers of observed Sandwich Terns during monthly aerial surveys. 'Effort' represents the coverage of the study area in one- or two-sided valid conditions during the particular survey, 'N birds' the actual number of birds counted within transects, 'N birds band-A' the actual number of birds counted within transect bands A1 and A2, 'Density band-A' is calculated density based on bird numbers observed in band-A1 and A2, 'Total estimate' represents the total number of birds estimated for the area surveyed during a particular survey.

Survey	Effort	N birds	N birds band-A	Density band-A	Total estimate
16-01-13	76%	0	0	0	0
13-02-13	100%	0	0	0	0
04-03-13	94%	0	0	0	0
01-04-13	100%	0	0	0	0
07-05-13	90%	77	9	0.09	220
05-06-13	97%	0	7	0.06	158
06-07-13	100%	9	15	0.14	369
22-08-13	99%	22	3	0.02	57
13-09-13	92%	5	0	0	0
17-11-13	100%	0	0	0	0

Month-to-month comparison of density estimates show the species being present in the Horns Rev area only during summer and transitional periods, the species is absent in the area in winter (Table 3.30, Figure 3.31).

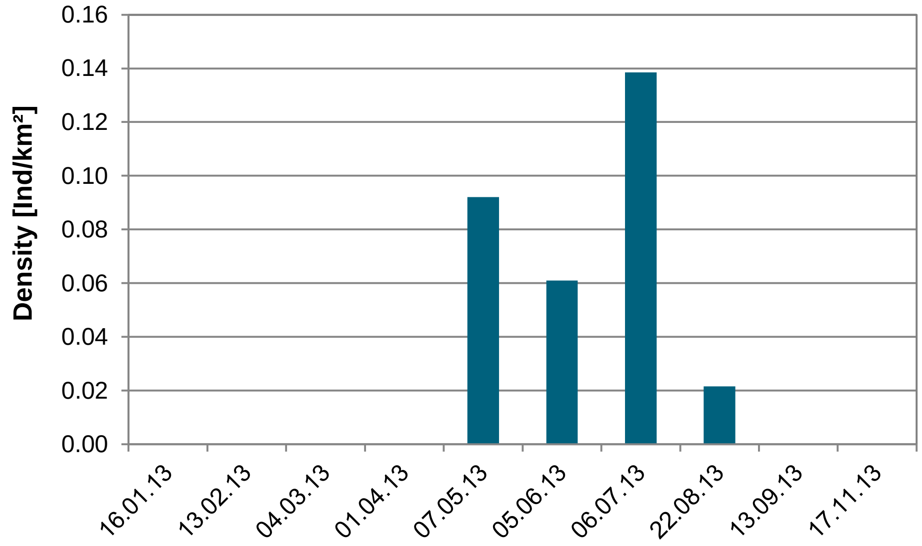


Figure 3.31 Mean density estimates of the Sandwich Tern estimated for aerial surveys undertaken between January 2013 and November 2013. Densities are estimated from bird observations in band-A, thus no confidence interval can be given.

The highest seasonal density was calculated for the summer season (represented by June and July surveys), which corresponds to a seasonal estimate of 266 Sandwich Terns (0.16% of the biogeographic population) using the Horns Rev 3 study area in summer (Table 3.31).

Table 3.31 Mean seasonal densities and abundance estimates for the Sandwich Tern in the Horns Rev 3 study area (2,663 km²).

Survey	Surveys represented	Mean density	Seasonal estimate
Spring	Apr-May	0.05	123
Summer	Jun-Jul	0.10	266
Autumn	Aug-Sep	0.01	29
Winter	Jan-Mar, Nov	0.00	0

3.2.15.2. Distribution of Sandwich Terns in the Horns Rev 3 area

Sandwich Terns distribution varied between surveys and seasons (Figure 3.32, for monthly distribution maps see also Appendix p.185ff). During spring and summer Sandwich Terns were mostly recorded in the western part of the study area, in autumn the species was observed mostly close to the coast line (Figure 3.32).

Figure 3.32 Mean seasonal distributions of the Sandwich Tern from aerial survey data recorded between January 2013 and November 2013. Species specific seasons were defined according to Garthe et al. (2007). The densities are shown in 4 km squares.

3.2.15.3. Abundance and distribution according to other studies

Christensen et al. (2003) recorded Sandwich Terns in 7 out of 14 survey flights during the baseline investigations of the Horns Rev 1 study area, which is situated slightly further south than the Horns Rev 3 study area with some overlap between the two. A total of 382 birds were counted. Unfortunately no surveys were made in May-July, the peak months of occurrence in the present study. Peak counts during the baseline were during autumn and spring migration. Most sightings were made along the coast at Blåvands Huk and Skallingen. But distribution varied between surveys and there was no consistent pattern in occurrence over the two study years. The total number of Sandwich Terns recorded in the Horns Rev 1 study area during 34 surveys (including the above) from 1999-2005 was 1,066 birds (Christensen et al. 2006).

Six survey flights during the baseline observations for Horns Rev 2 were scheduled to coincide with the expected peak of scoter and diver abundance in winter and spring and recorded 138 Sandwich Terns on the last two flights in April (Skov et al. 2008b) coinciding with the arrival of the species in the North Sea.

At Blåvands Huk strong passage of Sandwich Terns is noted from mid-July until the end of August. Spring migration is far less conspicuous and mainly noted at the end of April and early May (Jakobsen 2008). During SAS surveys in the German Bight the species was mainly found in coastal waters (Mendel et al. 2008).

3.2.15.4. Importance of the Horns Rev area to Sandwich Tern

In July 2013 the maximum number of 369 Sandwich Terns was estimated for the Horns Rev 3 study area, the maximum seasonal estimate in summer of 266 birds equals 0.16% of the biogeographic population. Therefore, and due to the very high conservation/protection status of the species (Sandwich Tern is listed in the Annex I of the EU Birds Directive) the Horns Rev 3 study area is assessed to be of high importance to the Sandwich Tern.

Importance level	High

Sandwich Tern © Thomas W. Johansen

3.2.16 Common Tern / Arctic Tern

Common Tern – *Sterna hirundo*	**DK: Fjordterne**
Biogeographic population: Northern & Eastern Europe (bre)	
Breeding range: NE Europe, mainly countries around Baltic	
Non-breeding range: Mainly Southern Africa	
Population size: 640,000 – 1,500,000	
1% value: 9,800	
Conservation status:	EU Birds Directive, Annex I: listed EU SPEC Category: Non-SPEC EU Threat Status: Secure IUCN Red List Category: Least Concern
Trend: STA	Trend quality: Poor
Key food: fish, also invertebrates	
Arctic Tern – *Sterna paradisaea*	**DK: Havterne**
Biogeographic population: Western Eurasia (bre)	
Breeding range: Europe N of France, Scandinavia, Russia	
Non-breeding range: Antarctic Ocean	
Population size: 1,000,000 – 1,000,001	
1% value: 20,000	
Conservation status:	EU Birds Directive, Annex I: listed EU SPEC Category: Non-SPEC EU Threat Status: (Secure) IUCN Red List Category: Least Concern
Trend: STA	Trend quality: No idea
Key food: fish, also invertebrates	

3.2.16.1. Abundance of Common / Arctic Terns in the Horns Rev 3 area

The two tern species, Common Tern and Arctic Tern, are treated together as it is almost impossible to distinguish both species from the airplane. Both species occur in the Horns Rev 3 area. Following the precautionary principle for the assessment of the importance of the species group and later for the impact assessment the 1% value of the smaller Common Tern population will be applied.

Abundance estimates of Common and Arctic Terns have to be regarded as minimum estimates due to approximately 42% unidentified terns in all observations not accounted for in the density estimates.

Terns observed in larger distance to the observer or observed in large flocks often cannot be identified to the species level. Therefore Distance analysis (Thomas et al. 2010) could not be applied for the tern species. The abundance of Common and Arctic Terns in the Horns Rev 3 area was estimated by calculating bird densities from observed numbers within the distance bands A1 and A2 (band-A; BSH 2007), assuming no detection bias for the data within these distance bands closest to the observers. This approach was chosen since most unidentified terns have been recorded in more distant bands of the transect, thus density estimation using data from band-A only was regarded to be the most reliable method. Bird densities estimated by applying both methods (band-A and Distance analysis) were found to correspond closely for several species (see Appendix, p. 144), thus density estimation using the band-A approach according to BSH (2007) is regarded being appropriate.

The limited access to military areas prevented a full coverage of the entire study area during some aerial surveys. As numbers of Common and Arctic Terns have only been estimated for the area actually surveyed, monthly bird numbers should be regarded as minimum estimates for the respective surveys. The highest estimate of 872 Common and Arctic Terns was obtained during the autumn migration period on 22-08-2013 (Table 3.32).

Month-to-month comparison of density estimates show the two tern species being present in the Horns Rev area chiefly during autumn migration, the species are absent in the area in winter (Table 3.32, Figure 3.33).

Table 3.32 Numbers of observed Common Terns and Arctic Terns during monthly aerial surveys. 'Effort' represents the coverage of the study area in one- or two-sided valid conditions during the particular survey, 'N birds' the actual number of birds counted within transects, 'N birds band-A' the actual number of birds counted within transect bands A1 and A2, 'Density band-A' is calculated density based on bird numbers observed in band-A1 and A2, 'Total estimate' represents the total number of birds estimated for the area surveyed during a particular survey.

Survey	Effort	N birds	N birds band-A	Density band-A	Total estimate
16-01-13	76%	0	0	0	0
13-02-13	100%	0	0	0	0
04-03-13	94%	0	0	0	0
01-04-13	100%	0	0	0	0
07-05-13	90%	1	0	0	0
05-06-13	97%	0	0	0	0
06-07-13	100%	3	2	0.02	49
22-08-13	99%	51	46	0.33	872

Survey	Effort	N birds	N birds band-A	Density band-A	Total estimate
13-09-13	92%	18	11	0.10	234
17-11-13	100%	0	0	0	0

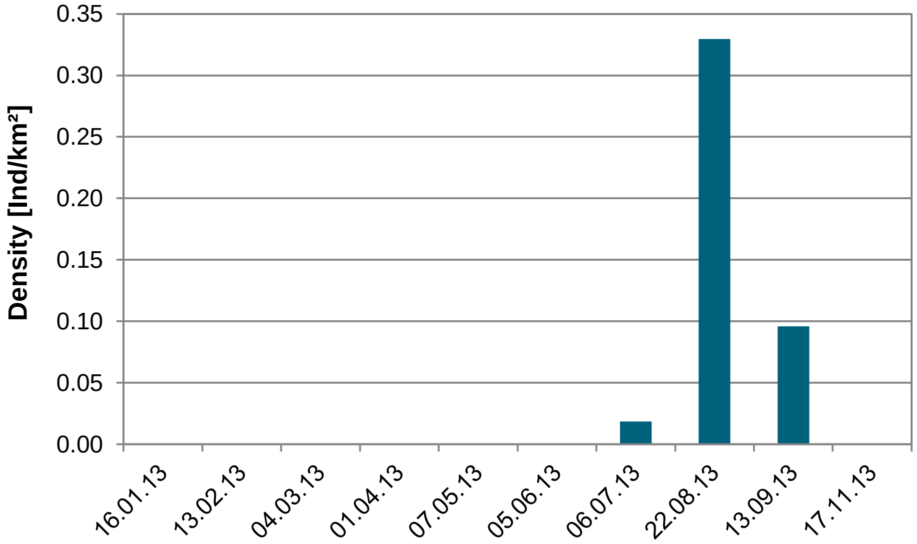


Figure 3.33 Mean density estimates of Common / Arctic Terns estimated for aerial surveys undertaken between January 2013 and November 2013. Densities are estimated from bird observations in band-A, thus no confidence interval can be given.

The highest seasonal density was calculated for the autumn season (represented by the surveys in August and September), which corresponds to a seasonal estimate of 567 Common and Arctic Terns (corresponds to 0.06% of the biogeographic population of the Common Tern) using the Horns Rev 3 study area in autumn (Table 3.33).

Table 3.33 Mean seasonal densities and abundance estimates for Common Tern and Arctic Tern in the Horns Rev 3 study area (2,663 km²).

Survey	Surveys represented	Mean density	Seasonal estimate
Spring	Apr-May	0	0
Summer	Jun-Jul	0.01	25
Autumn	Aug-Sep	0.21	567
Winter	Jan-Mar, Nov	0	0

3.2.16.2. Distribution of Common / Arctic Terns in the Horns Rev 3 area

Common and Arctic Terns were rarely observed in the Horns Rev 3 study area outside the autumn season. During autumn migration period the species were mostly observed close to the coast (Figure 3.34).

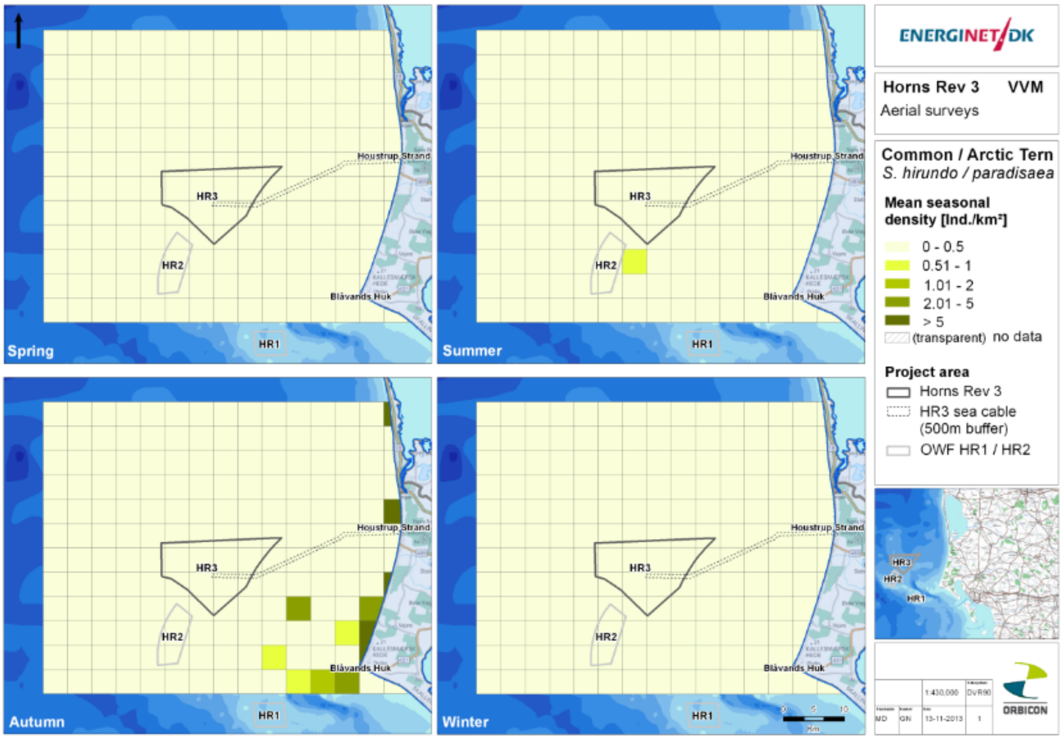


Figure 3.34 Mean seasonal distributions of Common / Arctic Terns from aerial survey data recorded between January 2013 and November 2013. Species specific seasons were defined according to Garthe et al. (2007). The densities are shown in 4 km squares.

3.2.16.3. Abundance and distribution according to other studies

Christensen et al. (2003) recorded Common / Arctic Terns during 8 out of 14 survey flights during the baseline investigations in the Horns Rev 1 study area. A total of 2,404 birds were counted. Peak counts were during autumn and spring migration. However, there were no survey flights from May-July. Most sightings were made to the west of Horns Rev 1 and along the coast at Blåvands Huk and Skallingen. But distribution varied between surveys and there was no consistent pattern in occurrence over the two study years. The total number of Common / Arctic Terns recorded in the Horns Rev 1 study area during 34 surveys (including the above) from 1999-2005 was 3,279 birds (Christensen et al. 2006).

Six survey flights during the baseline observations for Horns Rev 2 were scheduled to coincide with the expected peak of scoter and diver abundance in winter and spring and recorded 19 Arctic or Common Terns on the last two flights in April (Skov et al. 2008b) The survey flights were too early to record larger numbers of these two species which only start to arrive in the area in mid-April.

At Blåvands Huk strong passage of Arctic and Common Terns is noted in spring from the end of April until mid-May and in late summer from mid-July to early September (Jakobsen 2008).

3.2.16.4. Importance of the Horns Rev area to Common / Arctic Tern

In August 2013 the maximum number of 872 Common and Arctic Terns was estimated for the Horns Rev 3 study area, the maximum seasonal estimate in summer of 567 birds equals 0.06% of the biogeographic population (of the smaller Common Tern population). The species is observed mainly during migration periods. Therefore the Horns Rev 3 study area is assessed to be of low importance as resting habitat to the two tern species Common Tern and Arctic Tern.

Importance level	Low

Gull with pipit © Graeme Pegram

3.2.17 Common Guillemot / Razorbill

Common Guillemot – *Uria aalge*	**DK: Lomvie**
Biogeographic population: North Sea - Baltic Sea (non-br)	
Breeding range: NE Atlantic	
Non-breeding range: North Sea – Kattegat	
Population size: > 4,300,000*	
1% value: 43,000*	
Conservation status:	EU Birds Directive, Annex I: not listed EU SPEC Category: Non-SPEC EU Threat Status: (Secure) IUCN Red List Category: -
Trend: -	Trend quality: -
Key food: fish	
Razorbill – *Alca torda*	**DK: Alk**
Biogeographic population: North Sea – Baltic Sea (non-br)	
Breeding range: NE Atlantic	
Non-breeding range: North Sea - Kattegat	
Population size: > 500,000	
1% value: 5,000	
Conservation status:	EU Birds Directive, Annex I: not listed EU SPEC Category: Non-SPEC[E] EU Threat Status: (Secure) IUCN Red List Category: -
Trend: -	Trend quality: -
Key food: fish	

3.2.17.1. Abundance of auks in the Horns Rev 3 area

The two auk species, Common Guillemot and Razorbill, are treated together, as only a small proportion of auk observations from airplane can be determined to species level. Both species are known to regularly occur in the area (e.g. Christensen et al. 2001, Petersen 2005, Petersen and Fox 2007). Following the precautionary principle for the importance assessment of this species group and later for the impact assessment the 1% value of the smaller Razorbill population will be applied.

The abundance of auks (Common Guillemot and Razorbill) in the Horns Rev 3 area was estimated by applying Distance analysis (Thomas et al. 2010) on the monthly aerial survey data. The effective strip width (ESW) for auks during aerial surveys, calculated using the entire dataset, was 179 m (95% CI 128 m – 252 m). The limited access to military areas prevented a full coverage of the entire study area during some aerial surveys. As numbers of auks have only been estimated for the area actually surveyed, monthly bird numbers should be regarded as minimum estimates for the respective surveys. The highest estimate of 4,564 Guillemots and Razorbills was obtained in winter during the survey on 17-11-2013 (Table 3.34).

Table 3.34 Numbers of observed auks (Common Guillemot and Razorbill) during monthly aerial surveys and results of Distance analysis. 'Effort' represents the coverage of the study area in one- or two-sided valid conditions during the particular survey, 'N birds' the actual number of birds counted within transects, 'Density' the number of birds per km^2. 'D LCI' represents the lower 95% confidence interval, 'D UCI' the upper 95% confidence interval of the density; Total estimate represents the total number of birds estimated for the area surveyed during a particular survey.

Survey	Effort	N birds	Density	D LCI	D UCI	Total estimate
16-01-13	76%	61	0.37	0.26	0.52	755
13-02-13	100%	14	0.06	0.04	0.08	152
04-03-13	94%	26	0.16	0.11	0.22	388
01-04-13	100%	14	0.08	0.06	0.12	220
07-05-13	90%	0	0	0	0	0
05-06-13	97%	0	0	0	0	0
06-07-13	100%	9	0.06	0.04	0.08	147
22-08-13	99%	4	0.02	0.01	0.03	50
13-09-13	92%	32	0.19	0.13	0.26	451
17-11-13	100%	354	1.71	1.22	2.40	4,564

Month-to-month comparison of density estimates show the species occurring in the Horns Rev area between autumn and spring with highest numbers being observed in winter. In the summer months auks were only occasionally observed in the Horns Rev 3 study area (Table 3.34, Figure 3.35).

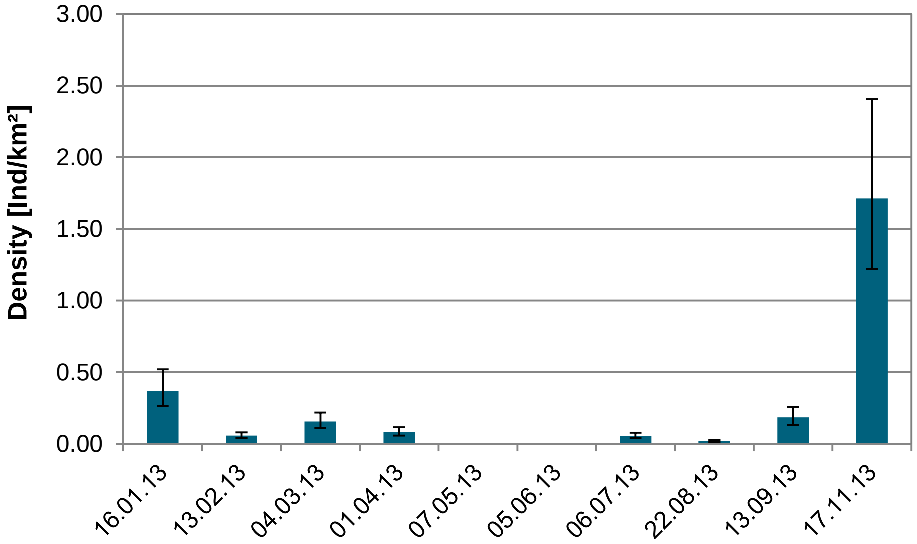


Figure 3.35 Mean density estimates and 95% confidence intervals of auks (Common Guillemot and Razorbill) estimated for aerial surveys undertaken between January 2013 and November 2013.

Corresponding to monthly results the highest seasonal density was calculated for the winter season (represented by surveys in January, February and November), which corresponds to a seasonal estimate of 1,495 Common Guillemots and Razorbills using the Horns Rev 3 study area in winter (Table 3.35).

Table 3.35 Mean seasonal densities and abundance estimates for Common Guillemot and Razorbill in the Horns Rev 3 study area (2,663 km²).

Survey	Surveys represented	Mean density	Seasonal estimate
Spring	Mar-Apr	0.12	323
Summer	May-Jul	0.02	57
Autumn	Aug-Sep	0.09	242
Winter	Jan-Feb, Nov	0.56	1,495

3.2.17.2. Distribution of auks in the Horns Rev 3 area

Auks were observed being widely distributed in the Horns Rev 3 study area with the distribution patterns varying between seasons (Figure 3.36, for monthly distribution maps see also Appendix p.187ff). During spring Guillemots and Razorbills were recorded mostly in the western offshore parts of the study area, in autumn and winter the species were also found being more easterly distributed (Figure 3.36).

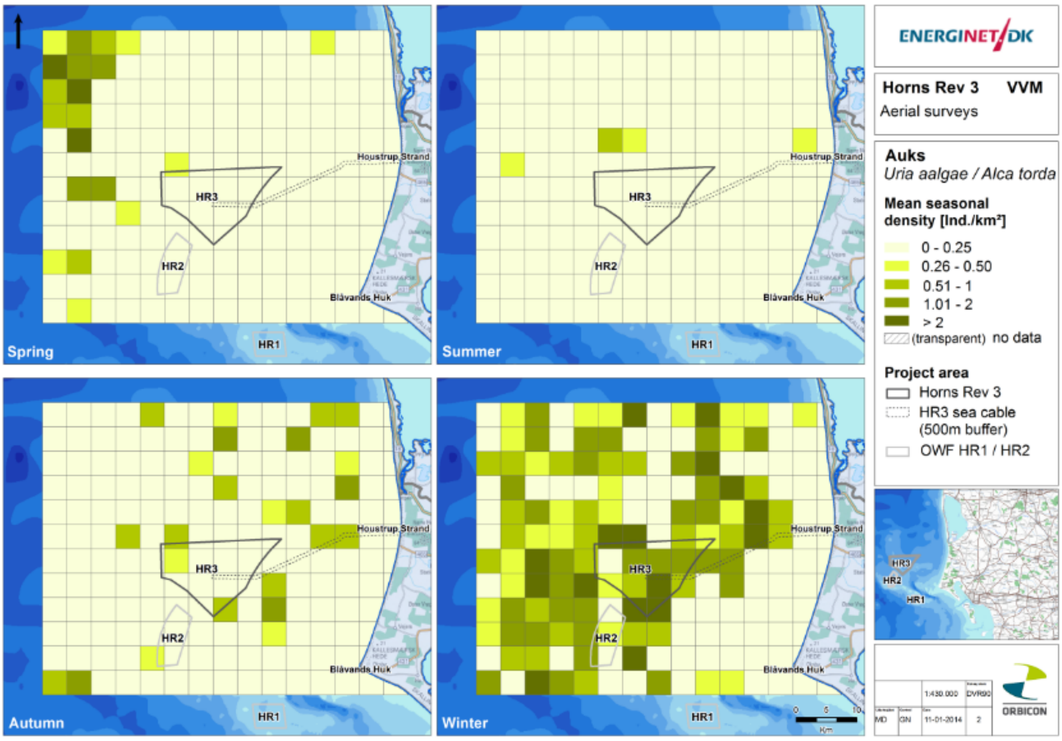


Figure 3.36 Mean seasonal distributions of auks (Common Guillemot and Razorbill) from aerial survey data recorded between January 2013 and November 2013. Species specific seasons were defined according to Garthe et al. (2007). The densities are shown in 4 km squares.

3.2.17.3. Abundance and distribution according to other studies

Christensen et al. (2003) recorded Common Guillemots / Razorbills during all but one of 14 survey flights during the baseline investigations in the Horns Rev 1 study area. A total of 959 birds were counted. Highest numbers were recorded in October-November. Auks were found being concentrated in the most offshore parts of the study area. In late winter auks were found concentrated southwest of Horns Rev 1. The total number of Common Guillemots / Razorbills recorded in the Horns Rev 1 study area during 34 surveys (including the above) from 1999-2005 was 2,430 birds (Christensen et al. 2006).

Six survey flights during the baseline observations for Horns Rev 2 were scheduled to coincide with the expected peak of scoter and diver abundance in winter and spring and recorded 377 Common Guillemots / Razorbills with the majority of birds recorded in December and February and most records in the areas most distant to the coast (Skov et al. 2008b).

At Blåvands Huk passage of Guillemots and Razorbills is noted from September-November with very low numbers outside this time (Jakobsen 2008). Occurrence at the coast does not seem to be representative for the presence in offshore areas for these two species.

Both species breed on Helgoland in a large seabird colony with 29 breeding pairs of Razorbills and 2,570 breeding pairs of Guillemots in 2012 (Dierschke et al. 2013). Except for the small breeding population Razorbills are fairly rare in the south-eastern North Sea during summer and early autumn (Mendel et al. 2008). Strong passage is noted at Helgoland in October probably due to the arrival of the wintering population (Dierschke et al. 2011). In winter Razorbills are fairly abundant in offshore areas of the German Bight and are noted in considerable numbers till early spring. Ring recoveries indicate an origin of wintering Razorbills from the British Isles (Mendel et al. 2008, Dierschke et al. 2011). Common Guillemots are found year round in the German Bight. After the breeding season they are concentrated in areas of 40-50 m water depths (BSH 2008, Mendel et al. 2008). The highest abundance is recorded in winter when the species is evenly distributed across the German Bight (BSH 2008, Mendel et al. 2008). Records of Guillemots / Razorbills at Horns Rev 3 in July-September are likely Guillemots due to the phenology of the two species.

3.2.17.4. Importance of the Horns Rev area to auks

In November 2013 the maximum number of 4,564 auks was estimated for the Horns Rev 3 study area. The maximum seasonal estimate in winter of 1,495 birds equals 0.3% of the biogeographic population (the smaller Razorbill population as reference population). Therefore and due to the medium conservation/protection status of the Razorbill the Horns Rev 3 study area is assessed to be of medium importance to auks.

Importance level	Medium

Auk

4. IMPACT ASSESSMENT

4.1. Assessment methodology

To ensure a uniform and transparent basis for the EIA, a general impact assessment methodology for the assessment of predictable impacts has been prepared together with a list of terminology.

4.1.1 The Impact Assessment Scheme

The overall goal of the assessment is to describe the **Severity of Impact** caused by the project. The assessment comprises two steps; where the first step is an analysis of the magnitude of the pressure and an analysis of the sensitivity of the environmental factor. Combining the two analyses leads to the **Degree of Impact**. In the second step; the results from the Degree of Impact is combined with the importance leading to the Severity of Impact.

As far as possible the impacts are assessed quantitatively, accompanied by a qualitative argumentation. The assessment steps are shown in Figure 4.1.

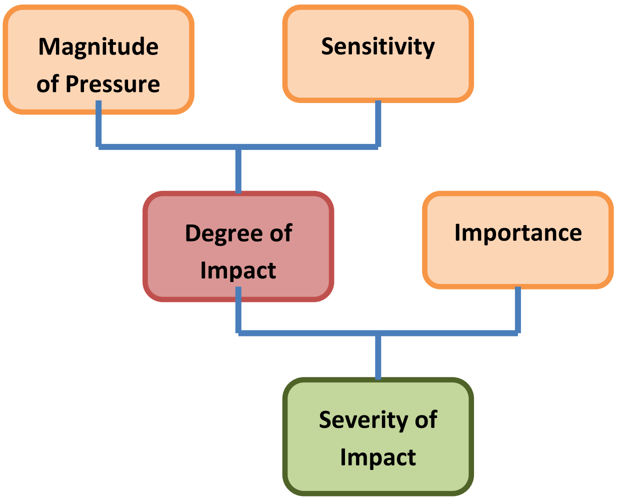


Figure 4.1 Drawing of the overall assessment approach.

4.1.2 Magnitude of Pressure

There are several crucial steps in the outlined assessment procedure shown in Figure 4.1. The foremost is the determination of the Magnitude of Pressure and the Sensitivity.

The Magnitude of Pressure is described by pressure indicators, see Table 4.1. These indicators are based on the modes of action on environmental factors in order to achieve most optimal descriptions of pressure for the individual factors; e.g. mm deposited sediment within a certain period and area. The content of the Magnitude of Pressure is thus made up of:

- intensity
- duration
- range

The *intensity* evaluates the force of the pressure and should as far as possible be estimated quantitatively.

The *duration* determines the time span of the pressure. Some pressures (like footprints) are permanent and do not have a finite duration. Some pressures occur as events of differing durations.

The *range* of the pressure defines the spatial extent. Outside of the range, the pressure is regarded as non-existing or negligible.

Distinctions are made between direct and indirect pressures where direct pressures are those imposed directly by the project activities on the environmental factors while the indirect pressures are the consequences of those impacts on other environmental factors and thus express the interactions between environmental factors.

As far as possible the Magnitude of Pressure is assessed quantitatively. The method of quantification depends on the specific pressure (spill from dredging, noise, vibration, etc.) and on the environmental factor to be assessed (calling for different aggregations of intensity, duration and range).

Table 4.1 Aggregates included in the Magnitude of Pressure.

Magnitude of Pressure		
Intensity	**Duration**	**Range**
Very High	Recovery takes longer than 10 years or is permanent	International
High	Recovered within 10 years after end of construction	National
Medium	Recovered within 5 years after end of construction	Regional
Low	Recovered within 2 years after end of construction	Local

4.1.3 Sensitivity

The best way to describe the sensitivity of a species to a certain pressure varies between the environmental factors involved. To assess the sensitivity, more factors may be taken into consideration; such as intolerance to the pressure and the capability of recovering after impairment or a temporary loss. In most cases, the sensitivity of a certain environmental factor is based on a study of the relevant literature and is very often given as a threshold value.

4.1.4 Degree of Impact

In order to determine the Degree of Impact; the Magnitude of Pressure and Sensitivity are combined in a matrix, see Table 4.2. The Degree of Impact is the pure description of an impact to a given environmental factor without putting it into a broader perspective (the latter is done by including the Importance in the evaluation, see 4.1.5 below).

Table 4.2 The matrix used for the assessment of the Degree of Impact.

		Sensitivity			
		Very high	**High**	**Medium**	**Low**
Magnitude of Pressure	**Very high**	Very High	Very High	High	High
	High	Very High	High	High	Medium
	Medium	High	High	Medium	Low
	Low	Medium	Medium	Low	Low

4.1.5 Importance

The importance of the environmental factor is assessed for each environmental sub-factor. Some sub-factors are assessed as a whole, but in most cases, the importance assessment is broken down into components and/or sub-components in order to conduct a more specific environmental impact assessment.

Considerations about population sizes and spatial distribution are important for some sub-factors, such as bird populations, and are in these cases incorporated into the assessment. The assessment is based on *importance criteria* defined by the functional value of the environmental sub-factor and the legal status given by EU directives, national laws, etc.

The importance criteria are graded into four tiers, see Table 4.3. In a few cases, such as climate, grading does not make sense. As far as possible the spatial distribution of the importance classes are shown on maps.

Table 4.3 The definition of importance to an environmental factor.

Importance level	Description
Very high	Components protected by international legislation/conventions (Annex I, II and IV of the Habitats Directive, Annex I of the Birds Directive), or of international ecological importance. Components of critical importance for wider ecosystem functions.
High	Components protected by national or local legislation, or adapted on national “Red Lists”. Components of importance for far-reaching ecosystem functions.
Medium	Components with specific value for the region, and of importance for local ecosystem functions
Low	Other components of no special value, or of negative value

4.1.6 Severity of Impact

Severity of Impact is assessed from the grading of Degree of Impact and Importance of the environmental factor using the matrix in Table 4.4. If it is not possible to grade Degree of Impact and/or Importance, an assessment is given based on expert judgment.

Table 4.4 The matrix used for the assessment of the Severity of Impact.

		Importance of the environmental component			
		Very high	**High**	**Medium**	**Low**
Degree of Impact	**Very high**	Very High	High	Medium	Low
	High	High	High	Medium	Low
	Medium	Medium	Medium	Medium	Low
	Low	Low	Low	Low	Low

Based on the Severity of Impact, such an expert judgement can state the significance of the impact through the phrases given in Table 4.5. The content of the table has been defined by Energinet.dk.

Table 4.5 The definition of Impact to an environmental factor. The table shows how the impact assessment result can be translated to the scheme defined by Energinet.dk.

Severity of Impact	Relative Impact *(påvirkningens relative størrelse)*	Following effects are dominating *(følgende efferkter er dominerende)*
Very high	**Significant negative impact** *(Væsentlige negative påvirkninger)*	**Impacts are large in extent and/or duration. Reocurrence or likelihood is high, and irreversible impacts are possible.** *(Der forekommer påvirkninger, som har et stort omfang og/eller langvarig karakter, er hyppigt forekommende eller sandsynlige, og der vil være mulighed for irreversible skader i betydelig omfang).*

Severity of Impact	Relative Impact *(påvirkningens relative størrelse)*	Following effects are dominating *(følgende efferkter er dominerende)*
High	**Moderate negative impact** *(Moderat negativ påvirkning)*	**Impacts occur, which are either relative large in extent or are long term in nature (lifetime of the project). The occurrence is recurring, or the likelihood for recurrence is relatively high. Irreversible impact may occur, but will be strictly local, on e.g. cultural or natural conservation heritage.** *(Der forekommer påvirkninger, som enten har et relativt stort omfang eller langvarig karakter (f.eks. i hele anlæggets levetid), sker med tilbagevendende hyppighed eller er relativt sandsynlige og måske kan give visse irreversible men helt lokale skader på eksempelvis bevaringsværdige kultur- eller naturelementer).*
Medium	**Minor negative Impact** *(Mindre negativ påvirkning)*	**Impacts occur, which may have a certain extent or complexity. Duration is longer than short term. There is some likelihood of an occurrence but a high likelihood that the impacts are reversible.** *(Der forekommer påvirkninger, som kan have et vist omfang eller kompleksitet, en vis varighed udover helt kortvarige effekter, og som har en vis sandsynlighed for at indtræde, men med stor sandsynlighed ikke medfører irreversible skader).*
Low	**Neglegeble negative impact** *(Ubetydelig negativ påvirkning)*	**Small impacts occur, which are only local, uncomplicated, short term or without long term effects and without irreversible effects** *(Der forekommer små påvirkninger, som er lokalt afgrænsede, ukomplicerede, kortvarige eller uden langtidseffekt og helt uden irreversible effekter).*
Low	**Neutral / no impact** *(Neutral/uden påvirkning)*	**No impact compared to status quo** *(Ingen påvirkning i forhold til status quo).*
	Positive impacts *(Positive påvirkninger)*	**Positive impact occurring in one or more of the above statements** *(Der forekommer positive påvirkninger på en eller flere ovennævnte punkter).*

4.1.7 Significance

The impact assessment is finalised with an overall assessment stating the significance of the predicted impacts. This assessment of significance is based on expert judgement. The reasoning for the conclusion on the significance is explained. Aspects such as Degree and Severity of Impact, recovery time and the Importance of the environmental factor are taken into consideration.

4.1.8 Assessment of cumulative impacts

The aim of the assessment of cumulative impacts is to evaluate the extent of the environmental impact of the project in terms of intensity and geographic extent compared with other projects in the area and the vulnerability of the area. The assessment of the cumulative conditions includes activities associated with existing utilised and unutilised permits or approved plans for projects.

When more projects within the same region affect the same environmental conditions at the same time, they are defined to have cumulative impacts. A project is relevant to include, if the project meets one or more of the following requirements:

- The project and its impacts are within the same geographical area as the Project
- The project affects some of the same or related environmental conditions as the Project
- The impact of the Project occurs simultaneously or overlaps in time

For each environmental component it is considered if cumulative impact with the projects above is relevant.

4.1.9 Mitigation and compensation issues

A significant part of the purpose of an EIA is to optimize the environmental aspects of the project applied for, within the legal, technical and economic framework.

Remediation measures are described in the technical background reports. The most important ones are included in the EIA.

4.1.10 Application of the Assessment methodology for resting birds

4.1.10.1. Importance

The importance of the area for resting birds was determined on the species level by accounting both for the conservation/protection status of a species and the numerical abundance of a species in the area in relation to its relevant biogeographic population (see chapter 3.1.3).

4.1.10.2. Magnitude of Pressure

The magnitude of pressure is regarded as the technical description of the construction works or the wind farm itself. The Magnitude of Pressure and the Sensitivity of a bird species to a pressure often cannot be treated separately as the Magnitude of Pressure cannot be assessed without assessing the species' sensitivity. For example the Magnitude of Pressure regarding e.g. the structure of the wind farm is only determined by the species response. Thus, the sensitivity (the qualitative response) to a given pressure is used in an initial screening to identify species which may be subject to relevant impacts and thus require a detailed assessment. The Degree of Impact, for example the proportion of local bird numbers displaced, is then assessed only for those species, and is directly assessed by available information of a species response to the pressure. If the assessment results in a very high degree of impact to a species, i.e. a complete displacement of all birds from impaired areas is expected, this corresponds to a very high Magnitude of Pressure.

4.1.10.3. Sensitivity

For resting birds the sensitivity is assessed on a species level. The sensitivity (the qualitative response) to a given pressure is used in an initial screening to identify species which may be subject to relevant impacts and thus require a detailed assessment.

4.1.10.4. Degree of Impact

The Degree of Impact representing, the proportion of birds within the impact zone getting impaired by a pressure, was directly assessed by available information about species response to a particular pressure. The different levels of Degree of Impact were defined separately for the different pressure types (Table 4.6). For birds which get displaced from an area as a consequence of a pressure, it has been defined that the displacement of >50% of the birds within the impact zone equals to a very high Degree of Impact, 25–50% to a high, 5–25% to a medium and <5% to a low Degree of Impact.

Table 4.6 Criteria for assessing the Degree of Impact for resting birds in the Horns Rev 3 area based on the sensitivity of a species to a pressure.

Construction-, structure- or operation related pressures of the project	Degree of Impact	Description of the Degree of Impact
Disturbance	**Very high**	>50% of birds occurring in the impact zone are expected to be displaced from the area, or the proportion of displacement is not assessable.
	High	25–50% of birds occurring in the impact zone are expected to be displaced from the area.
	Medium	5–25% of birds occurring in the impact zone are expected to be displaced from the area.
	Low	Disturbance does not lead to a detectable displacement of resting birds from the impact zone (<5% displacement).
Habitat change	**Very high**	Habitat changes result in >50% reduction in bird numbers within the impact zone, or the degree of reduction in bird numbers in not assessable.
	High	Habitat changes result in 25–50% reduction in bird numbers within the impact zone.
	Medium	Habitat changes result in 5–25% reduction in bird numbers within the impact zone.
	Low	Habitat changes do not result in a detectable reduction in bird numbers in the impact zone (<5% displacement).

4.1.10.5. Severity of Impact

The Severity of Impact for resting birds was assessed following the scheme presented in Table 4.4. The severity of Impact is assessed by combining the Degree of Impact with the importance level assessed for a species. This is done based on the number of birds of a species estimated to be affected by a pressure. The assessment of Severity of Impact is conducted for the season of maximum abundance of a species in the study area.

For pressures related to displacement and collision of birds a quantitative approach for determining the Severity of Impact is followed wherever possible. Here, the Severity of Impact is assessed from the Degree of Impact and accounting for the number of birds predicted to be affected within the impact zone in relation to the species biogeographic reference population and the species' conservation status (see importance criteria above).

4.1.10.6. Significance

The assessment of the significance of the project impact to resting birds was conducted on a species level considering the overall impact of the project. When assessing the significance of the project impact, the duration of different pressures was taken into account.

4.2. Relevant Project pressures

Based on the information from the baseline studies the Impact Assessment on resting birds is structured along the following main pressures:

Environmental pressures related to the construction of Horns Rev 3 wind farm

- *Habitat change*

The construction works including dredging activities result in local changes of habitats and spilled sediments will locally decrease the water transparency which may affect resting birds in the area.

- *Disturbance from construction works and traffic*

The construction of the wind farm will need presence and activity of various types of construction vessels which may cause disturbance to resting birds in the marine areas. Helicopters are commonly used as mode of transportation to offshore construction vessels and may cause disturbance to resting birds in the marine areas as well. Indirectly, disturbance from construction works might result in a barrier, reducing the movements of birds between staging areas.

- *Collision with construction vessels*

Resting birds may collide with construction vessels. The collision risk for birds during construction and operation of the Horns Rev 3 OWF is assessed in the report on migrating birds as pressures affecting flying resting birds cannot be assessed separately from migrating birds (see report no. HR3-TR-042).

Environmental pressures related to the operation of Horns Rev 3 wind farm

- *Habitat loss from footprint*

Marine habitats utilised by birds as resting and foraging habitat will be lost through the foundations and scour protection layers.

- *Habitat changes, including provision of artificial reefs and roosts*

Changes to the marine environment may impact birds indirectly through changes in their habitats and food availability. Also underwater structures such as foundations and protection layers will provide additional hard substrate at the seafloor and in the water column. These structures will be colonised by hard substrate benthic communities which may attract birds. Overwater structures of the wind turbines and transformer platform may serve as roosts for some species.

- *Disturbance from wind farm structures, including noise emissions and light*

The physical structure of the wind farm as well as the movement of the blades, noise and light emissions are may disturb birds and cause displacement. Disturbances may also occur from maintenance traffic.

- *Barrier effect of the wind farm*

Disturbance effects also can result in barrier effects when resting birds avoid passing the wind farm area or need to invest additional energy to pass or circumvent the wind farm when flying from one resting or foraging site to another. For resting birds the barrier effect is closely related to the disturbance effect and therefore assessed as part of this pressure.

- *Collision with wind farm structures*

Resting birds flying from one resting or foraging site to another may collide with wind farm structures, especially with the moving blades of the turbines. The collision risk for birds during construction and operation of the Horns Rev 3 OWF is assessed in the report on migrating birds as pressures affecting flying resting birds cannot be assessed separately from migrating birds (see report no. HR3-TR-042).

4.3. Sensitivity analysis

4.3.1 Approach

The sensitivity of a species affects the response of the species to the magnitude of a pressure, thus it is the predictor for general dose-response relationships. If a species is known to show a strong response to a given pressure it is ranked to be of higher sensitivity compared to a species showing a weak response. If information on a species response is not available, the sensitivity analysis has been subject to expert judgement.

In order to select species which are relevant for the Environmental Impact Assessment, a sensitivity screening has been carried out. Species showing a minor sensitivity to a pressure or for which the Horns Rev 3 area was assessed to be of low importance were not treated further in the Impact Assessment of a particular pressure. For these species the severity of impact cannot be higher than low (see assessment criteria for the assessment of Severity of Impact in Table 4.4).

In addition bird species were excluded from the Impact Assessment if a pressure was judged as being irrelevant considering the distribution of a species.

4.3.2 Sensitivity to different pressures

4.3.2.1. Habitat loss

Habitat loss from the footprint of the wind farm structures was not subject of the sensitivity analysis. In general all species are sensitive to habitat loss. It is part of the impact assessment later to assess the severity of impact based on the area lost in relation to the species distribution.

4.3.2.2. Habitat change

The pressure 'habitat change' comprises various aspects how habitats are altered from construction, structures and operation of the offshore wind farm Horns Rev 3. During the construction works and dredging activities for the wind farm structures itself and the subsea cables the amount of suspended sediment in the water column will be increased. However, located close to the Wadden Sea, water turbidity levels are naturally high in the Horns Rev area, thus diving waterbirds using the area experience low visibility under natural conditions and are thus considered to be tolerant to construction related increases in turbidity levels.

Other habitat changes such as changes in hydrographic parameters, electromagnetic fields or from the provision of additional hard substrates (artificial reefs) are considered not to have any direct impact on waterbirds using the area. Indirect impacts from changes in the food resources, i.e. changes in availability and distribution of fish and benthic communities, may have an impact on waterbirds if relevant changes in their food resources occur.

Although bird populations may not necessarily be food-limited in the areas utilised, their abundance and distribution is dependent on food available in sufficient amount and quality. Human activities have often been shown to substantially reduce marine prey communities resulting in starvation or fitness reductions of the affected seabird species, especially due to exploitation of fish stocks by commercial fisheries (e.g., Tasker et al. 2000, Montevecchi 2002 and references therein). A mass starvation event of Common Eiders in the Wadden Sea in 1999/2000 was related to overfishing of mussels and cockles in the Wadden Sea in the early 1990s (Camphuysen et al. 2002), indicating that human-caused food reductions can have detrimental effects on seabirds.

In general waterbirds are known to adjust their foraging behaviour in response to variation in food abundance or quality (e.g. Monaghan et al. 1994, Richman and Lovvorn 2003) and show a certain plasticity which allows them switching between preys. Common Scoter relying on benthic prey are known to forage on a wide range of bivalves, depending on the dominant benthic community in the area (e.g. Madsen 1954, Meissner and Bräger 1990, Durinck et al. 1993, Leopold et al. 1995, Žydelis 2002) and the species is able to exploit new food resources in changed environments (e.g. Leonhard and Skov 2012). Regarding piscivorous birds prey selection is largely dominated by size selection rather than selection of particular fish species (e.g. Bauer et al. 2005).

It is concluded that the sensitivity to the pressure habitat changes is assessed as high for species specialized to benthic prey or fish. Species foraging on various different food items are assessed being minor sensitive to habitat changes.

It is known that reef structures are suitable habitats for different fish species and may attract fish from the surrounding area (e.g. Grossman et al. 1997, Inger et al. 2009, Lindeboom et al. 2011). Little is known about the use of artificial reefs by waterbirds. Offshore wind farms provide artificial reefs in the marine environment. Due to disturbance effects (see chapter 4.3.2.3) some species may avoid areas within wind farms. During aerial surveys of this study Common Scoters were regularly observed within the OWF Horns Rev 2 using also areas close to the turbines. Lindeboom et al. (2011) mentions single observations of Common Eiders foraging on epifauna from such artificial reefs. Higher densities of fish and hard bottom benthic communities at artificial reefs may attract birds foraging on these organisms. Observations of cormorants are reported for offshore wind farms, where the additional food supply in combination with provision of resting sites (above water structures of wind mills) attract these birds (Petersen et al. 2006, Lindeboom et al. 2011).

4.3.2.3. Disturbance

Disturbance of birds may occur both, during construction and from operation of an offshore wind farm. The pressure disturbance includes visual disturbances, disturbance from artificial lights, noise and vibrations. The sensitivity of birds to these different components cannot be separated and is therefore assessed as one pressure. Construction vessels, ships and helicopter traffic may cause disturbance especially during the construction phase, though maintenance traffic during operation will also locally cause disturbances to waterbirds. During operation sensitive bird species will be disturbed by the wind farm structures, especially the moving blades of the turbines are expected to cause disturbance effects to waterbirds.

Seabirds and waterbirds respond in different ways to on-site or approaching vessels. Some species are attracted to vessels as they expect food (e.g. gulls, fulmars or gannets following fishing vessels). Others show a negative response and flee from an approaching vessel at variable distances. The response differs not only between species but also depends on season, function of the area and structure of the waterbird assemblage (Mori et al. 2001). Waterbirds are especially sensitive during moult. Besides, reaction distances are known to be smaller during wintering period (Thiel et al. 1992). Species like the Common Scoter and the diver species exhibit large fleeing distances of 1-2 km, other species such as Common Eiders usually show fleeing distances below 1 km (Bellebaum et al. 2006, Schwemmer et al. 2011). However, initiation of fleeing reactions vary over a broad range of distances and the response distance usually increases with flock size making large aggregations more sensitive to disturbance (Mori et al. 2001, Larsen and Laubek 2005, Schwemmer et al. 2011). Also, repeated disturbances may have a cumulative effect (Merkel et al. 2009). If shipping is channelled within a predictable corridor, some birds may habituate to disturbance and show lower fleeing distances (Schwemmer et al. 2011). Fleeing distances of waterbirds are also described to vary with the hunting pressure. Waterbirds show larger fleeing distances in areas where hunting occurs and hunted species exhibit larger fleeing distances than non-hunted species (e.g. Madsen and Fox 1995, Laursen et al. 2005).

Gulls and terns are generally described as being insensitive to disturbance from shipping since they are often associated with vessels (Garthe and Hüppop 2004, Mendel et al. 2008). Gulls often scavenge on fish discards and therefore are attracted to ships (e.g. Walter and Becker 1997, Garthe and Scherp 2003, Garthe et al. 2004). Terns are also known to use turbulences caused by ship's propeller for foraging (Garthe et al. 2004, Mendel et al. 2008). Therefore, all gull and tern species are assessed exhibiting low sensitivity to disturbance from construction vessels and construction related traffic.

Waterbirds are known to be sensitive to disturbance from aircrafts and helicopters. Both noise from the aircraft and the visual stimulus are expected to cause disturbance to waterbirds with the intensity of the disturbance effect being related to the flight altitude and helicopters usually causing more disturbance than planes (Komenda-Zehnder et al. 2003). In this study disturbance effects were studied in an experimental approach and a minimum altitude of 450 m above ground was determined at which disturbance effects from helicopters became negligible. Helicopters are described to cause severe disturbance to birds regardless of the species if flying at a low altitude as reviewed for Switzerland by Bruderer and Komenda-Zehnder (2005). Smit and Visser (1993) in a review about disturbance of shorebirds in the Dutch Wadden Sea came to the same conclusion with helicopters causing considerable disturbance of roosting waders. Garthe and Hüppop (2004) ranked the sensitivity of seabirds to ships and helicopters on a scale with five levels. Common and Velvet Scoters were ranked level 5, i.e. the most sensitive to disturbance from ships and helicopters. Both divers were ranked at level 4, auks and Common Eider were ranked level 3 and all gulls and terns were ranked at level 1-2. In a recent study Furness et al. (2013) largely confirmed this sensitivity ranking and also described divers and scoters having the highest disturbance score (level 5).

Consequently divers and both scoter species, which exhibit the largest fleeing distances, were assessed to have a very high sensitivity to disturbance from construction vessels and traffic. Common Eiders and auks were assessed being highly sensitive to this pressure, though disturbance reactions may vary largely among species and with situation (e.g. species composition, flock size, disturbance frequency). All other species were either not assessed regarding sensitivity due to low importance of the area to the species or were assessed exhibiting only low sensitivity to this pressure.

Disturbance of birds from the structures of the turbines and especially from the rotors is difficult to assess requiring a carefully designed 'before after controlled impact assessment' (BACI) and is consequently debated somewhat controversially. Displacement of waterbirds from wind farm areas that is generally attributed to disturbance caused by the wind turbines seems to be highly species specific with effects ranging from complete avoidance to attraction:

Studies at the Horns Rev 1 and Nysted wind farm reported a displacement of divers (Petersen et al. 2006). Divers showed significant avoidance response to the area of the Horns Rev 1 wind farm an effect that was noted up to a distance of 2 km around the wind farm. The dataset at Nysted OWF was small and consequently recorded no statistical effects but indices were similar to Horns Rev 1. These findings were supported by more recent studies by Petersen and Fox (2007) which located no divers inside the wind farm and the closest diver in 1.6 km distance to the wind farm. Analysis of data on Common Scoters was hindered by a shift in distribution of the birds between the baseline studies with scoters being absent from the wind farm site and the post construction period with Common Scoters using the area in high densities. The distribution of Common Scoters indicated avoidance towards the wind farm (Petersen et al. 2006), however, fairly large numbers of birds were observed inside the wind farm during more recent surveys indicating a possible habituation (Petersen and Fox 2007). Selectivity indices suggested that Razorbills and Common Guillemots avoided the area of the wind farm and a buffer zone but results were not statistically significant. Gulls and Terns showed no significant response to the wind farm from baseline to operation period except for Little Gulls whose indices suggested an attraction effect (Petersen et al. 2006). For Common Eiders a strong avoidance affect was noted for migrating birds (Petersen et al. 2006).

Studies at the Egmont van Zee wind farm in the Netherlands (Leopold et al. 2011) had to deal with large variation of abundance which hindered analysis of data in form of a BACI approach. However, for each survey avoidance or attraction of the wind farm was statistically tested. For divers the analysis showed avoidance for 3 out of 8 tested surveys and no significant differences between inside and outside the wind farm for the remaining 5 surveys. For Common Scoters only one survey could be tested which did not show a significant difference. For Common Guillemot avoidance was significant in 2 surveys (9 non-significant) and for Razorbills 1 survey showed avoidance (5 non-significant). For terns and Fulmars no significant results were found. Gulls showed both surveys with significant avoidance and attraction. For Cormorants, a strong statistically significant attraction effect to the wind farm has been shown.

Monitoring carried out at the British wind farm Thanet (Percival 2013) points in the same direction as the above studies. At Thanet wind farm divers and Razorbills were found to be significantly avoiding the area of the wind farm although avoidance was not complete. For divers numbers dropped to 18% of the baseline level during construction and to 27% during operation. Effects in the buffer zone were not statistically significant. Razorbills were found to be more sensitive with numbers dropping to 11% during the construction period and 5% in the first year past construction with similar effects in a buffer zone of 500 m around the wind farm. For Guillemots the results were not conclusive as a drop in numbers from baseline to construction period was mirrored in the reference area. Monitoring of Red-throated Divers at Kentish Flats found an 80% reduction in the wind farm, 60% reduction in a buffer zone of 0-500 m and 20% reduction at 500-1,000 m with some evidence of habituation (Percival 2011). These studies show that diver displacement from offshore wind farms is lower than expected so far. As the available monitoring studies now provide actual results from several years of monitoring they are considered as being the most suitable basis for the impact assessment.

For the British wind farm Robin Rigg results from the first year of operation (Walls et al. 2013) could not show an impact on resting Common Scoters in the study area during the first year of operation, but core areas for the species were located outside the impact area. For divers there was some evidence for a decrease in numbers within the wind farm which also was found for auks and Gannets. A strong increase of Cormorants was noted with a shift in distribution inside the study area. Kittiwakes declined from baseline to construction but showed an increase during operation. For all other gulls an increase in numbers was noted from baseline to operation.

The species distributions in relation to the OWF Horns Rev 2 found during Horns Rev 3 surveys in 2013 largely confirm the avoidance patterns described in other studies, though data have not been statistically analysed with regard to avoidance effects from the existing wind farm Horns Rev 2. During the Horns Rev 3 surveys only one diver and two auk observations were recorded within the Horns Rev 2 wind farm indicating the species largely avoiding the wind farm area. Common Scoters were frequently observed occurring in the Horns Rev 2 wind farm area, also in high densities and in close vicinity to the wind turbines (Figure 4.2). This proofs that scoters may use wind farm areas to a certain extent at least several years after construction. However, disturbance effects seem to vary over time and between different wind farm sites, thus some avoidance effects have to be expected at least for the first years after construction and cannot be excluded for the later years of operation.

Figure 4.2 Common Scoters swimming in the vicinity of turbines of the Horns Rev 2 OWF. Picture taken during aerial survey on 13-02-2013. Photo: Thomas Grünkorn.

To conclude, both diver species are assessed to exhibit very high sensitivity to disturbances from construction, structures and operation of an offshore wind farm. The same holds for the auk species which are also assessed being very sensitive to disturbance (very high sensitivity). Both scoter species are assessed being very highly sensitive to disturbances from construction activities and being highly sensitive to disturbances from structures and operation of an OWF. Common Eiders are assessed being highly sensitive to disturbances both from construction and operation of an OWF. For the remaining species occurring in relevant numbers in the study area the sensitivity to this pressure is assessed as low.

4.3.2.4. Barrier effects

Flying birds usually respond to an obstacle by vertical or horizontal changes in their intended flight route. A barrier effect of a structure is basically meant as a barrier to movement and thus is different from other pressures resulting in displacement or redistribution of birds such as disturbance effects. However, for resting birds barrier effects are closely related to disturbance and are to be assessed in this context. The sensitivity to a barrier effect from the wind farm structures and operation was assessed to correspond to the assessed sensitivity to disturbance and is assessed as part of the pressure disturbance (see chapter 4.3.2.3).

Birds flying over water respond in different ways to on-site or approaching vessels. Some species are attracted to vessels such as gulls or terns (e.g. Walter and Becker 1997, Garthe and Scherp 2003, Garthe et al. 2004, Mendel et al. 2008); others show a negative response such as divers or scoters (Bellebaum et al. 2006, Schwemmer et al. 2011) for which it is expected that they avoid flying over vessels and would detour ships at a greater distance. These reactions would result in extra energy expenditures for an individual bird, but the extra energetic costs of detouring around ships are expected to be low.

4.3.2.5. Collisions

Birds may collide under a variety of circumstances with non-moving and moving structures. The collision risk is depending on various factors including the bird's behaviour, technical specifications of the obstacle and environmental conditions. Regarding the individual bird, the risk of collision is relevant to the flying bird, irrespective if it is on migration or moves between different foraging areas or breeding site and foraging areas. However, when observing flying birds it can hardly be distinguished between birds on migration and birds relocating within their resting or wintering habitat. Thus, when using bird observation data in the sensitivity analysis to this pressure for migrating birds these data also include movements of local birds. The sensitivity of the different resting bird species to collisions with wind farm structures is therefore assessed as part of the impact assessment on migrating birds (see report no. HR3-TR-042).

4.3.2.6. Summary sensitivity analysis

A sensitivity assessment was conducted for all resting bird species, for which the Horns Rev 3 study area was assessed to be of medium to very high importance. From these a species will be further regarded in the impact assessment for a pressure if the species was assessed to be at least medium sensitive to that pressure. If a species is assessed being relevant for the later impact assessment it is marked with a blue box in Table 4.7.

Table 4.7 Sensitivity assessment of resting bird species in the Horns Rev 3 area to different pressures related to the construction and operation of the OWF Horns Rev 3. There was no sensitivity analysis conducted for species for which the study area is only of low importance. Whether a particular pressure is assessed to be relevant to a species regarding importance and sensitivity is indicated by a blue box. Abbreviations used for importance and sensitivity levels: VH: Very high, H: High, M: Medium, L: Low.

Species	Importance	Sensitivity to the pressure		
		Habitat loss	Habitat change	Disturbance
Divers	**VH**	VH	H	VH
Red-necked Grebe	L			
Fulmar	L			
Gannet	L			
Common Eider	**M**	VH	H	H

Species	Importance	Sensitivity to the pressure		
		Habitat loss	Habitat change	Disturbance
Common Scoter	**VH**	VH	H	VH / H*
Velvet Scoter	**H**	VH	H	VH / H*
Little Gull	**H**	VH	L	L
Black-headed Gull	L			
Common Gull	L			
Lesser Black-backed Gull	**M**	VH	L	L
Herring Gull	**M**	VH	L	L
Great Black-backed Gull	L			
Kittiwake	L			
Sandwich Tern	**H**	VH	H	L
Common/Arctic Tern	L			
Guillemot/Razorbill	**M**	VH	H	VH

* Sensitivity is assessed being very high during construction phase and high during operation phase.

4.4. Assessment of the worst case scenario of the project regarding resting birds

The impact assessment on resting birds was conducted based on the worst case scenario among the possible technical specifications described in chapter 2.2. For assessing the worst case scenario the different project pressures were screened for relevant differences regarding the impacts on resting birds. Depending on different distribution patterns of different waterbird species the location of the worst case scenario would be species specific. However, all wind farm scenarios affect the same general area, thus for most species no relevant differences between different locations can be assessed. Therefore there was one worst case scenario assessed regarding the distribution of the most relevant species in the area and applied to the impact assessment of all other waterbird species using the Horns Rev 3 area.

4.4.1 Location of the wind farm

There were three different general wind farm locations proposed: (1) closest to the shore (easterly in project area), (2) in the centre of the project area, and (3) in the western part of the project area. Species sensitive to disturbance may be displaced from the wind farm site due to construction activities and/or from the structures in operation. There are two species (groups) highly sensitive to human caused disturbances that are highly abundant in the Horns Rev 3 study area:

Divers: aerial surveys and data from former surveys show the species occurring widely distributed in the Horns Rev area with seasonal and between year variations in concentrations close to shore and offshore. However, Horns Rev 3 studies indicate divers using the northern part of the study area and project area more frequently than areas further south. Therefore the second location with wind turbines placed in the centre of the project area, which also represents the most northern wind turbine placement, is regarded as the worst case scenario for divers.

Common Scoters: Scoter distributions are highly variable and are described to vary within and between seasons. However, aerial surveys conducted for this project and in other studies show this benthivorous seaduck mostly using shallow areas of up to 20 m water depth. During the Horns Rev 3 surveys highest concentrations of Common Scoters were observed in coastal areas and south of the Horns Rev 3 project area. Within the project area no gradient in Common Scoter abundances was found and therefore all three scenarios are expected to have an equal impact.

Regarding the wind farm location the location in the centre of the project area is used as worst case scenario for the impact assessment on resting birds. However, there are no large differences between the three different locations expected.

4.4.2 Turbine type

With regard to the turbine type two different aspects are relevant for resting birds: depending on the wind turbine size: (1) the distance between the single turbines differ (becomes larger the larger the turbine is) and also the total number of turbines varies; and (2) the total rotor swept zone of the wind farm.

There is no study which would compare the avoidance reactions between a wind farm with many smaller turbines with a wind farm with a smaller number of larger turbines. However, the smaller distances between wind turbines and the greater total number of turbines of a wind farm with smaller turbines may cause stronger reactions in resting birds with regard to disturbance and barrier effects than a smaller number of larger turbines in greater distance to each other. Also rotor blades (optically) seem to move faster for small turbines. Thus, based on expert judgement the smallest turbine type (here the 3 MW turbines) would be the worst case turbine type.

Among other relevant factors affecting bird collision rates the risk to collide increases with the area of the risk zone where collisions can happen, i.e. the rotor swept zone of the turbine blades. The total rotor swept area of 134–136 3 MW turbines comprises a larger area than the total rotor swept area of a smaller numbers of larger turbines (see also report on migrating birds).

Thus, the smallest proposed turbine type (3 MW) is regarded as the worst case turbine type and therefore used in the impact assessment.

4.4.3 Foundation and scour protection

Differences in construction activities, such as seabed preparation, dredging (including increased water turbidity) or deployment of scour protection result in changed habitats in the wind farm area. However, there are no relevant differences between effects of different foundation types and scour protections of different wind farm scenarios expected for resting birds and thus not further assessed.

4.4.4 Conclusion worst case scenario for resting birds

For most resting bird species being widely distributed in the offshore areas no relevant differences between different wind farm locations and specifications can be assessed. During Horns Rev 3 aerial surveys divers were observed being more abundant in the northern part of the study area and project area, thus the northern-most location of the wind turbines within the project area was chosen as worst case (Figure 4.3). The 3 MW turbines are expected to cause more disturbances to sensitive species due to higher total number of turbines and smaller distance between turbines compared to a smaller number of large turbines (Figure 4.3). Also with regard to collision risk the 3 MW turbine type is regarded as the worst case.

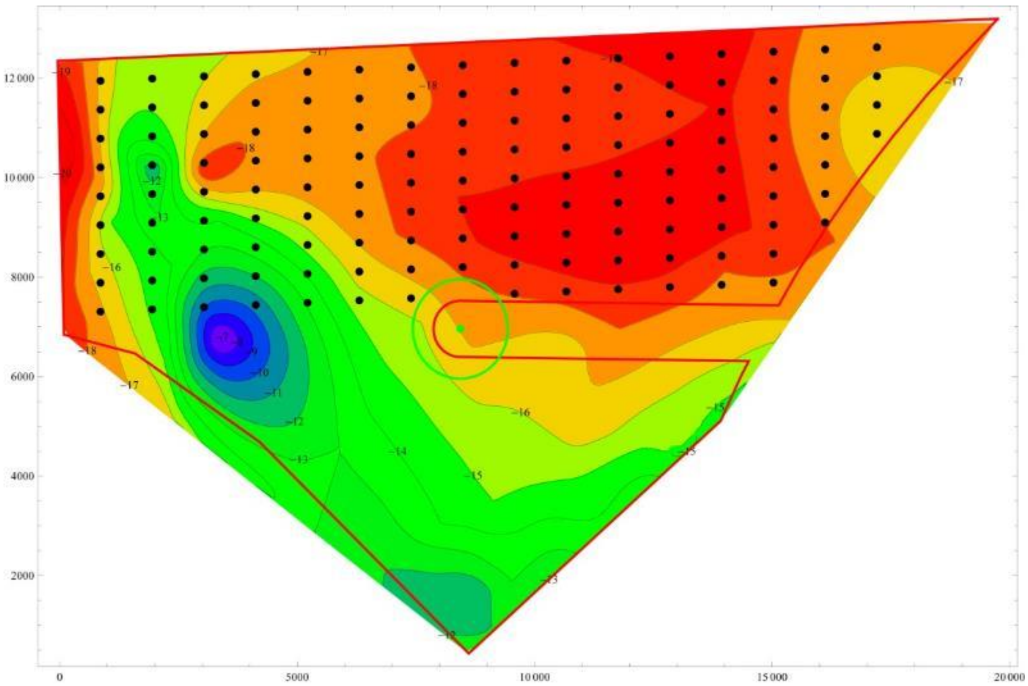


Figure 4.3 Worst case scenario of Horns Rev 3 wind farm used for the impact assessment on resting birds: Suggested layout for the 3.0 MW wind turbine at Horns Rev 3, located in the centre of the project area.

4.5. Impact assessment on resting birds

4.5.1 Construction phase

4.5.1.1. Habitat change

Description of the pressure

Construction activities can either directly or indirectly result in habitat changes for resting birds. Resting waterbirds occurring in important number in the Horns Rev 3 study area have been assessed having low sensitivity to the direct changes from construction of an offshore wind farm. Therefore direct impacts from habitat changes during construction works are not further assessed in this chapter.

Indirect changes from construction works in terms of changes in food availability are a relevant pressure to all species relying on the affected prey organisms. Bird species using lots of different prey were assessed having low sensitivity to habitat changes and are therefore not further assessed here.

The impact assessment on fish ecology in the Horns Rev 3 area (report HR-TR-025) predicts temporary impacts on fish from noise emissions during pile driving resulting in an assessment of medium Severity of Impact to most fish species in the area. Impacts from other pressures during the construction phase were assessed mostly with low Severity of Impact for fish, medium Severity of Impact from habitat change was assessed for sandeels and flatfish. It can be considered that fish avoidance reactions to construction activities are small-scale and mostly occur in close vicinity to the construction site. Furthermore, it is expected that avoidance effects of fish are temporary and the fish will return to impaired areas shortly after the construction works have stopped. Therefore the changes regarding food availability for piscivorous birds, such as divers and auks, are considered generally low.

The impact assessment on benthic habitats and communities (report HR-TR-024) predict no significant impacts to the clam species being relevant prey for scoters and eiders in the Horns Rev area. Only a small proportion of suitable *Spisula* and *Ensis* habitats are predicted to be affected by construction activities.

Impacts on benthic and fish communities are the highest close to the construction site, where impaired areas overlap with the disturbance zone of birds during construction activities (see chapter 4.5.1.2).

Degree of Impact

The Degree of Impact from habitat changes during construction of Horns Rev 3 OWF was assessed following the criteria defined in Table 4.6.

Piscivorous waterbirds

There are no relevant changes in fish availability predicted by the studies on fish ecology, though fish species being impaired and showing avoidance reactions to pressures during construction. Therefore there are no relevant indirect effects predicted for fish-eating waterbirds from changes in their food availability. The Degree of Impact from the pressure habitat changes is assessed as low for piscivorous birds.

Benthivorous seaducks

Regarding benthivorous seaducks, the studies on benthic habitats and communities predict no relevant changes in availability of the main food organisms – the Cut trough shell (*Spisula subtruncata)* and the Atlantic jack-knife clam (*Ensis directus*) – for the construction period of the Horns Rev 3 OWF. Therefore there are no relevant indirect effects predicted for the two scoter species and the Common Eider from changes in their food availability. The Degree of Impact from the pressure habitat changes is assessed as low for these species.

Severity of Impact

The Severity of Impact from the pressure was assessed following the criteria defined in chapter 4.1.10.5.

Piscivorous waterbirds

The Severity of Impact was assessed being low for all fish-eating waterbird species in the Horns Rev 3 study area due to low Degree of Impact predicted regarding changes in food availability for piscivorous birds. Therefore the Severity of Impact was assessed being low also for species occurring in medium to very high important numbers in the area.

Benthivorous seaducks

Seaducks and here especially the Common Scoter occur in very high abundances in the Horns Rev area. The area therefore was assessed being of very high importance to the species. The benthic clam species Cut trough shell and Atlantic jack-knife clam play a major role in Common Scoters' diet in the area (Skov et al. 2008, Leonhard and Skov 2012) thus the species is regarded being highly sensitive to changes in the availability of this food sources. The impact assessment studies on benthic habitats and communities predict only a very low proportion of suitable habitats of the respective benthic communities being impaired from construction works. Therefore the Degree of Impact and also the Severity of Impact from the pressure habitat change is assessed being low for the seaduck species at Horns Rev, namely Common Scoter, Velvet Scoter and Common Eider.

Summary

The Severity of Impact was determined from the total number of individuals per species which was estimated to be affected from the pressure within the disturbance zone and the Degree of Impact assessed for the particular species. The Severity of Impact is assessed to be low for all resting bird species in the area (Table 4.8).

Table 4.8 Assessment of the Severity of Impact from habitat change from the Horn Rev 3 OWF to resting birds based on the Degree of Impact and the importance of the number of birds being affected by the pressure. Beside the number of birds affected from the pressure (n birds affected) also the respective equals to the biogeographic population of a species (% of pop.) are given.

Species	Degree of Impact	n birds affected	% of pop.	Severity of Impact
Piscivorous water-birds	Low	low number		Low
Benthivorous sea-ducks	Low	low number		Low
Other species	Low	low number		Low

4.5.1.2. Disturbance from construction activities

Description of the pressure

The construction of the OWF Horns Rev 3 and deployment of the subsea cables (inter-array cables and transmission cable to the land station) will require various shipping activities, including construction vessels, dredgers, guard and transport vessels and helicopter flights, which are expected to cause disturbances to sensitive bird species. The pressure includes visual disturbances as well as disturbances from noise (e.g. from pile driving), vibrations and light emissions. Disturbances to waterbirds from construction activities in the wind farm area are considered to occur within the same defined disturbance zone as defined for the operation phase of the wind farm (Figure 4.4; see also chapter 4.5.2.3). The disturbance zone was calculated to affect an area of 94.02 km². However, construction activities are expected to be restricted to a relatively small area at a time and the area which is disturbed by construction activities at a time is much smaller.

The barrier effects resulting from Horns Rev 3 construction activities to flying resting birds are closely related to the disturbance effects and are part of the assessment of this pressure.

Additionally to the construction works within the project area dredging activities and installation of the subsea transmission cable between the transformer station and Blåbjerg Substation will cause some disturbances to birds (Figure 4.4). However, construction vessels involved in the cable installation are expected to operate slowly and cable installation works will only impair a small section of the total length of the transmission cable (ca. 38 km) at a time.

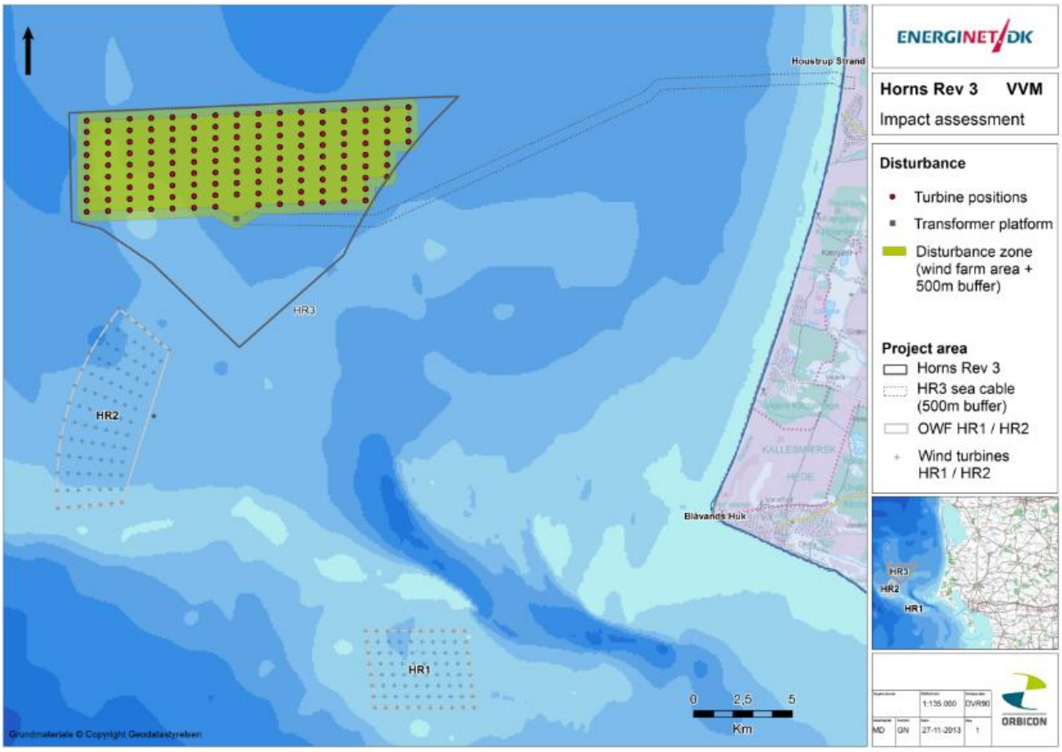


Figure 4.4 Area in which disturbance occurs during construction of the OWF Horns Rev 3 (scenario with 3 MW turbines in centred position within the project area) with 500 m buffer zone. Additionally locally disturbances will occur along the cable trays during installation of the Horns Rev 3 subsea cable.

Degree of Impact

The Degree of Impact is assessed following the criteria described in chapter 4.1.10.4 and is deduced from the sensitivity analysis undertaken in chapter 4.3.2. As the magnitude of pressure cannot be assessed independently from the species' reaction to potential disturbances (i.e. its sensitivity), the Degree of Impact was assessed at the same level as the sensitivity. Consequently the Degree of Impact was assessed being very high for divers, the two scoter species (Common Scoter and Velvet Scoter) and auks (Guillemot and Razorbill), and high for the Common Eider. All other species are either not relevant for the impact assessment due to low importance of the area to the species or are assessed being minor sensitive to disturbances from construction activities for an OWF with corresponding low Degree of Impact regarding these species.

Following the criteria shown in Table 4.6 and following the precautionary principle for species, for which a very high Degree of Impact is assessed it is assumed that all birds are displaced from a disturbance zone comprising of the site of actual construction activities plus a 500 m buffer zone. It is expected that the actual areas being disturbed during construction are much smaller than the disturbance zone defined for the operation phase. Also 100% avoidance is considered to be unlikely, however, there are no studies that would quantify the proportion of birds displaced from a wind farm construction site. Therefore the worst case with 100% displacement was assumed for the construction phase.

In the course of the construction period additionally to the construction activities the growing structure of the wind farm will cause additional disturbances to birds. Thus the dimension of the disturbance zone is expected to increase from a relatively small area to the area assessed as disturbance zone during operation (see chapter 4.5.2.3). For species, for which the Degree of Impact was assessed as high for the disturbance zone, it is assumed that 50% of the birds are permanently displaced from the disturbance zone. For species, for which sensitivity and Degree of Impact were assessed as being low, no relevant changes in bird abundances within the disturbance zone is predicted. These species are not further assessed in detail in this chapter.

Severity of Impact

Divers

For the disturbance zone of construction site plus 500 m buffer a very high Degree of Impact was assessed based on the sensitivity analysis. The assessment of the Severity of Impact is therefore based on the assumption of complete displacement of all divers from that impact zone. A total of 133 divers are estimated to be affected by very high Degree of Impact and be displaced from the impact zone during spring, the season of maximum numbers using the area. This number corresponds to 0.05% of the biogeographic population of the Red-throated Diver. According to the assessment methodology (see Table 4.4) the combination of very high Degree of Impact affecting low important numbers of a species results in low Severity of Impact for the diver species.

Common Eider

The distribution of Common Eiders in the Horns Rev 3 study area was found to be concentrated in the very south-eastern part of the surveyed area. The disturbance zone from construction of the Horns Rev 3 OWF is rarely used by Common Eiders. Therefore the impact zone is assessed being of low importance to the species. The Severity of Impact to the species therefore is assessed as being low.

Common Scoter

For the disturbance zone of the construction site plus 500 m buffer a very high Degree of Impact was assessed based on the sensitivity analysis. The assessment of the Severity of Impact is therefore based on the assumption of 100% displacement of Common Scoters from the impact zone. A total of 2,808 Common Scoters are estimated to be affected by very high Degree of Impact and to be displaced from the impact zone during winter, the season of maximum numbers occurring in the area. This numbers correspond to 0.51% of the biogeographic population of the Common Scoter. According to the assessment methodology (see Table 4.4) the combination of very high Degree of Impact affecting medium important numbers of a species results in medium Severity of Impact for the Common Scoter.

Velvet Scoter

The distribution of Velvet Scoters in the Horns Rev 3 study area was found to be concentrated in the very southern part of the surveyed area. The disturbance zone from construction of the Horns Rev 3 OWF is rarely used by Velvet Scoters. Therefore the impact zone is assessed being of low importance to the species. The Severity of Impact to the species therefore is assessed as being low.

Common Guillemot / Razorbill

Regarding auks for the disturbance zone of the construction site plus 500 m buffer a very high Degree of Impact was assessed based on the sensitivity analysis to disturbances. The assessment of the Severity of Impact is therefore based on the assumption of complete displacement of all Common Guillemots and Razorbills from the impact zone. A total of 53 auks are estimated to be affected by very high Degree of Impact and be displaced from the impact zone during winter, the season of maximum numbers using the area. This number corresponds to 0.01% of the biogeographic population of the Razorbill. According to the assessment methodology (see Table 4.4) the combination of very high Degree of Impact affecting low important numbers of a species results in low Severity of Impact for the auk species.

Summary

The Severity of Impact was determined from the total number of individuals per species which were estimated to be affected from the pressure within the disturbance zone and the Degree of Impact assessed for the particular species. For assessment of the Severity of Impact during the construction period a complete disturbance of the above defined zone around the construction site was assumed. However, for most of the time during the construction period only part of the construction site will be disturbed from construction activities, thus the assessment result needs to be regarded as conservative estimate. For most of the assessed species the overall Severity of Impact is assessed to be low. The Severity of Impact is assessed to be medium for the Common Scoter (Table 4.9).

Table 4.9 Assessment of the Severity of Impact from disturbance during construction of the Horn Rev 3 OWF to resting birds based on the Degree of Impact and the importance of the number of birds affected by the pressure. Beside the number of birds affected from the pressure (n birds affected) also the estimate of birds being displaced from the disturbance zone (n birds displaced) is given, as well as the respective equals to the biogeographic population of a species (% of pop.). Assessment result represents the worst case assumption that the entire construction site is impaired from activities resulting in comparable impacts as predicted for the operation phase (see Table 4.12).

Species	Degree of Impact	n birds affected	% of pop.	n birds displaced	% of pop.	Severity of Impact
Divers	Very high	133	0.05%	133	0.05%	Low
Common Eider	High	low number		low number		Low
Common Scoter	Very high	2,808	0.51%	2,808	0.51%	Medium
Velvet Scoter	Very high	low number		low number		Low
Guillemot / Razorbill	Very high	53	0.01%	53	0.01%	Low
Other species						Low

4.5.2 Operation phase and structures

4.5.2.1. Habitat loss from footprint

Description of the pressure

Structures of the Horns Rev 3 OWF result in small scale habitat loss. Habitat loss is expected to differ depending on foundation and turbine type and number of turbines. Additionally sea floor habitats will be lost by scour protection layers which may later serve as new habitats for hard substrate communities, but it firstly is to be assessed as loss of the original habitat.

Additionally to the loss of habitat by turbines, there will be marine habitats lost by the installation and scour protection of the offshore transformer substation. The area of loss is estimated to range between 600 m^2 and 1,500 m^2 (see report on benthic habitats and communities, report no. HR3-TR-024).

Some areas may also be lost if subsea cables are protected with rock-dump. However, the seabed in the project area is well suited for jetting cables into the seafloor. It is therefore expected that only very small areas will additionally be lost by rock dump.

Degree of Impact

The footprint area of the Horns Rev 3 wind farm foundations and scour protection is regarded as an area of complete habitat loss with no recovery for the life span of the project. Additional hard substrates from foundations and scour protection may serve as new habitats for hard substrate communities, which is assessed as part of the chapter 4.5.2.2. Habitat loss generally is assessed with very high Degree of Impact.

Severity of Impact

Areas lost from the project footprint comprise a relatively small area of in total less than 0.2% of the Horns Rev 3 project area and less than 0.1% of the Horns Rev 3 study area regarding resting birds. Thus only minor numbers of resting birds are predicted to be affected from the habitat loss. The Severity of Impact is therefore assessed to be low for all resting bird species in the area (Table 4.10).

Table 4.10 Assessment of the Severity of Impact from habitat loss to resting birds.

Species	Degree of Impact	n birds affected	% of pop.	n birds displaced	% of pop.	Severity of Impact
All resting bird species	Very high	low number		low number		Low

4.5.2.2. Habitat change

Description of the pressure

The pressure habitat change during operation of the Horns Rev 3 OWF comprises different aspects of direct and indirect changes in the habitats of resting birds. Turbine structures above sea level may serve as roosts for some species. Additional hard substrates inserted in the environment serve as artificial reefs with changes in benthic and fish communities resulting in changes in food availability for resting birds. Electromagnetic fields and heat from the sea cables are not expected to have any direct impact on resting birds, but indirect impacts via sensitive benthic and fish species for benthivorous and piscivorous waterbirds are relevant to be assessed.

Degree of Impact

Provision of artificial reefs and roosts is closely related to habitat loss by deployment of the additional hard substrates, which is assessed in the previous chapter 4.5.2.1. Some bird species might benefit from provision of artificial reefs and such effects were evaluated descriptively. For others no relevant impact is predicted to result from the artificial reefs. Changes in benthic and fish communities from other pressures such as electromagnetic fields or heat are predicted to either be restricted to a relatively small area or resulting in low impacts. Thus there are minor indirect effects predicted for resting birds feeding on these prey organisms. Therefore, the Degree of Impact for the pressure habitat change is assessed to be low for all resting bird species in the area.

Severity of Impact

The Severity of Impact was determined from the total number of individuals per species which was estimated to be affected from the pressure within the disturbance zone and the Degree of Impact assessed for the particular species. The Severity of Impact is assessed to be low for all resting bird species in the area (Table 4.11).

Table 4.11 Assessment of the Severity of Impact from habitat change to resting birds.

Species	Degree of Impact	n birds affected	% of pop.	Severity of Impact
Piscivorous water-birds	Low	low number		Low
Benthivorous sea-ducks	Low	low number		Low
Other species	Low	low number		Low

4.5.2.3. Disturbance from wind farm structures and operation

Description of the pressure

For the assessment of disturbance from structures and operation of the Horns Rev 3 wind farm the worst case scenario as described in chapter 4.4 was assumed. In this scenario the OWF Horns Rev 3 comprises of 136 3 MW turbines which are located in minimum distances of approximately 590 m – 1,100 m to each other.

The presence of the wind farm structures themselves, the moving blades, noise and light emissions are expected to result in disturbance of sensitive resting birds in the area. There is no disturbance from the deployed subsea cables to be expected and thus not further assessed in this chapter.

The presence of the structures and operation-related disturbances are also considered to result in barrier effects to resting birds conducting exchange flights between different resting and foraging habitats. However, for resting birds the barrier effect is considered being low in offshore areas in comparison with the disturbance effect resulting in displacement of birds from habitats. Barrier effects occurring in result of avoidance reactions from resting birds sensitive to disturbances are accounted for in the assessment on disturbance effects in this chapter.

Based on the sensitivity analysis of waterbirds to the pressure ‘disturbance’ from offshore wind farms, an impact zone (called ‘disturbance zone’ further on) was defined comprising of the total area between the 136 turbines and the transformer platform plus a 500 m buffer zone (Figure 4.5). For some species, such as divers, a larger buffer zone has been used in previous assessments of offshore wind farms, however, recent monitoring studies did only confirm small effects beyond 500 m. Outside the disturbance zone there may still be little avoidance effects detectable, which are accounted for in conservative assumptions of displacement rates within the defined disturbance zone. The same disturbance zone was applied for all species identified as being sensitive to this pressure.

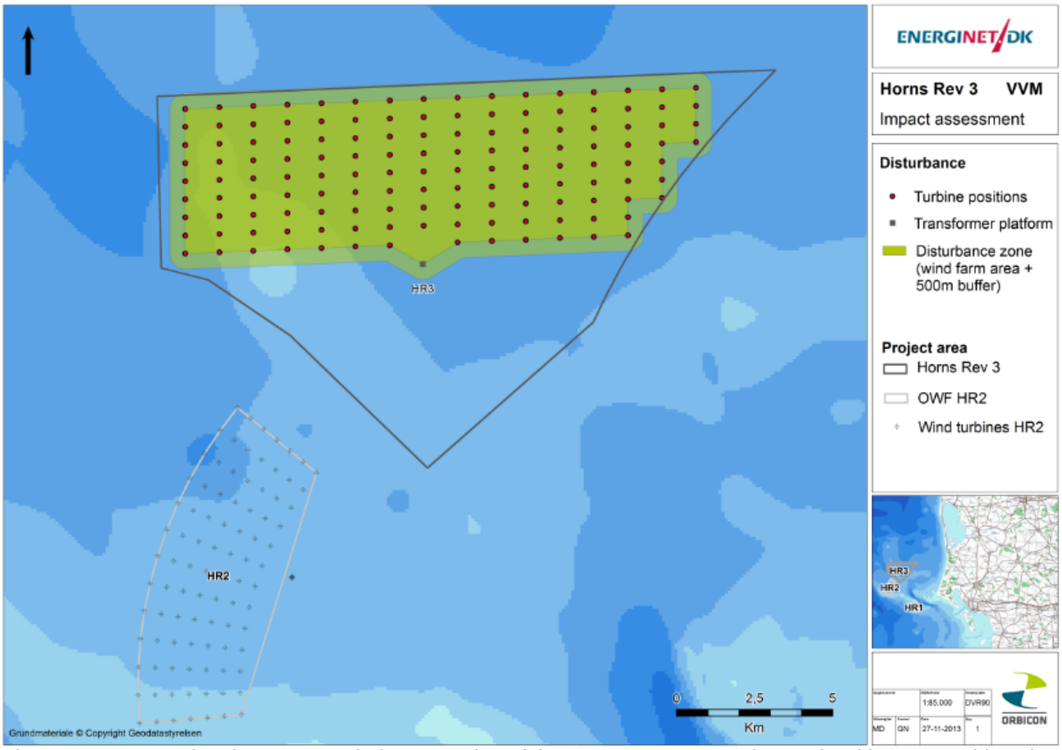


Figure 4.5 Disturbance zone during operation of the OWF Horns Rev 3 (scenario with 3 MW turbines in centred position within the project area) with 500 m buffer zone around.

Degree of Impact

The Degree of Impact is assessed following the criteria described in chapter 4.1.10.4 and is deduced from the sensitivity analysis undertaken in chapter 4.3.2. As the magnitude of pressure cannot be assessed independently from the species' reaction to potential disturbances (i.e. its sensitivity), the Degree of Impact was assessed at the same level as the sensitivity. Consequently the Degree of Impact was assessed being very high for divers and auks (Guillemot and Razorbill), and high for the seaduck species occurring in the area (Common Scoter, Velvet Scoter and Common Eider). All other species are either not relevant for the impact assessment due to low importance of the area to the species or are assessed being minor sensitive to disturbances from an OWF in operation with corresponding low Degree of Impact regarding these species.

Following the criteria shown in Table 4.6 and following the precautionary principle for species, for which a very high Degree of Impact is assessed for the disturbance zone, it is assumed that 50-100% of birds are permanently displaced from the disturbance zone. For divers recent effect studies in the UK resulted in avoidance rates of 70-80% within the wind farm and lower avoidance rates in buffer zones (60% reduction in a buffer zone of 0-500 m and 20% reduction at 500-1,000 m; Percival 2011). Following these results 85% reduction of divers for both the wind farm area and the 500 m buffer was assumed. This is a lower estimate as used in previous assessments (for German offshore wind farms, a 100% displacement from the wind farm plus 2km buffer has been assumed so far). However, while previous assessments used a very conservative approach in the light of little data, this assessment relies on actual monitoring studies which demonstrated a lower displacement of divers from wind farm area and buffer zone. For the auk species there are no studies available indicating habituation or relevant use of the wind farm area, thus the conservative approach was followed and 100% displacement from the disturbance zone was assumed for Guillemots and Razorbills.

For species, for which the Degree of Impact was assessed as high for the disturbance zone, it is assumed that 50% of the birds are permanently displaced from the disturbance zone. This is regarded to be a conservative approach regarding the Common Scoter, which was shown to use wind farm areas in comparably high densities after some years of operation. However, avoidance may be an issue in the first years of operation.

For species, for which sensitivity and therefore Degree of Impact was assessed as being low, no relevant changes in bird abundances within the disturbance zone is predicted. These species are not further assessed in detail in this chapter.

Severity of Impact

Divers

For the disturbance zone of the wind farm area plus 500 m buffer a very high Degree of Impact was assessed based on the sensitivity analysis. The assessment of the Severity of Impact is based on the assumption of 85% displacement of divers from the impact zone.

A total of 133 divers are estimated to be affected by very high Degree of Impact and 113 divers are predicted to be displaced from the impact zone during spring, the season of maximum numbers using the area. This number corresponds to 0.05% of the biogeographic population of the Red-throated Diver. According to the assessment methodology (see Table 4.4) the combination of very high Degree of Impact affecting low important numbers of a species results in low Severity of Impact for the diver species.

Common Eider

The distribution of Common Eiders in the Horns Rev 3 study area was found to be concentrated in the very south-eastern part of the surveyed area. The disturbance zone from operation of the Horns Rev 3 OWF is rarely used by Common Eiders. Therefore the impact zone is assessed being of low importance to the species. The Severity of Impact to the species therefore is assessed as being low.

Common Scoter

For the disturbance zone of the wind farm area plus 500 m buffer a high Degree of Impact was assessed for the Common Scoter. The assessment of the Severity of Impact is therefore based on the assumption of 50% displacement of Common Scoters from the impact zone. This is regarded as a very conservative assumption since aerial surveys during baseline investigation showed scoters using the Horns Rev 2 wind farm area in very high densities indicating no or less strong avoidance effects.

However, a total number of up to 2,808 Common Scoters are estimated to be affected from the pressure within the disturbance zone and up to 1,404 individuals are estimated to be displaced from this zone in winter, the season of maximum numbers occurring in the area. This numbers correspond to up to 0.51% of the biogeographic population being impaired by high Degree of Impact and up to 0.26% of the biogeographic population being displaced from the wind farm site. According to the assessment methodology (see Table 4.4) the combination of high Degree of Impact affecting medium important numbers of a species results in medium Severity of Impact for the Common Scoter.

Velvet Scoter

The distribution of Velvet Scoters in the Horns Rev 3 study area was found to be concentrated in the very southern part of the surveyed area. The disturbance zone from operation of the Horns Rev 3 OWF is rarely used by Velvet Scoters. Therefore the impact zone is assessed being of low importance to the species. The Severity of Impact to the species therefore is assessed as being low.

Common Guillemot / Razorbill

Regarding auks for the disturbance zone of the wind farm area plus 500 m buffer a very high Degree of Impact was assessed based on the sensitivity analysis to disturbances. The assessment of the Severity of Impact is based on the assumption of complete displacement of all Guillemots and Razorbills from the impact zone. A total of 53 auks are estimated to be affected by very high Degree of Impact and be displaced from the impact zone during winter, the season of maximum numbers using the area. This number corresponds to 0.01% of the biogeographic population of the Razorbill. According to the assessment methodology (see Table 4.4) the combination of very high Degree of Impact affecting low important numbers of a species results in low Severity of Impact for the auk species.

Summary

The Severity of Impact was determined from the total number of individuals per species which was estimated to be affected from the pressure within the disturbance zone and the Degree of Impact assessed for the particular species. For most of the assessed species the overall Severity of Impact is assessed to be low. The Severity of Impact is assessed to be medium for the Common Scoter (Table 4.12).

Table 4.12 Assessment of the Severity of Impact from disturbance from the Horn Rev 3 OWF to resting birds based on the Degree of Impact and the importance of the number of birds being affected by the pressure. Beside the number of birds affected from the pressure (n birds affected) also the estimate of birds being displaced from the disturbance zone (n birds displaced) is given, as well as the respective equals to the biogeographic population of a species (% of pop.).

Species	Degree of Impact	n birds affected	% of pop.	n birds displaced	% of pop.	Severity of Impact
Divers	Very high	133	0.05%	113	0.04%	Low
Common Eider	High	low number		low number		Low
Common Scoter	High	2,808	0.51%	1,404	0.26%	Medium
Velvet Scoter	High	low number		low number		Low
Guillemot / Razorbill	Very high	53	0.01%	53	0.01%	Low
Other species						Low

4.5.3 Decommissioning phase

Generally, the activities related to decommissioning of the Horns Rev 3 offshore wind farm are expected to be carried out in reverse order of the construction. The impacts on resting birds during decommissioning of the OWF are considered to be at the same level as for the construction regarding disturbance related pressures, barrier effect and collision risk. According to the impact assessments on benthic habitats and communities and fish ecology also impacts from habitat change for birds are assessed being comparable or lower than during construction and operation.

4.6. Mitigation

There are no mitigation measures to be recommended with special regard to resting birds.

4.7. Assessment of cumulative impacts

When several projects affect the same environmental conditions within a region at the same time, they are defined to have cumulative effects. For resting birds only other wind farm projects in the Danish North Sea are considered in the assessment of cumulative impacts. Two offshore wind farms already in operation and two planned near-shore wind farms are considered relevant in the cumulative assessment on resting birds:

- Horns Rev 1: The wind farm is in operation since 2002 and located c. 16 km south of the Horns Rev 3 project area,
- Horns Rev 2: The wind farm is in operation since 2010 and located c. 3 km southwest of the Horns Rev 3 project area,
- Vesterhavet Syd: The near-shore wind farm is in the planning status, the project area is located c. 30 km northeast of the Horns Rev 3 project area,

- Vesterhavet Nord: The near-shore wind farm is in the planning status, the project area is located c. 90 km northeast of the Horns Rev 3 project area.

The four wind farms to be considered in the cumulative assessment are either already in operation or not planned to be constructed at the same time as Horns Rev 3 OWF, thus there are no relevant cumulative impacts during construction activities to be assessed. Regarding the operation phase of Horns Rev 3 OWF the pressure disturbance is the only one being assessed resulting in more than minor impacts to resting birds in the area. Impacts from collision with wind farm structures and cumulative effects regarding this pressure are described as part of the impact assessment report on migrating birds.

Disturbance from wind farm structures as permanent pressure is assessed being relevant since disturbances may result in a functional loss of foraging and resting habitats to sensitive waterbird species. Within the baseline studies of the Horns Rev 3 project five species (groups) were identified being highly or very highly sensitive to the pressure disturbance, among which two species (groups) are considered being relevant with regard to cumulative impacts from disturbance in the Danish North Sea area: the two diver species Red-throated Diver and Black-throated Diver and the Common Scoter. Other species were either assessed not being sensitive to the pressure or are sensitive to the pressure, but use the impacted areas at Horns Rev 3 only in low numbers, such as Common Eiders, Velvet Scoters and the auk species.

4.7.1 Cumulative impacts – Red-throated Diver / Black-throated Diver

For assessing the impacts of the pressure disturbances from structures and operation of the Horns Rev 3 OWF it is predicted that up to 165 divers would be displaced from the wind farm site of Horns Rev 3 during operation of the wind farm. Studies on Horn Rev 1 and Horns Rev 2 wind farms describe divers avoiding Horns Rev 1 wind farm in the post-construction years with no indication of habituation (Petersen et al. 2003, Petersen 2005, Petersen and Fox 2007). For the planned near-shore wind farms Vesterhavet Syd and Vesterhavet Nord it is expected that divers using these areas will be displaced from the wind farm sites as well, though diver densities are expected to be lower in the coastal habitats of these planned projects.

Divers occur widely distributed in the coastal and offshore waters of the Danish North Sea and in the Baltic. The Danish population of divers in spring was roughly estimated by Petersen and Nielsen (2011) comprising c. 10,000 divers in the south-eastern parts of the Danish North Sea and c. 20,000 divers for the total Danish waters. The area south of Horns Rev is designated as Natura 2000 site (DK00VA347 Sydlige Nordsø) and thus protected from future spatial planning in one of the most important diver areas in the Danish North Sea.

Displacement of birds from habitats does not directly result in bird mortality, but first in redistribution of birds. Topping and Petersen (2011) assessed the cumulative impacts on the Red-throated Diver based in terms of impacts on population level on an agent-based model approach. The model used in their study predicted for different wind farm development scenarios relatively small impacts on the overall flyway population. For the scenario covering the development plan for offshore wind farms (scenario 2; Topping and

Petersen 2011), a trivial population effect of a decrease of 0.1% of the flyway population size is predicted.

In another study assessing the cumulative impacts of offshore wind farms in the Dutch North Sea, Poot et al. (2011) conclude that the effects of the multiple offshore wind farm scenarios are far away from the levels above which decreasing trends occur.

Based on the impact assessment for the Horns Rev 3 project and other studies on wind farm effects on divers there are no significant cumulative impacts predicted for these species.

4.7.2 Cumulative impacts – Common Scoter

For assessing the impacts of the pressure disturbances from structures and operation of the Horns Rev 3 OWF it is predicted that up to 1,750 Common Scoters would be displaced from the wind farm site of Horns Rev 3 during operation of the wind farm (based on the assumption of 50% displacement of all birds within the wind farm area plus a 500 m buffer zone). However, this prediction has to be regarded as very conservative since baseline studies for the Horns Rev 3 OWF and results of Petersen and Fox (2007) indicate that Common Scoters may use the wind farm areas of Horns Rev 1 and Horns Rev 2 at least some years after construction works have ended.

Petersen and Nielsen (2011) estimate a total abundance of Common Scoters of c. 200,000 birds for the near-shore part of the Danish North Sea between the German border and Ringkøbing Fjord. Further north along the west coast of Jutland, Common Scoters are observed in much lower densities. Therefore the planned near-shore wind farms Vesterhavet Syd and Vesterhavet Nord are expected to affect much lower numbers of Common Scoters.

Based on the results of impact assessment for the Horns Rev 3 OWF and other studies showing Common Scoters using offshore wind farms at least after some years of operation there are no significant cumulative impacts predicted for this species.

4.8. Summary of impact assessment

4.8.1 Temporary effects

Temporary impacts are only considered to occur during the construction period (and decommission period which is considered to result in similar impacts to resting birds as the construction period). During the construction period temporary effects on resting birds are predicted from disturbances and secondary effects from changes in benthic and fish communities. The impacts from habitat changes are predicted to be low for all resting birds. Larger effects are predicted to result from the pressure disturbance from construction activities, which results in displacement of sensitive birds from the disturbed areas. However, construction activities are expected to be restricted to a relatively small area at a time, thus the actually disturbed area is smaller than the total area predicted to be disturbed over the construction period. With progress of the installation works also disturbances from wind farm structures will add to the disturbances from construction activities, thus disturbance effects are predicted to increase over the construction period to the level predicted for the operation phase.

4.8.2 Permanent effects

Permanent impacts, i.e. impacts which are expected to last over the project life time, from the Horns Rev 3 OWF are only expected from structures and operation of the wind farm. Foundations and scour protection structures will result in permanent loss of marine habitats. However, the areas affected from the loss are very small compared to the available area, thus the Severity of Impact from habitat loss is predicted to be low for all resting birds. The Horns Rev 3 OWF results in permanent habitat changes in terms of provision of artificial reefs and other changes of benthic and fish communities which are relevant for bird species relying on benthic organism and fish as prey. Impacts on benthic communities and habitats and fish are predicted to either being small-scale or low, thus impacts on resting birds are assessed being low. Some habitat changes as introducing of artificial roosts or changed food supply in artificial reefs may result in attraction of some waterbird species.

The most relevant permanent pressure with regard to resting birds is the pressure 'disturbance from structures and operation'. Waterbird species being sensitive to disturbances, such as for example divers, auks and scoters, are predicted to be displaced from the disturbed areas which equals to a loss of function of the habitat to the affected birds. However, for some species habituation may reduce the impact as disturbed habitats may be used eventually to some extent by some species after some years of operation.

Collisions with structures and rotating blades of turbines is a relevant and permanent pressure with regard to flying birds and as such also relevant to resting birds conducting flights within or between their resting and foraging sites. This pressure is assessed as part of the impact assessment on migrating birds and thus not further assessed in this report.

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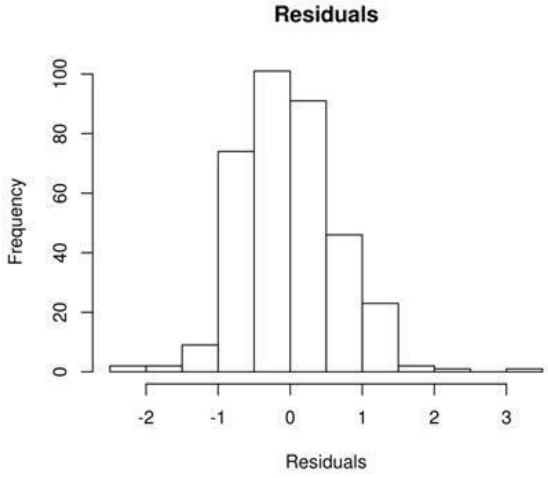
APPENDIX

Model diagnostic plots

a)



b)

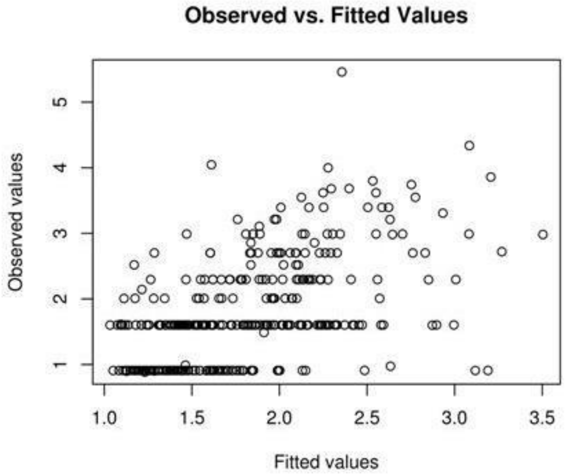


Figure 0.1 Diagnostic plots for the positive part of the two-part random Forest model for divers. A histogram of the residuals is displayed in (a) and the fitted against the observed values are displayed in (b).

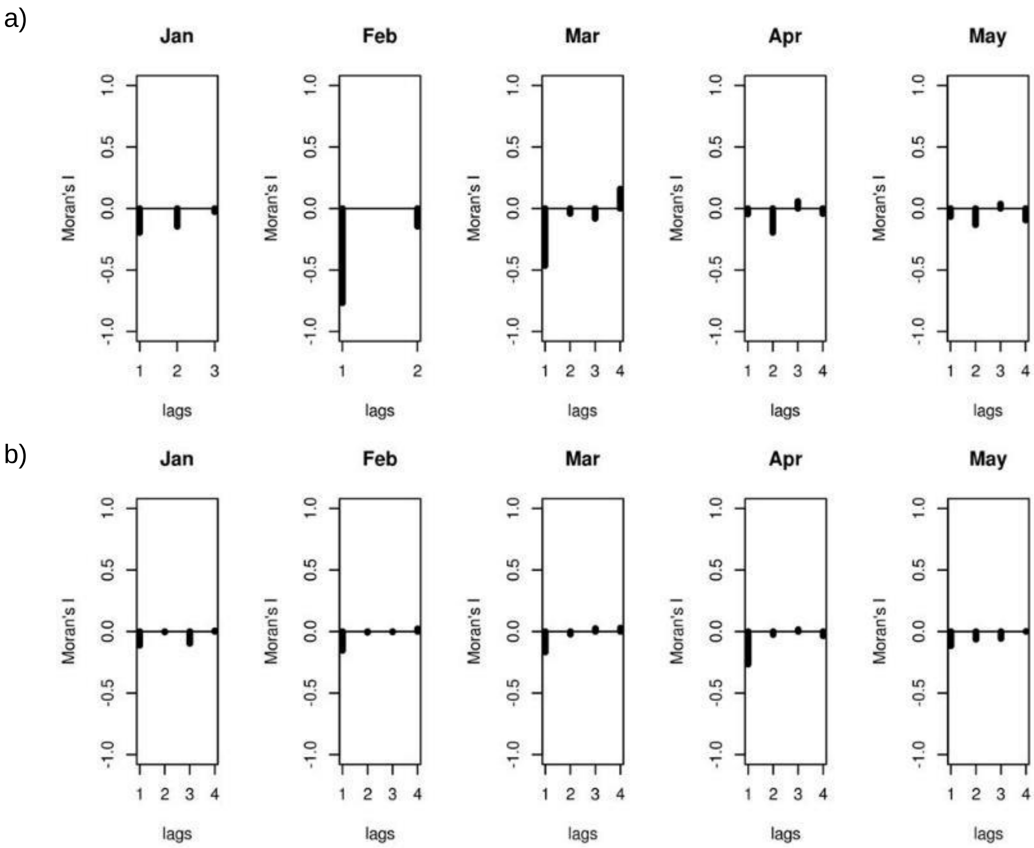


Figure 0.2 Spatial correlograms displaying the spatial autocorrelation in the residuals for the two-part Random Forest model for divers (a) indicates the positive part and b) indicates the presence and absence part). The bars show twice the square root of the variance from the estimated Moran's I value. 1 lag equals the defined nearest neighborhood of 20,000 meters.

Table 0.1 Test statistics for Moran I for the diver model. None of the tests revealed the presence of spatial autocorrelation. All P-values were > 0.05.

Month	Positive	Presence/Absence
January	-0.12	-0.53
February	0.29	-0.96
March	-1.36	-1.11
April	0.12	-1.18
May	0.20	-0.53

List of all observed birds during Horns Rev 3 aerial surveys

Table 0.2 Actually counted numbers of birds of all species during aerial surveys between January 2013 and November 2013. Presented are numbers of birds recorded by both main observers in valid conditions.

Species	Aerial survey									
	16/01/13	13/02/13	04/03/13	01/04/13	07/05/13	05/06/13	06/07/13	22/08/13	13/09/13	17/11/13
Red-throated Diver										41
Black-throated Diver										4
Divers (Red-throated Diver / Black-throated Diver)	80	44	119	257	370		2	13	28	64
Fulmar						5	4	3	1	11
Gannet	1	1		11	11	5	8	21	39	1
Great Cormorant								1		
Greylag Goose			48							
Mallard										6
Common Eider	12	973	323	4			22			1
Common Scoter	3,797	16,498	5,838	4,968		430	1,099	299	178	417
Velvet Scoter	2		96	308				1		2
Seaduck unidentified	30							20		
Curlew					14					
Wader unidentified								6		
Great Skua								1	3	
Skua unidentified								1		
Little Gull	15	25	45	12	9	1	20	12		18
Black-headed Gull		1	4	7	37	1	7	5	521	100

Species	Aerial survey									
	16/01/13	13/02/13	04/03/13	01/04/13	07/05/13	05/06/13	06/07/13	22/08/13	13/09/13	17/11/13
Common Gull	25	78	29	18	5	27	2	5	67	114
Lesser Black-backed Gull			6	2	11	75	425	35	16	
Herring Gull	46	33	17	26	48	27	23	120	513	601
Great Black-backed Gull	2		3	1		4	1	2	9	17
Kittiwake	25	3	7		1	7	14	1	2	31
Small Gull unidentified					1		1	1		
Large Gull unidentified		1	16	6	135	1	3	7	1	
Gull unidentified	1,069	45	538	20	5	233	521	215	180	37
Sandwich Tern					77		9	22	5	
Common / Arctic Tern					1		3	51	18	
Little Tern								1		
Tern unidentified					88	2	6	32	5	
Common Guillemot										217
Razorbill									1	43
Common Guillemot / Razorbill	61	14	26	14			9	4	31	94
Black Guillemot				1						
Skylark			3	3						
Passerine unidentified			1	6	7			1		

Comparison of density estimates from aerial surveys using two different methods

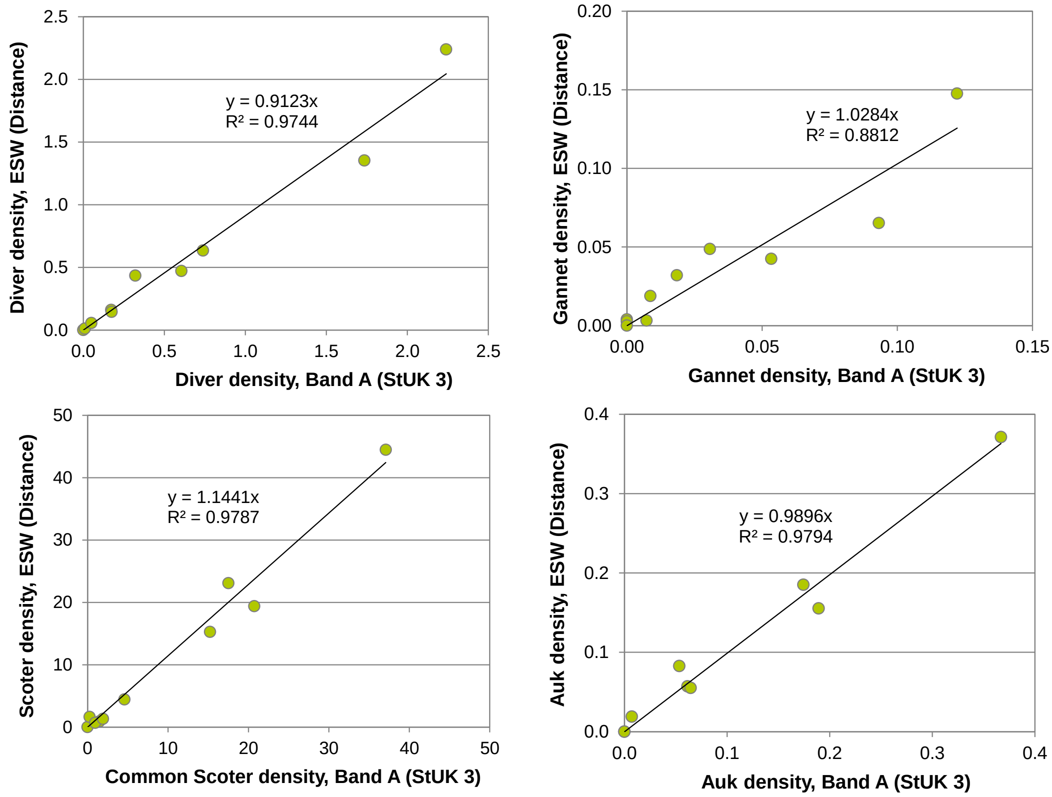


Figure 0.3 Bird densities observed in band-A of aerial transects correspond closely to densities calculated using Distance analysis approach: plots for four species (groups) common in the Horns Rev area: divers, Gannet, Common Scoter and auks).

Distribution maps from aerial surveys

Divers (Red-throated Diver/Black-throated Diver)

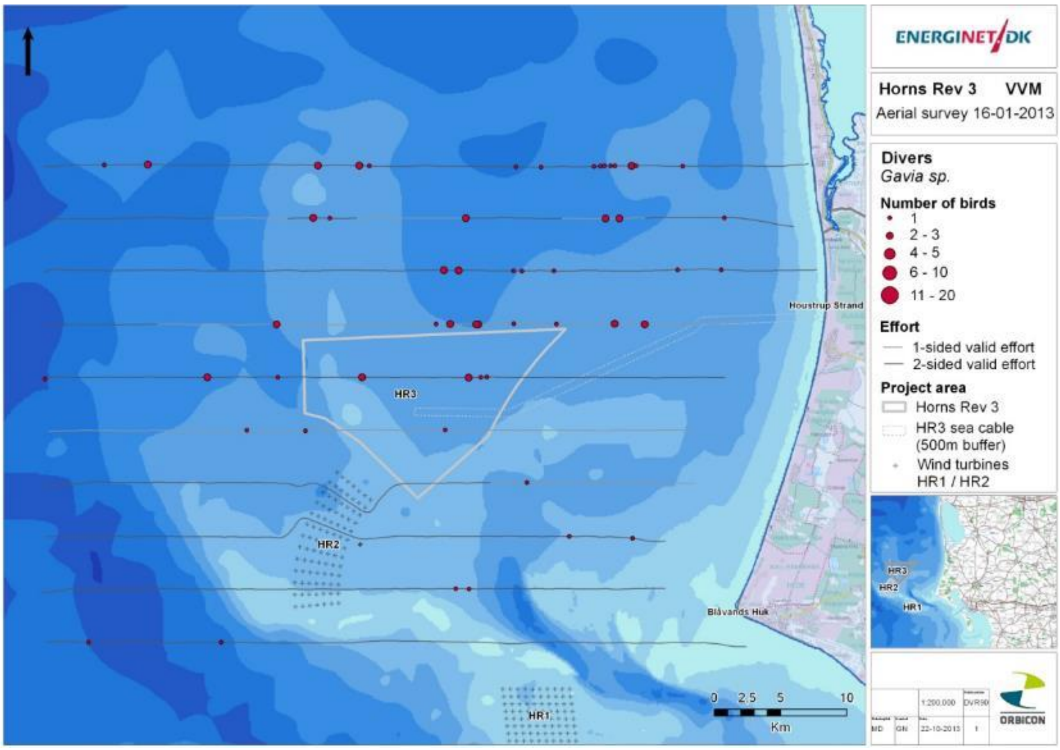


Figure 0.4 Observed diver distribution (Red-throated Diver/Black-throated Diver) during the aerial survey on 16-01-2013.

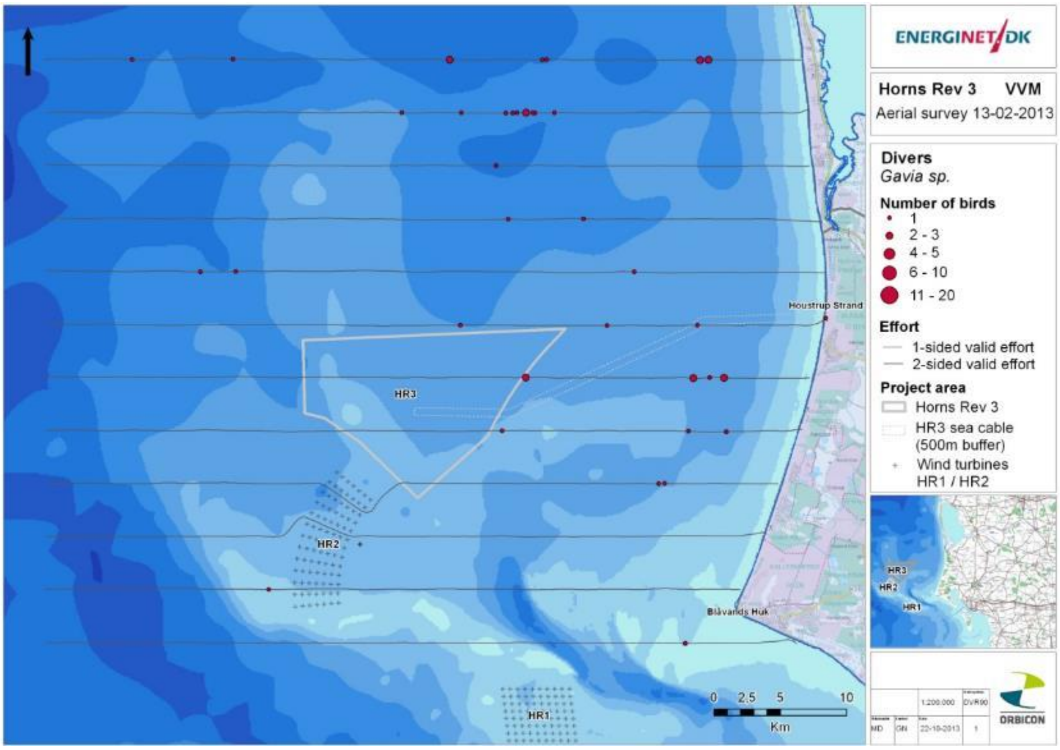


Figure 0.5 Observed diver distribution (Red-throated Diver/Black-throated Diver) during the aerial survey on 13-02-2013.

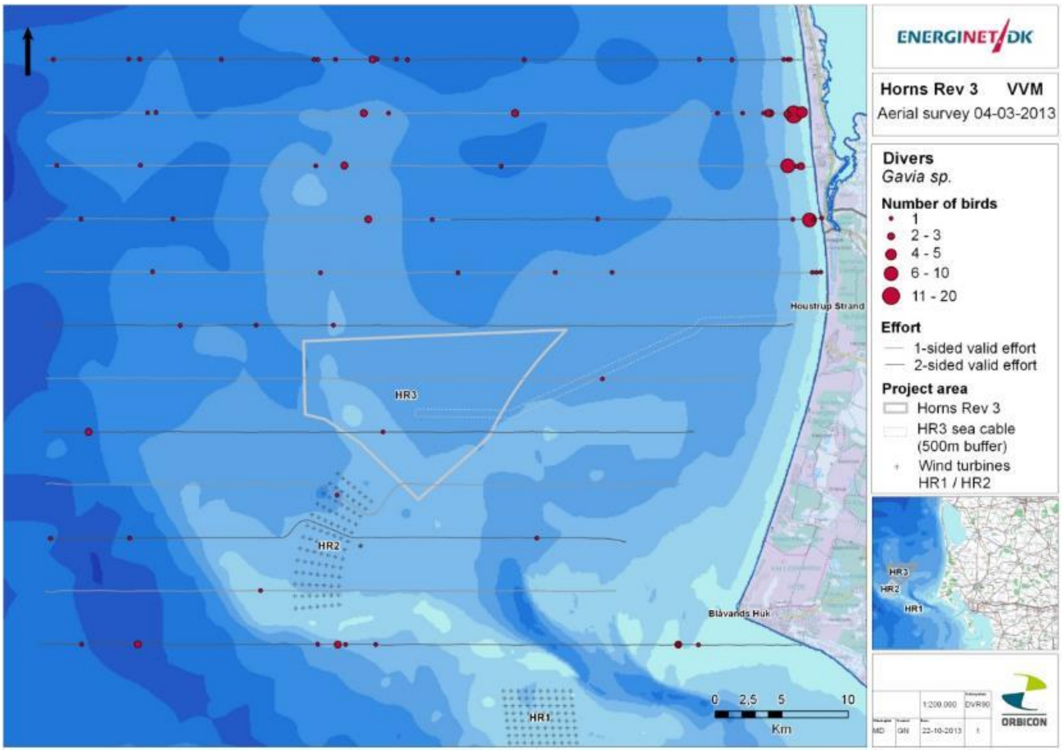


Figure 0.6 Observed diver distribution (Red-throated Diver/Black-throated Diver) during the aerial survey on 04-03-2013.

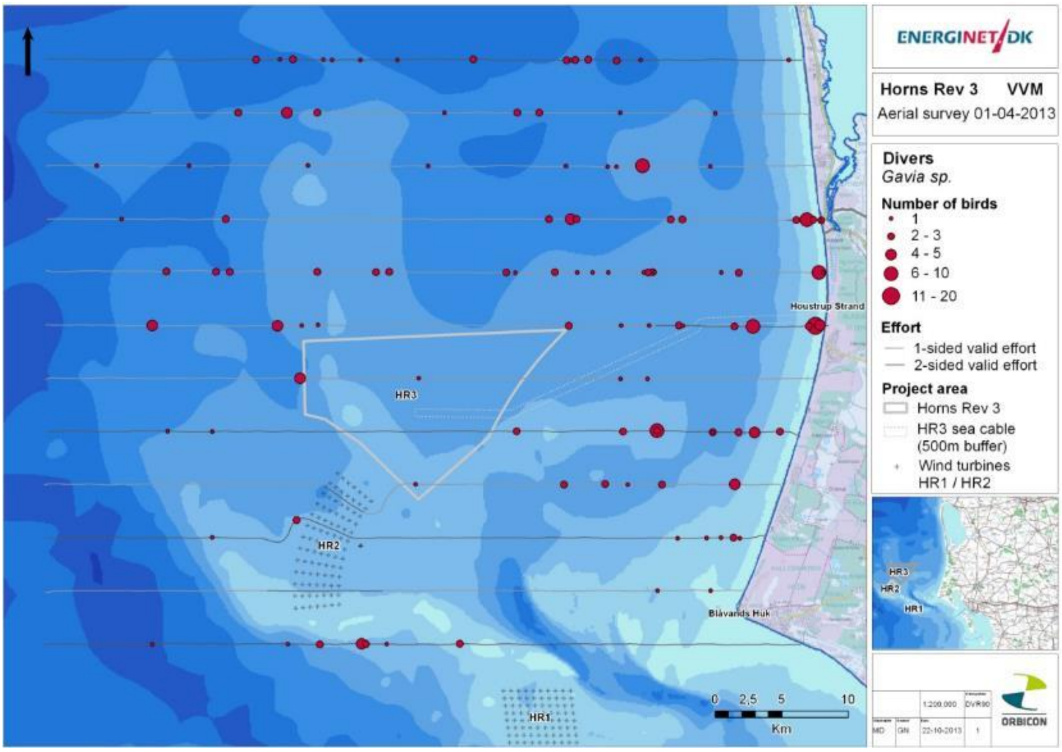


Figure 0.7 Observed diver distribution (Red-throated Diver/Black-throated Diver) during the aerial survey on 01-04-2013.

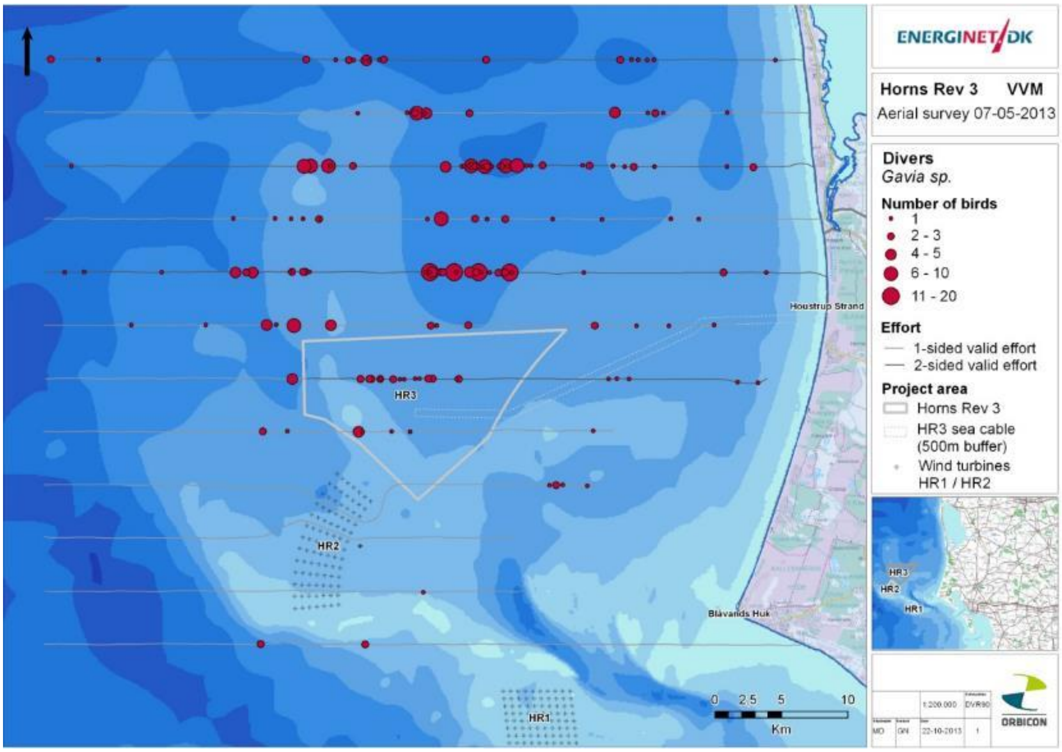


Figure 0.8 Observed diver distribution (Red-throated Diver/Black-throated Diver) during the aerial survey on 07-05-2013.

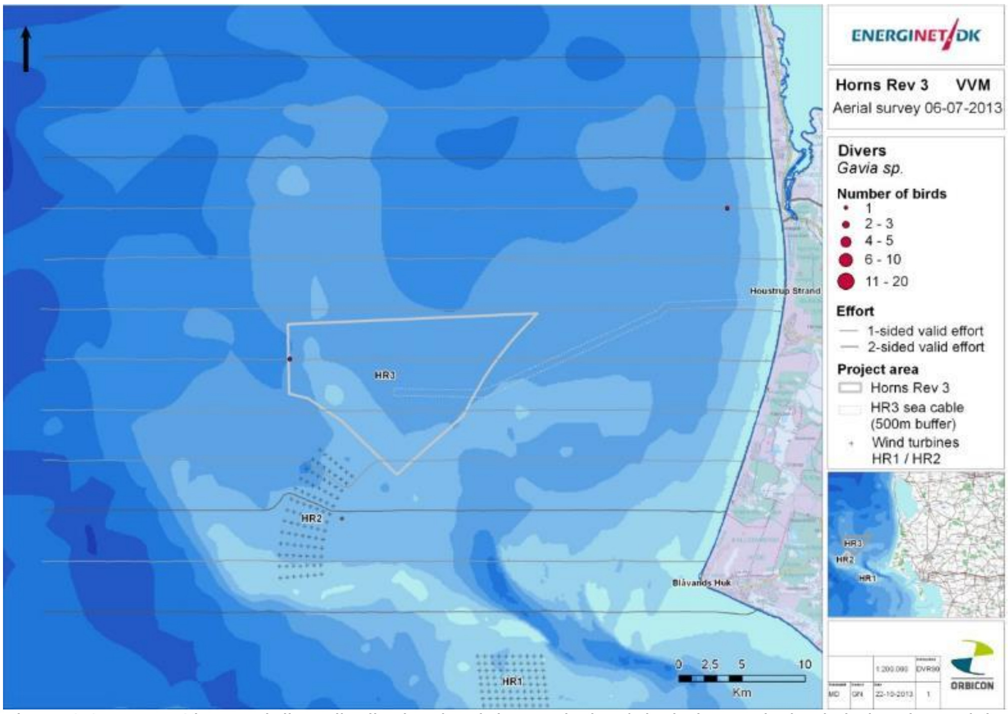


Figure 0.9 Observed diver distribution (Red-throated Diver/Black-throated Diver) during the aerial survey on 06-07-2013.

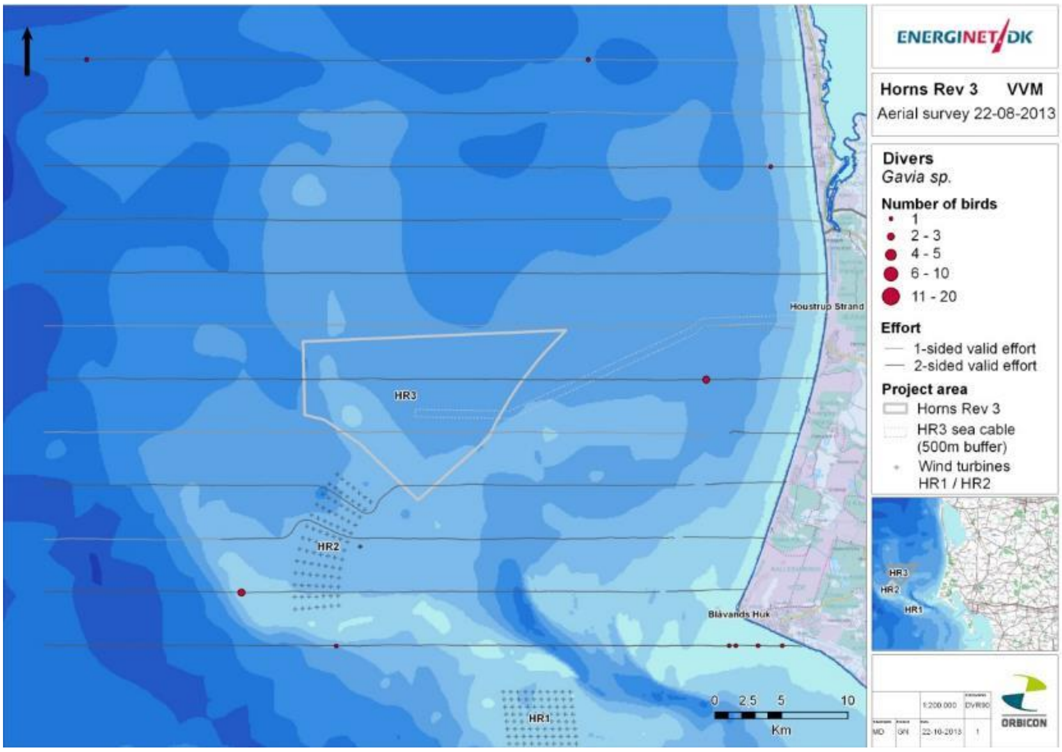


Figure 0.10 Observed diver distribution (Red-throated Diver/Black-throated Diver) during the aerial survey on 22-08-2013.

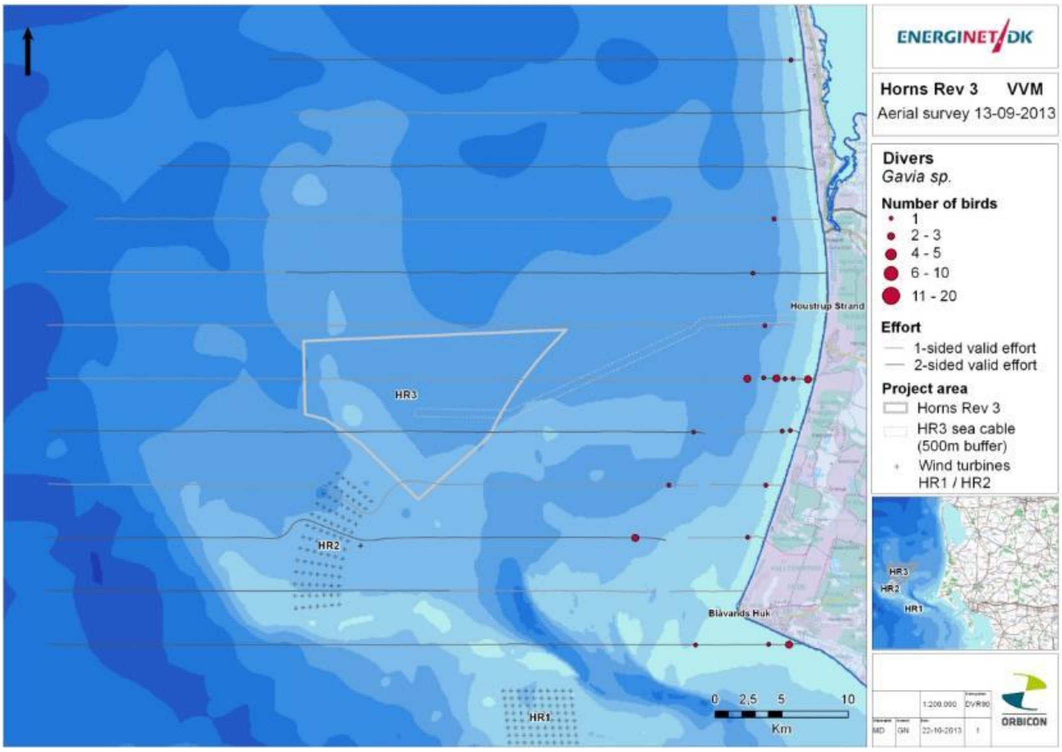


Figure 0.11 Observed diver distribution (Red-throated Diver/Black-throated Diver) during the aerial survey on 22-08-2013.

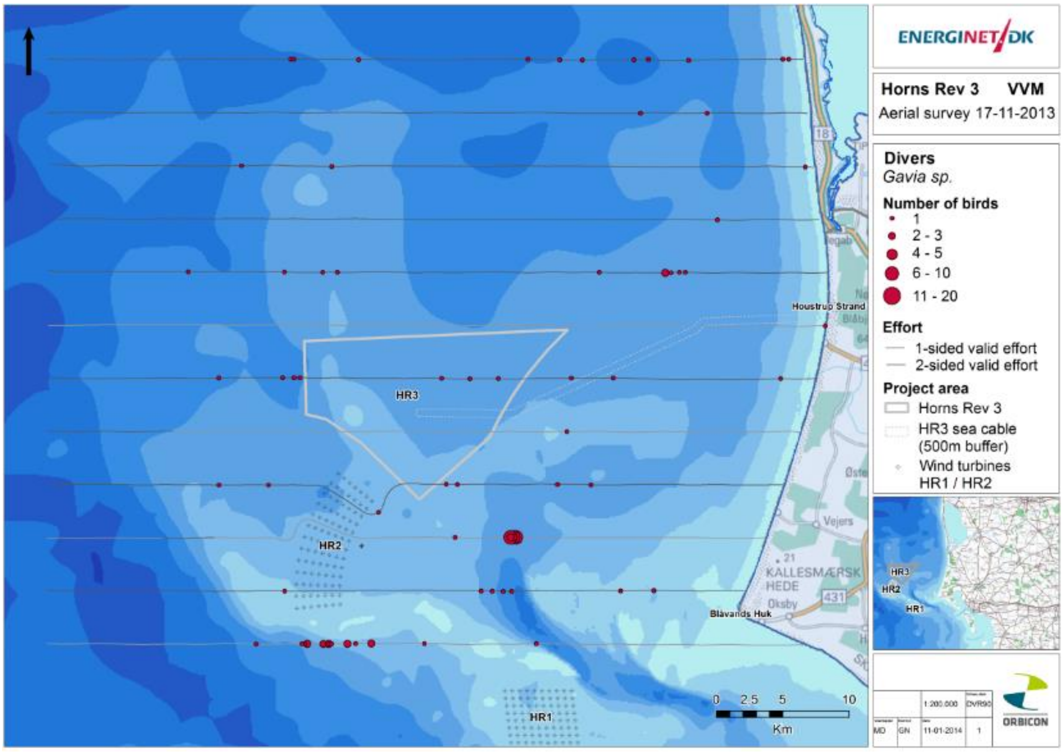


Figure 0.12 Observed diver distribution (Red-throated Diver/Black-throated Diver) during the aerial survey on 17-11-2013.

Gannet / Fulmar

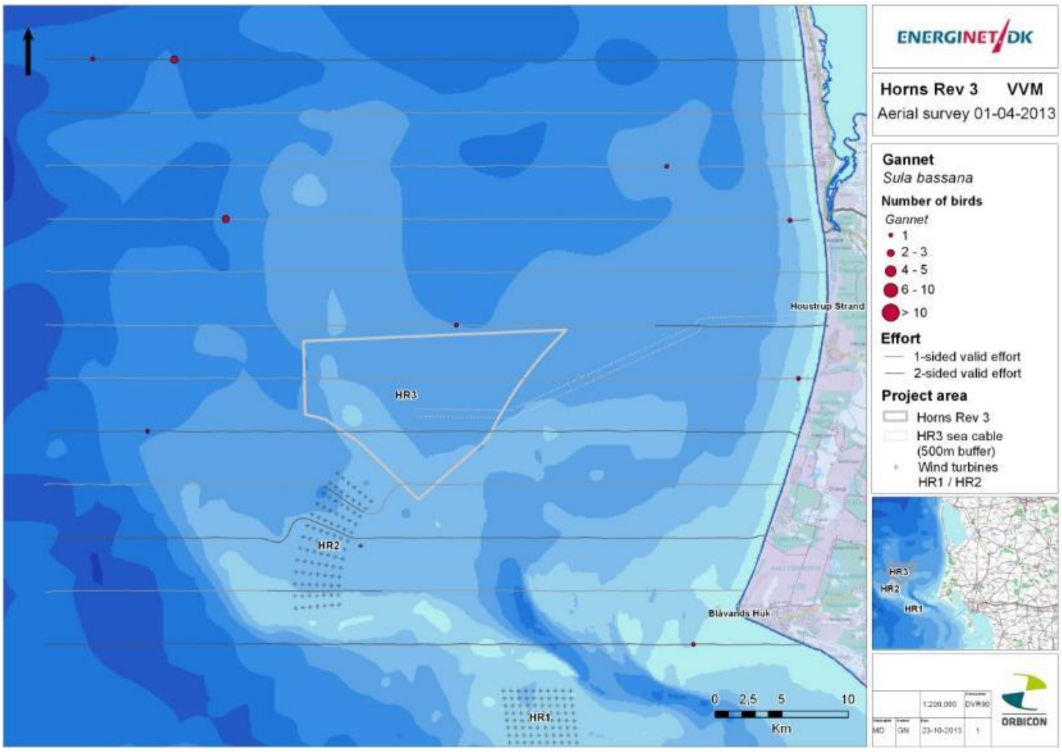


Figure 0.13 Observed Gannet distribution during the aerial survey on 01-04-2013.

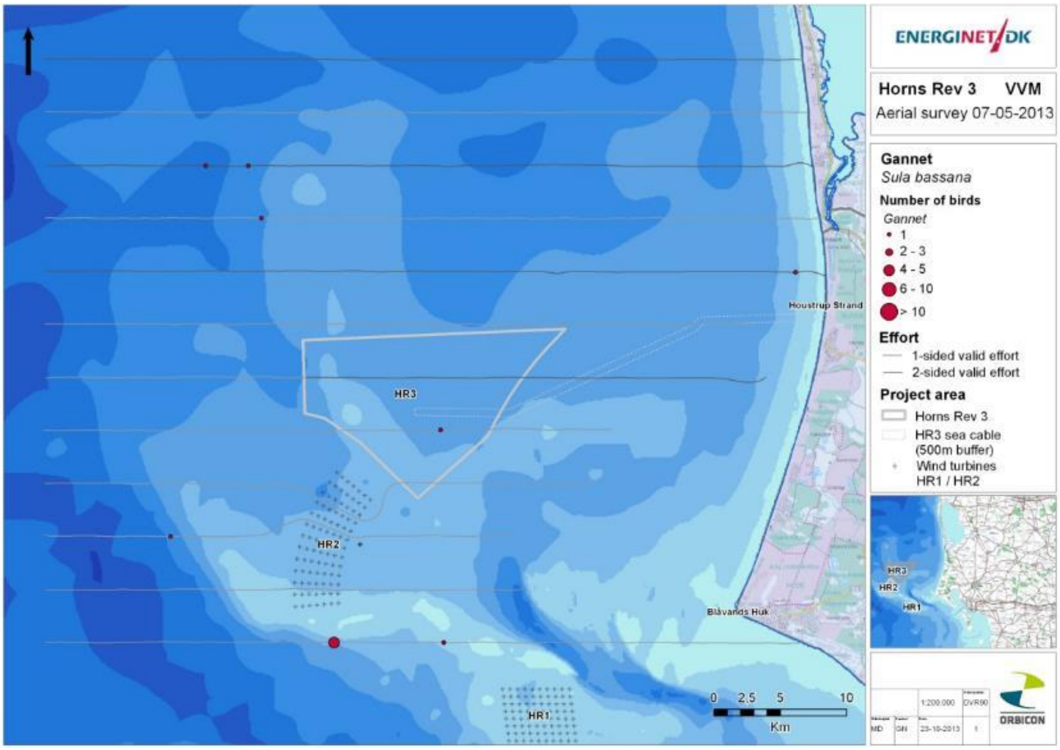


Figure 0.14 Observed Gannet distribution during the aerial survey on 07-05-2013.

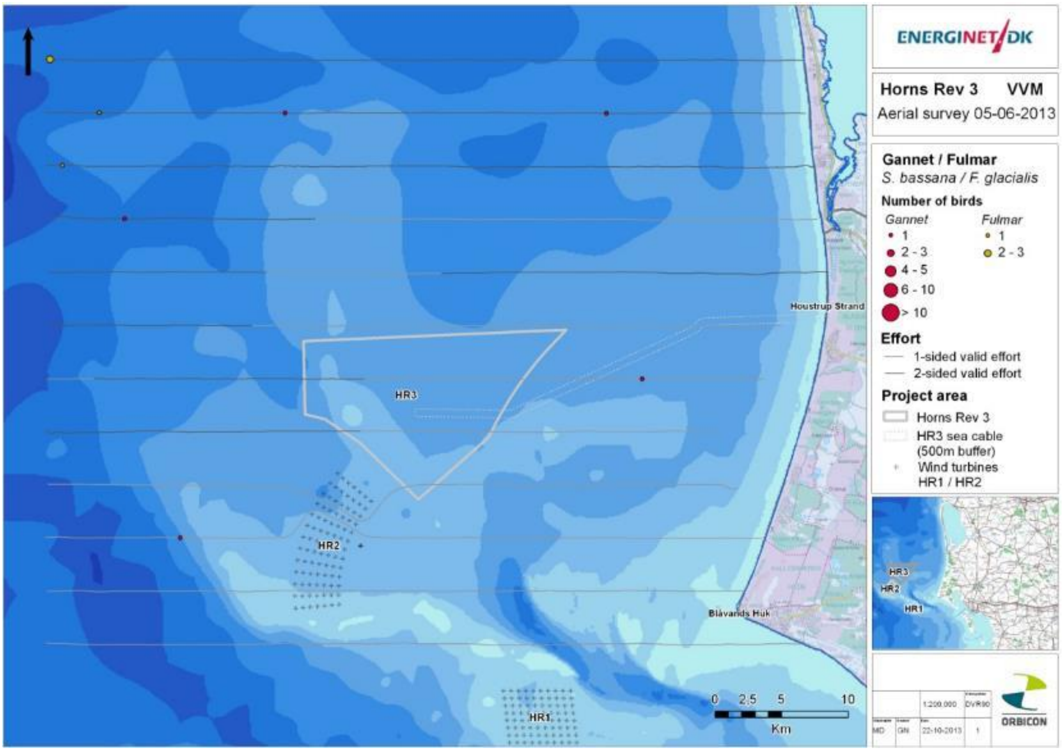


Figure 0.15 Observed Gannet and Fulmar distributions during the aerial survey on 05-06-2013.

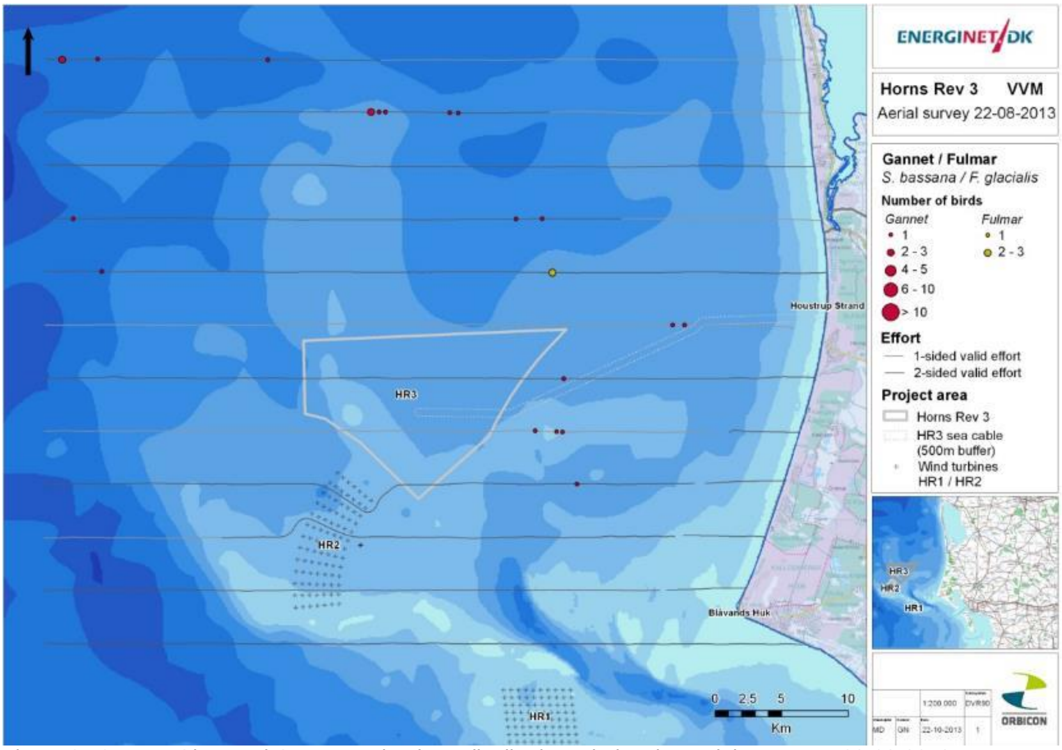


Figure 0.16 Observed Gannet and Fulmar distributions during the aerial survey on 22-08-2013.

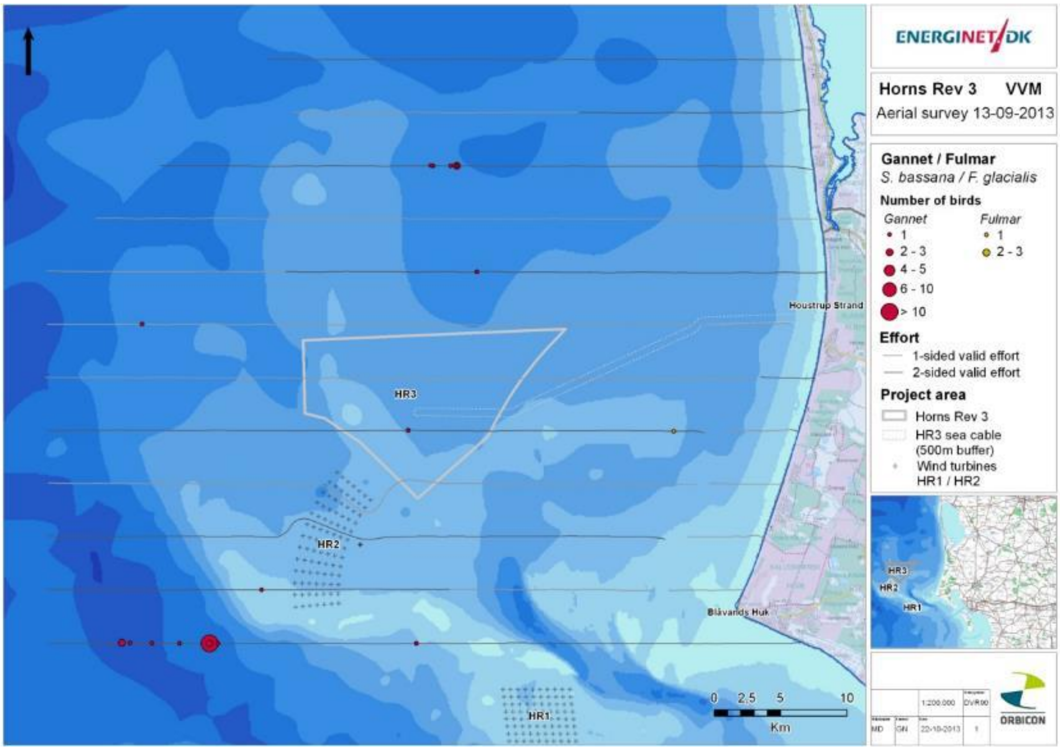


Figure 0.17 Observed Gannet and Fulmar distributions during the aerial survey on 13-09-2013.

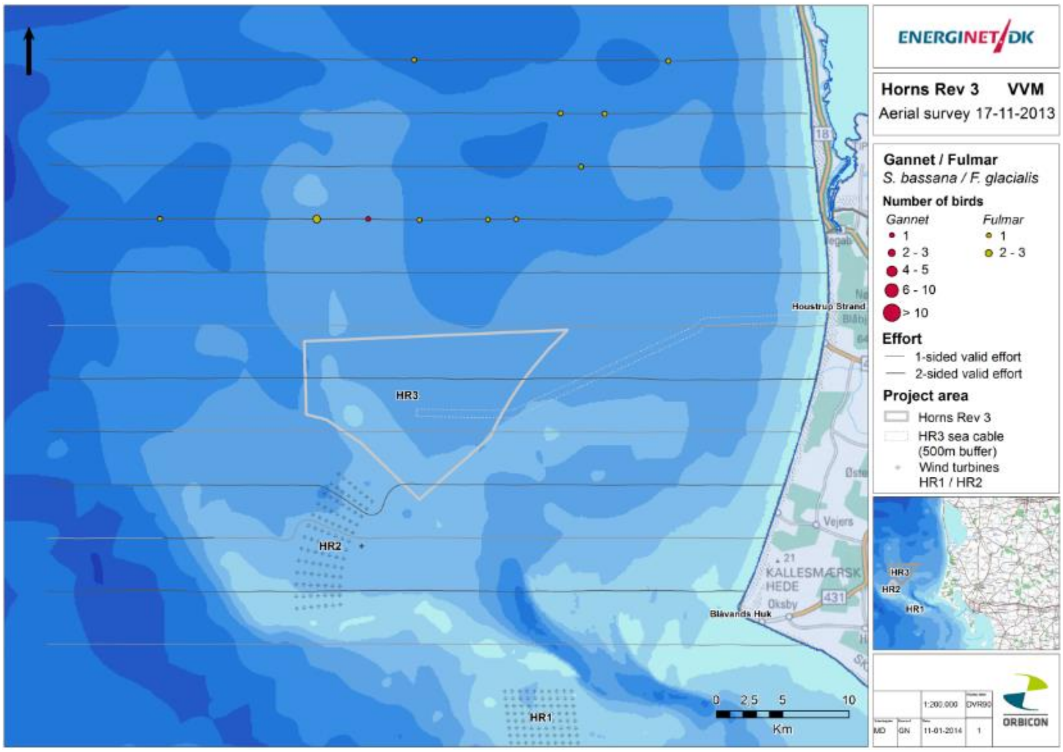


Figure 0.18 Observed Gannet and Fulmar distributions during the aerial survey on 17-11-2013.

Common Eider

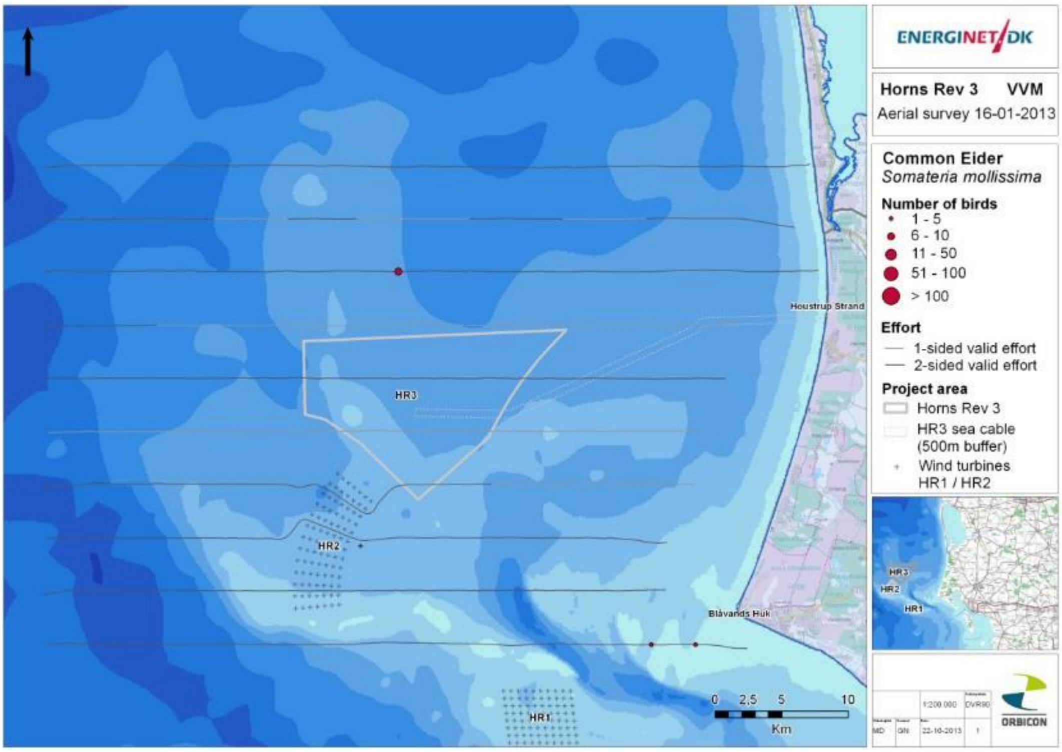


Figure 0.19 Observed Common Eider distribution during the aerial survey on 16-01-2013.

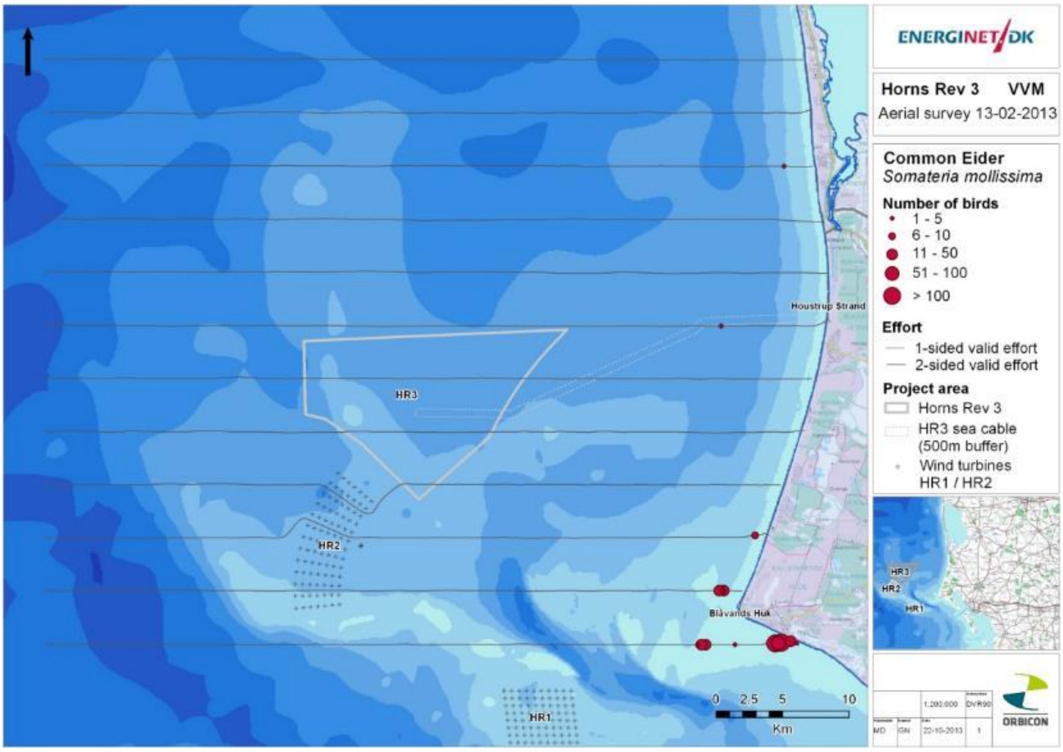


Figure 0.20 Observed Common Eider distribution during the aerial survey on 13-02-2013.

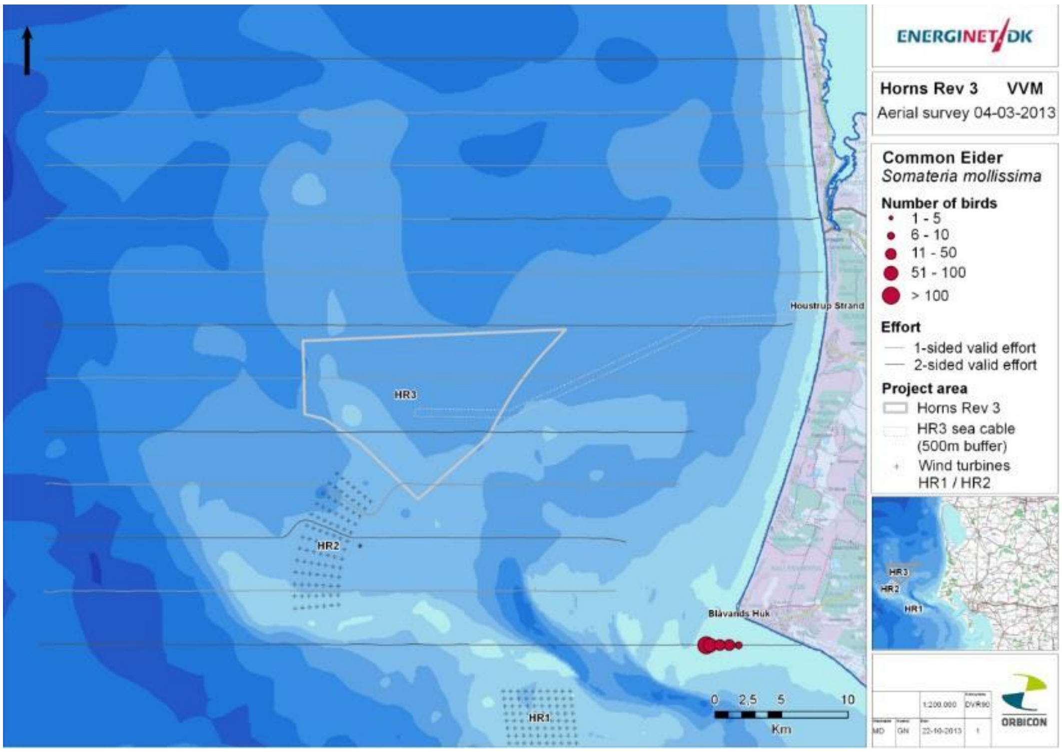


Figure 0.21 Observed Common Eider distribution during the aerial survey on 04-03-2013.

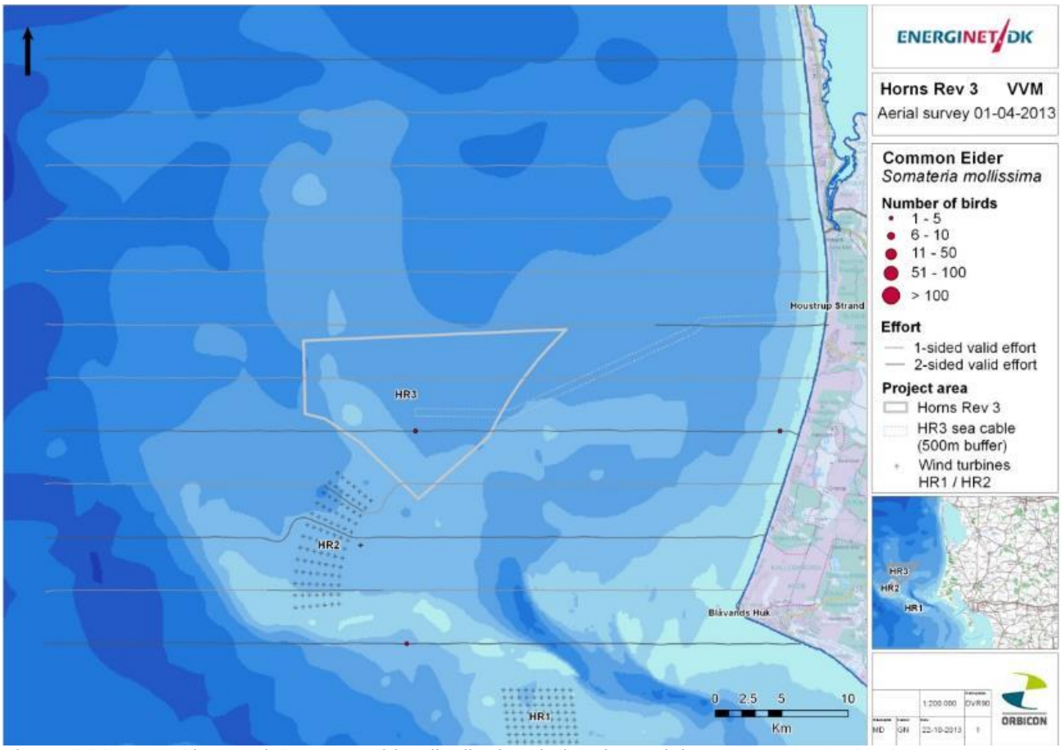


Figure 0.22 Observed Common Eider distribution during the aerial survey on 01-04-2013.

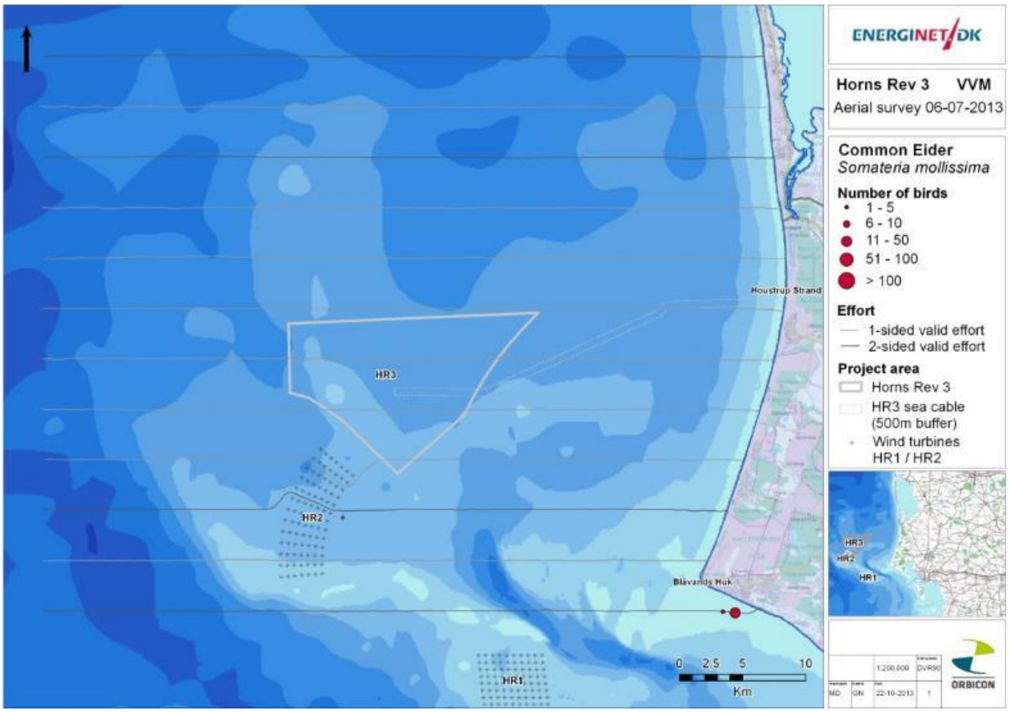


Figure 0.23 Observed Common Eider distribution during the aerial survey on 06-07-2013.

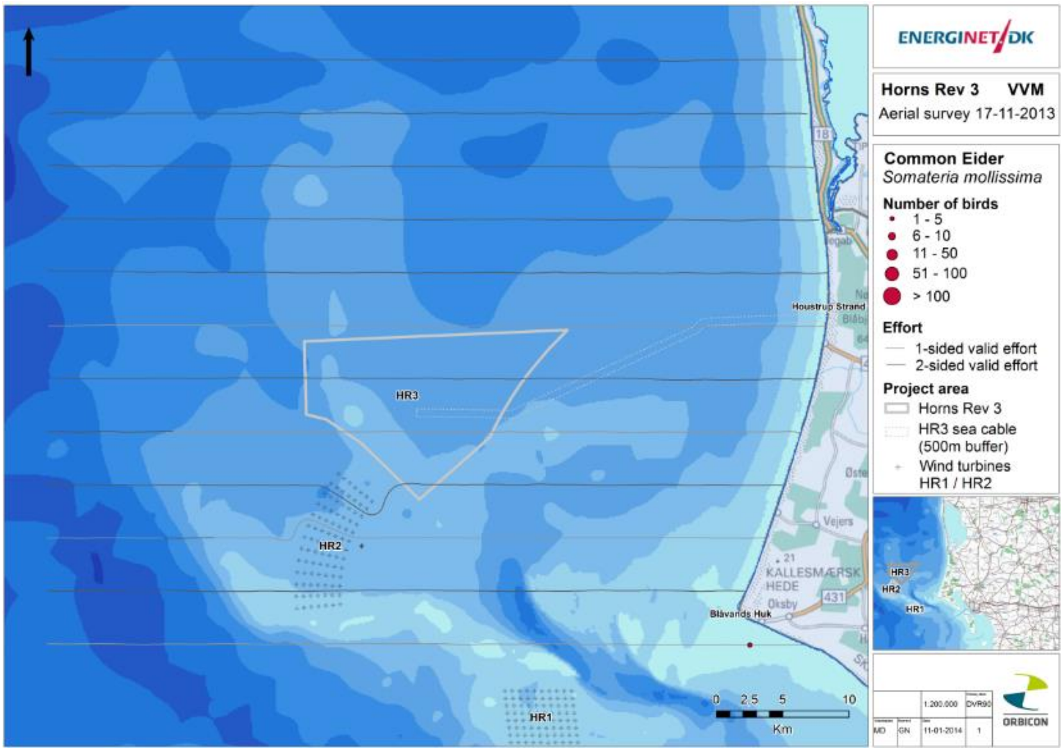


Figure 0.24 Observed Common Eider distribution during the aerial survey on 17-11-2013.

Scoters (Common Scoter/Velvet Scoter)

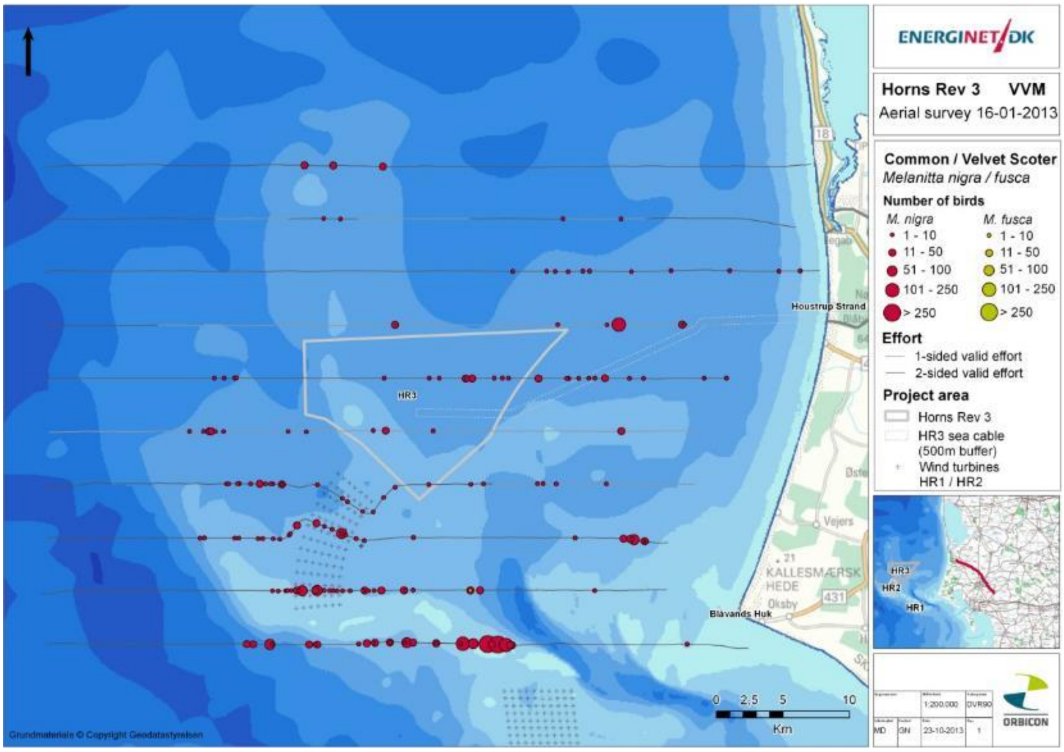


Figure 0.25 Observed scoter distribution (Common Scoter and Velvet Scoter) during the aerial survey on 16-01-2013.

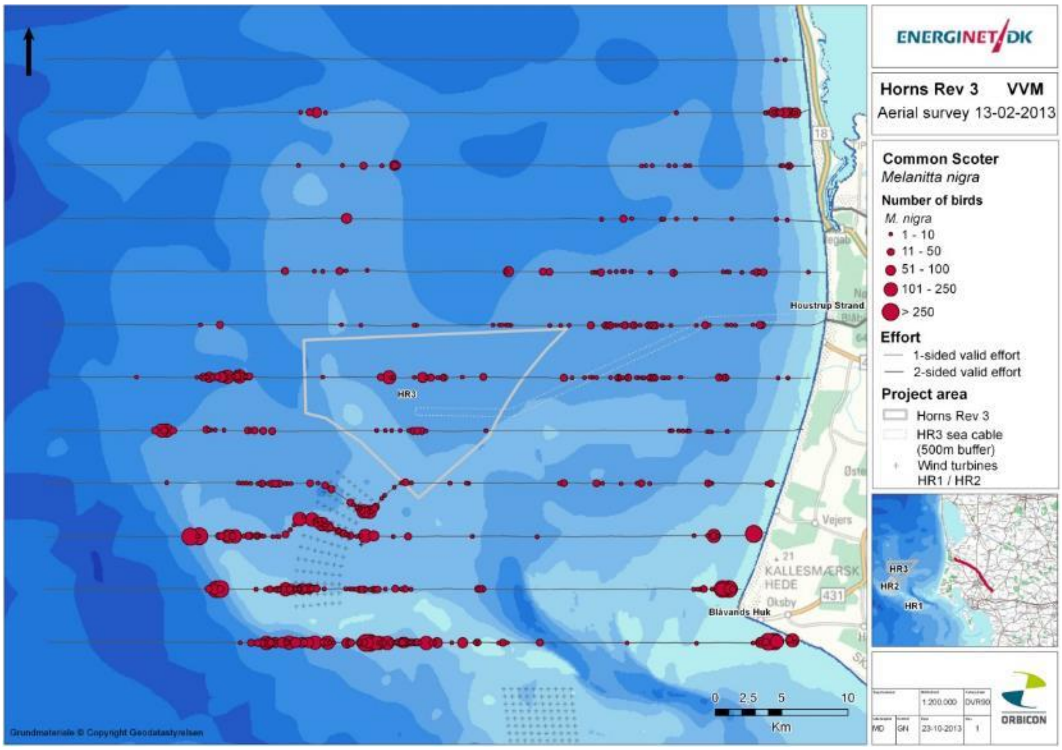


Figure 0.26 Observed Common Scoter distribution during the aerial survey on 13-02-2013.

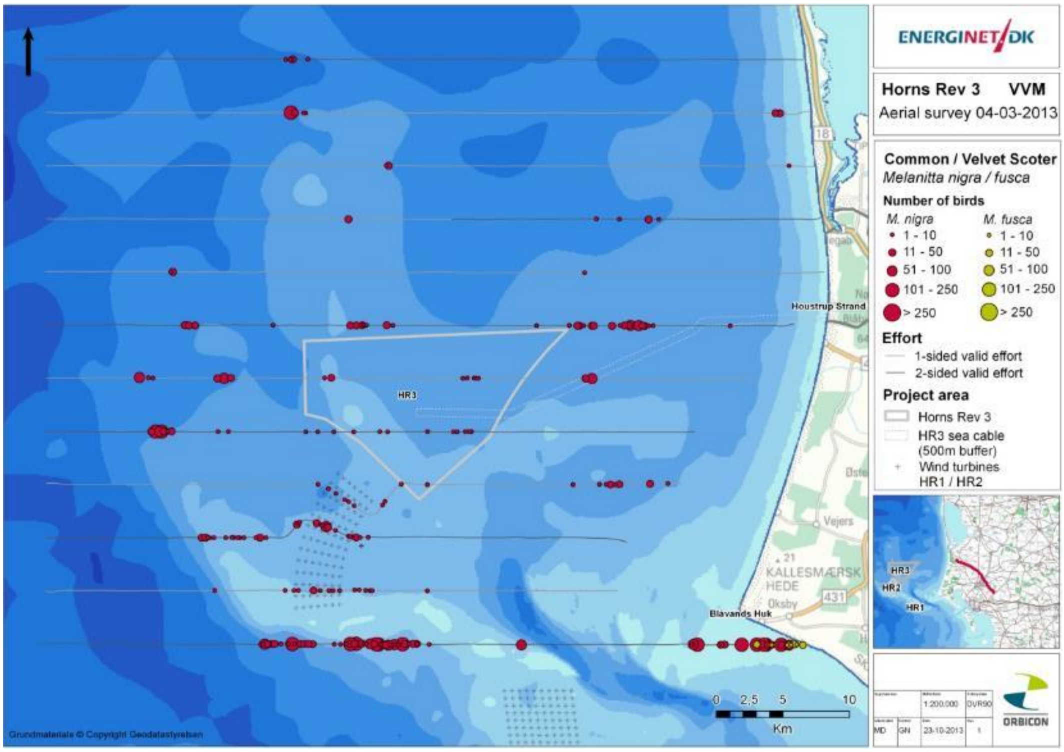


Figure 0.27 Observed scoter distribution (Common Scoter and Velvet Scoter) during the aerial survey on 04-03-2013.

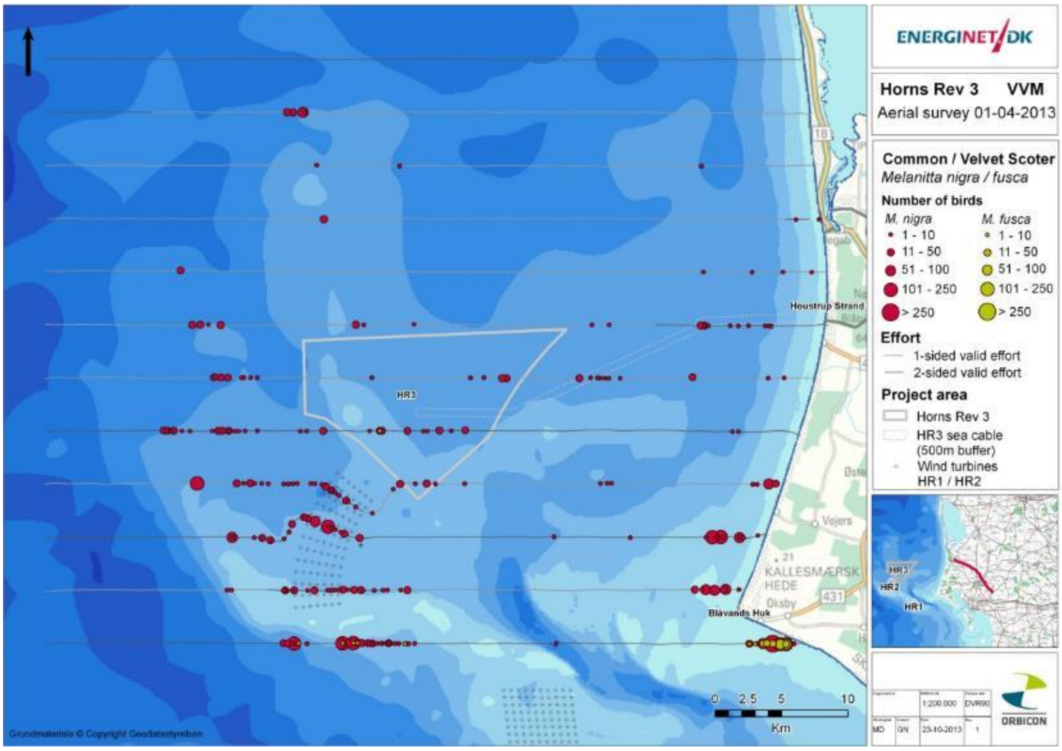


Figure 0.28 Observed scoter distribution (Common Scoter and Velvet Scoter) during the aerial survey on 01-04-2013.

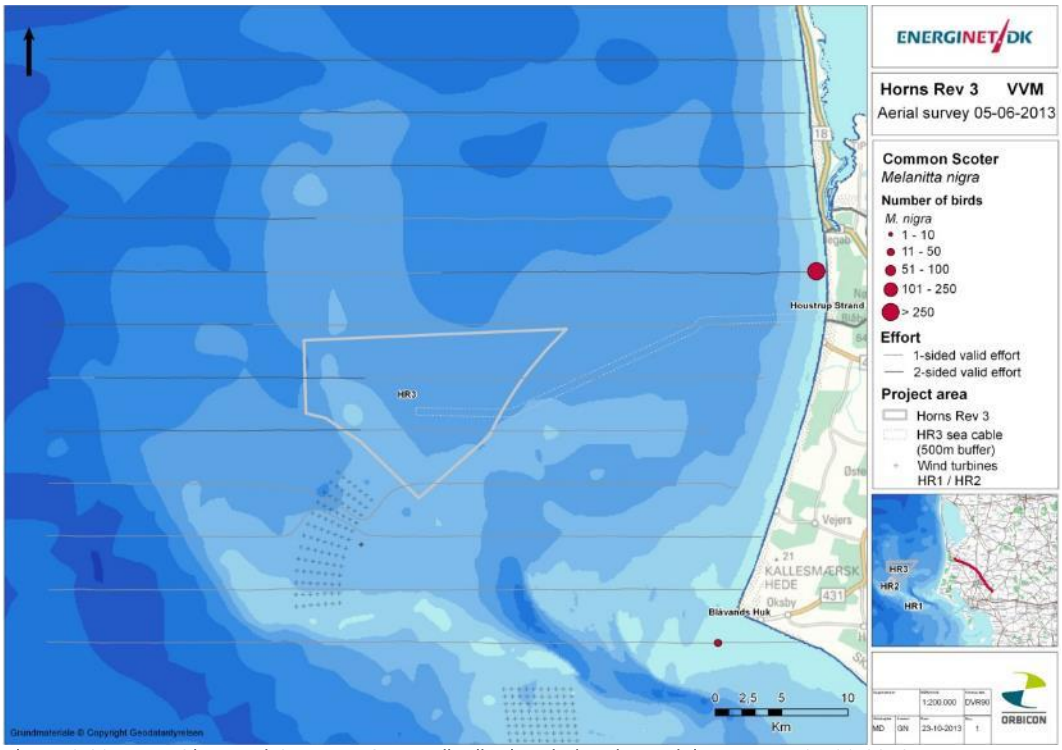


Figure 0.29 Observed Common Scoter distribution during the aerial survey on 05-06-2013.

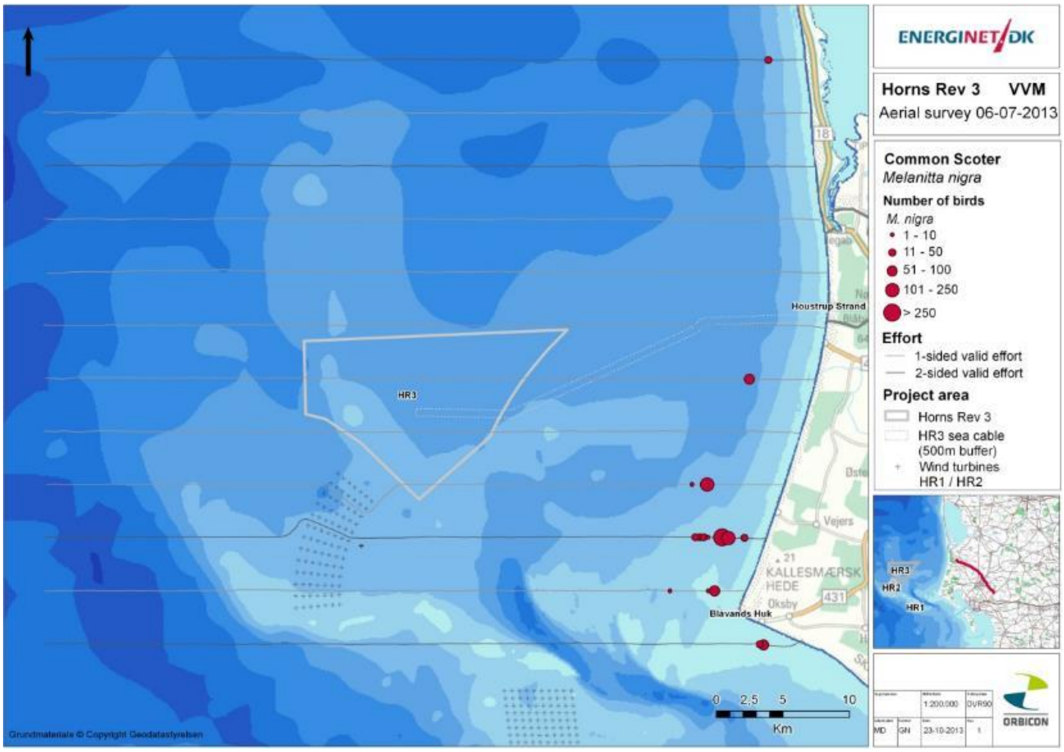


Figure 0.30 Observed Common Scoter distribution during the aerial survey on 06-07-2013.

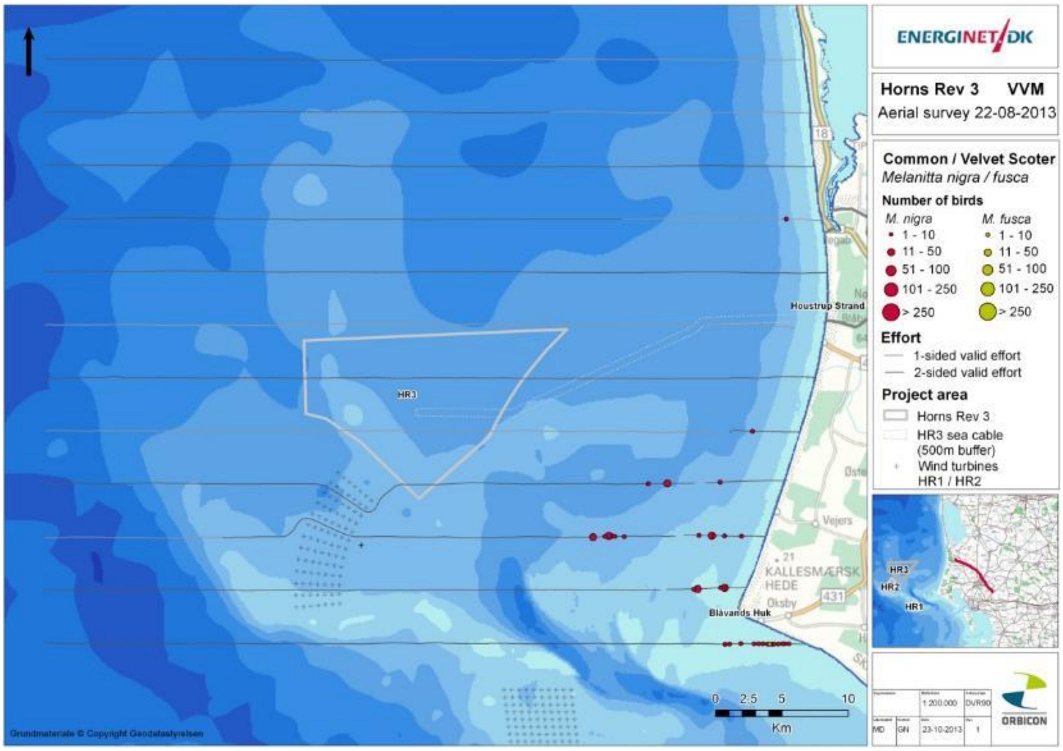


Figure 0.31 Observed scoter distribution (Common Scoter and Velvet Scoter) during the aerial survey on 22-08-2013.

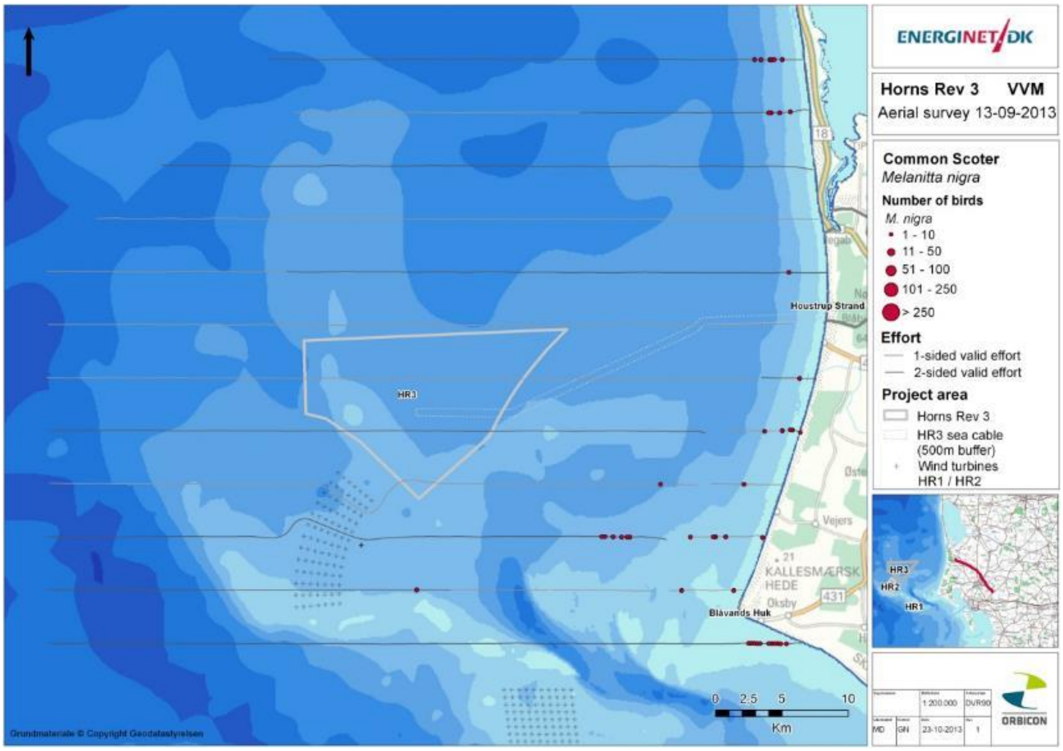


Figure 0.32 Observed Common Scoter distribution during the aerial survey on 13-09-2013.

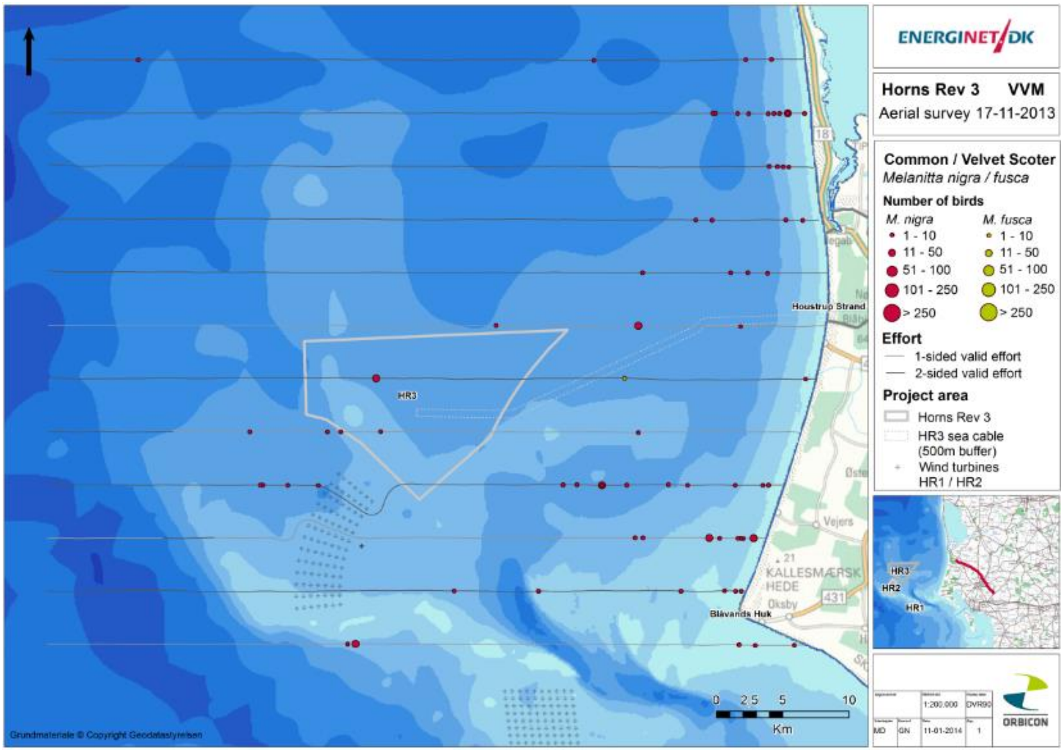


Figure 0.33 Observed scoter distribution (Common Scoter and Velvet Scoter) during the aerial survey on 17-11-2013.

Little Gull

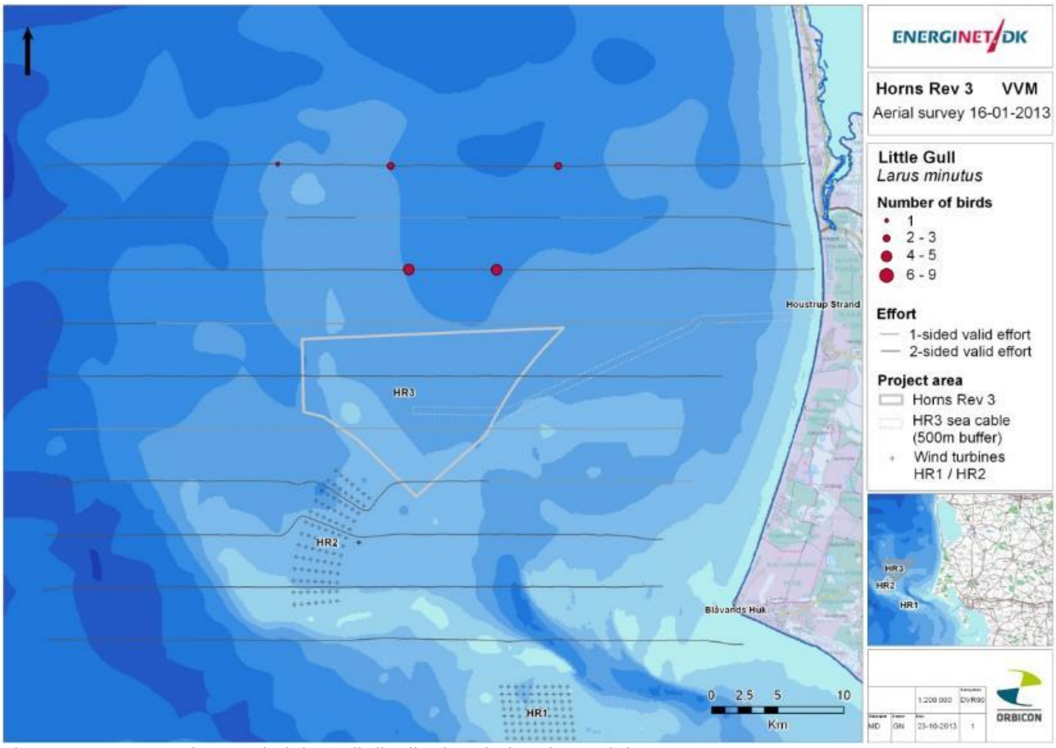


Figure 0.34 Observed Little Gull distribution during the aerial survey on 16-01-2013.

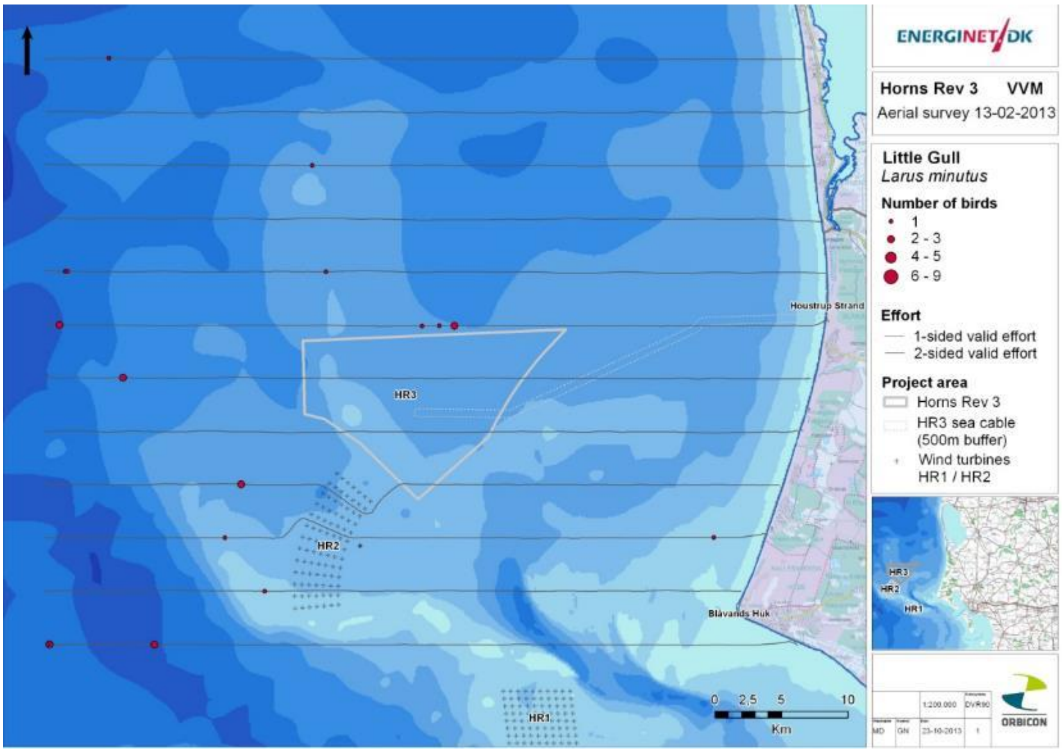


Figure 0.35 Observed Little Gull distribution during the aerial survey on 13-02-2013.

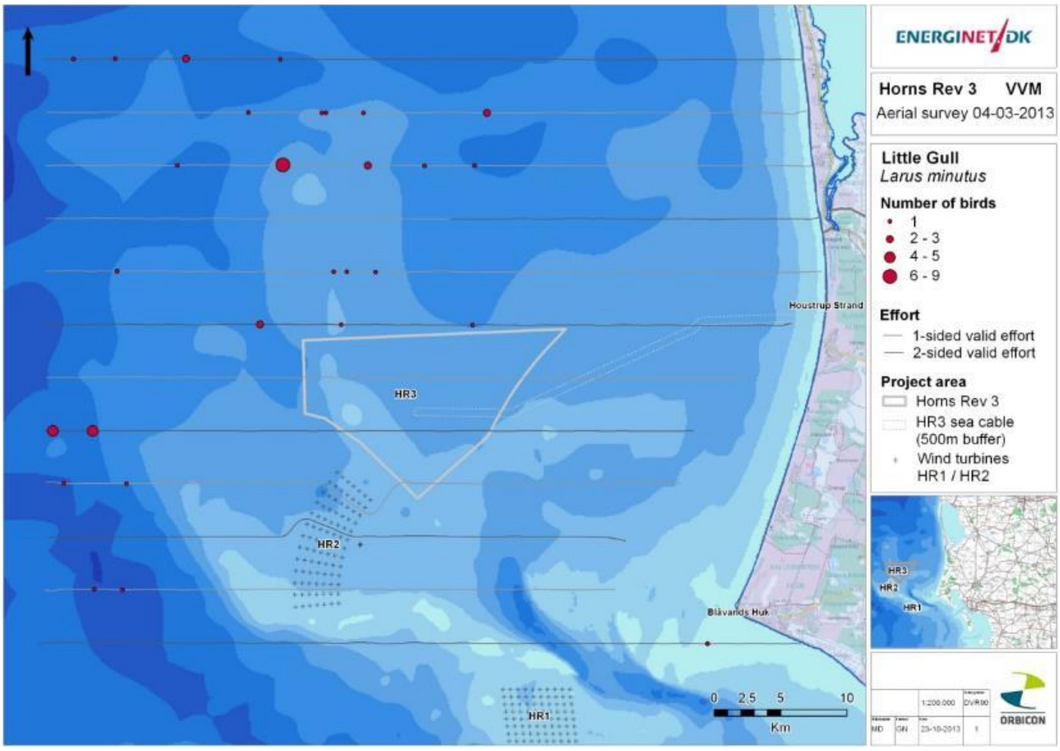


Figure 0.36 Observed Little Gull distribution during the aerial survey on 04-03-2013.

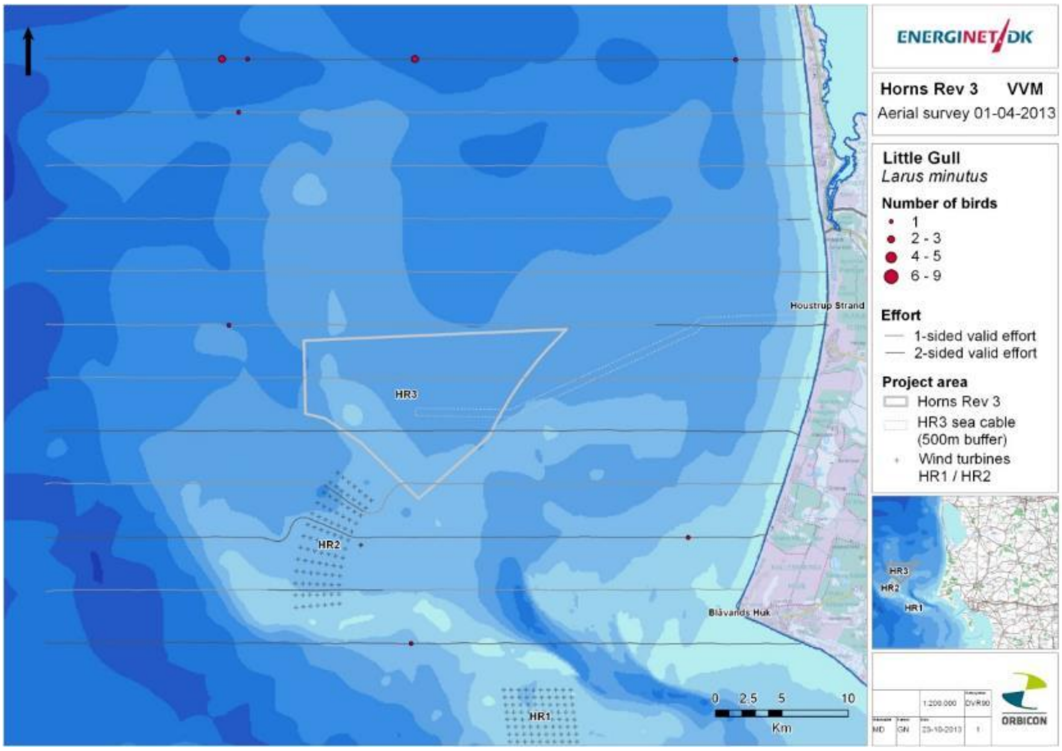


Figure 0.37 Observed Little Gull distribution during the aerial survey on 01-04-2013.

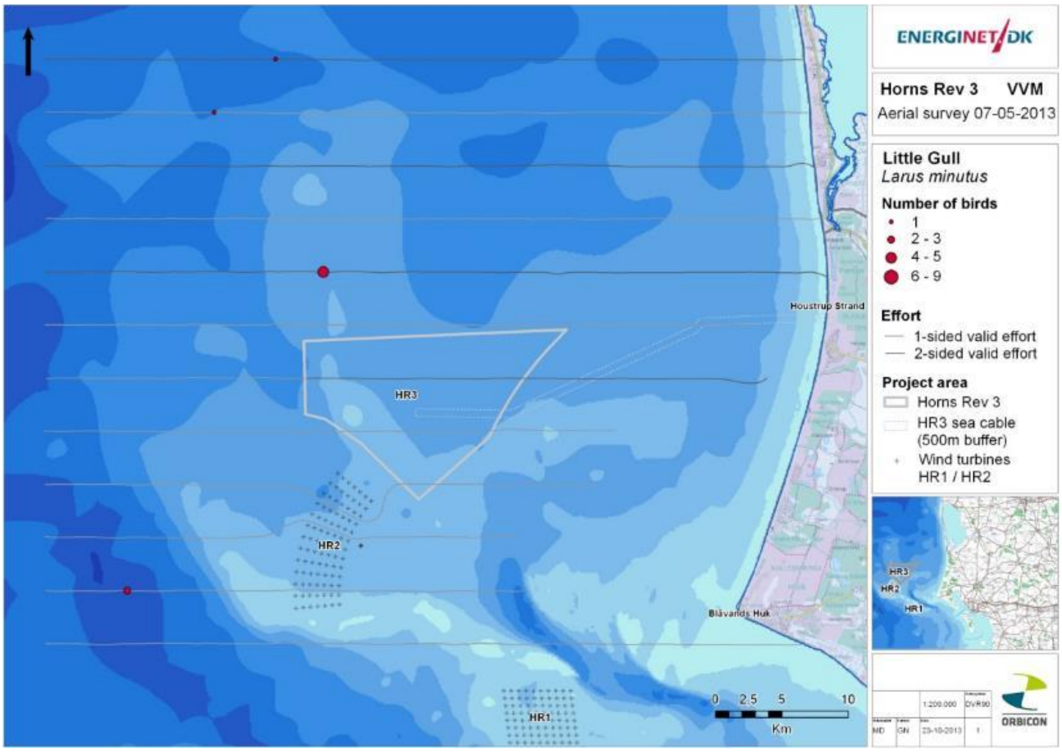


Figure 0.38 Observed Little Gull distribution during the aerial survey on 07-05-2013.

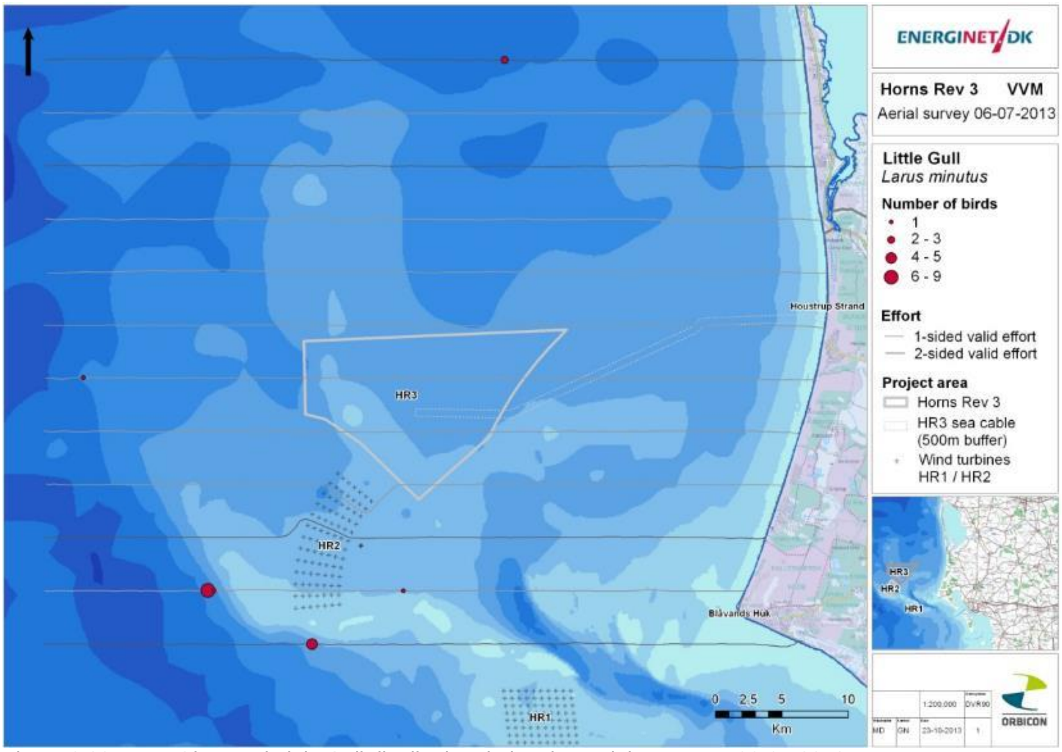


Figure 0.39 Observed Little Gull distribution during the aerial survey on 06-07-2013.

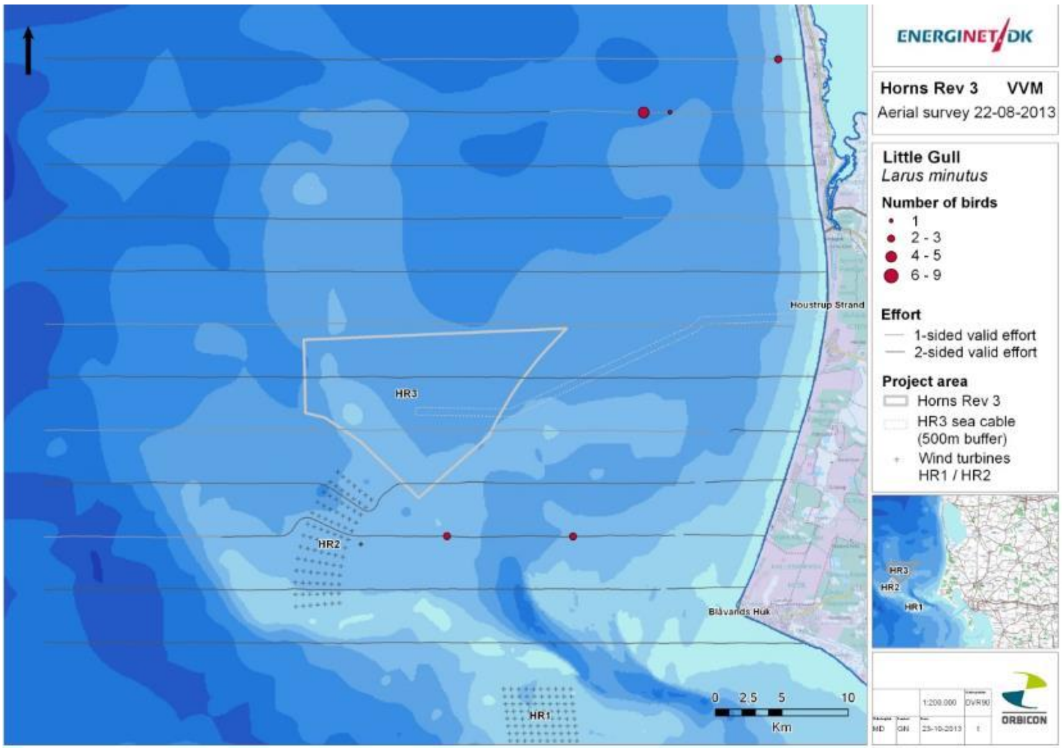


Figure 0.40 Observed Little Gull distribution during the aerial survey on 22-08-2013.

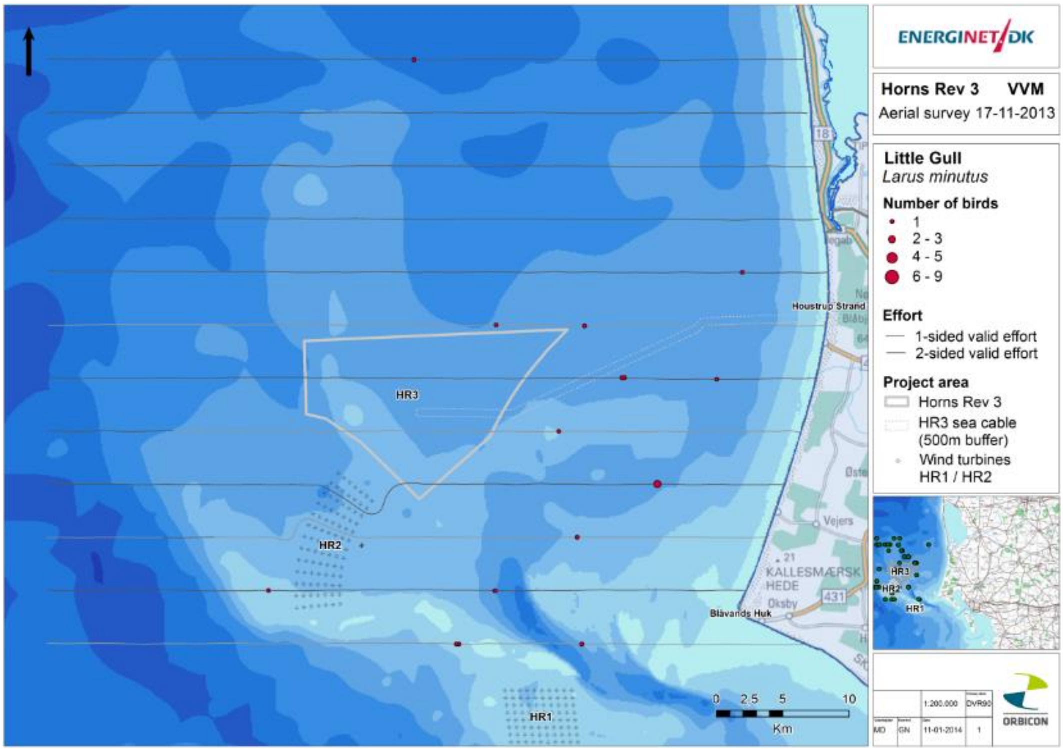


Figure 0.41 Observed Little Gull distribution during the aerial survey on 17-11-2013.

Black-headed Gull

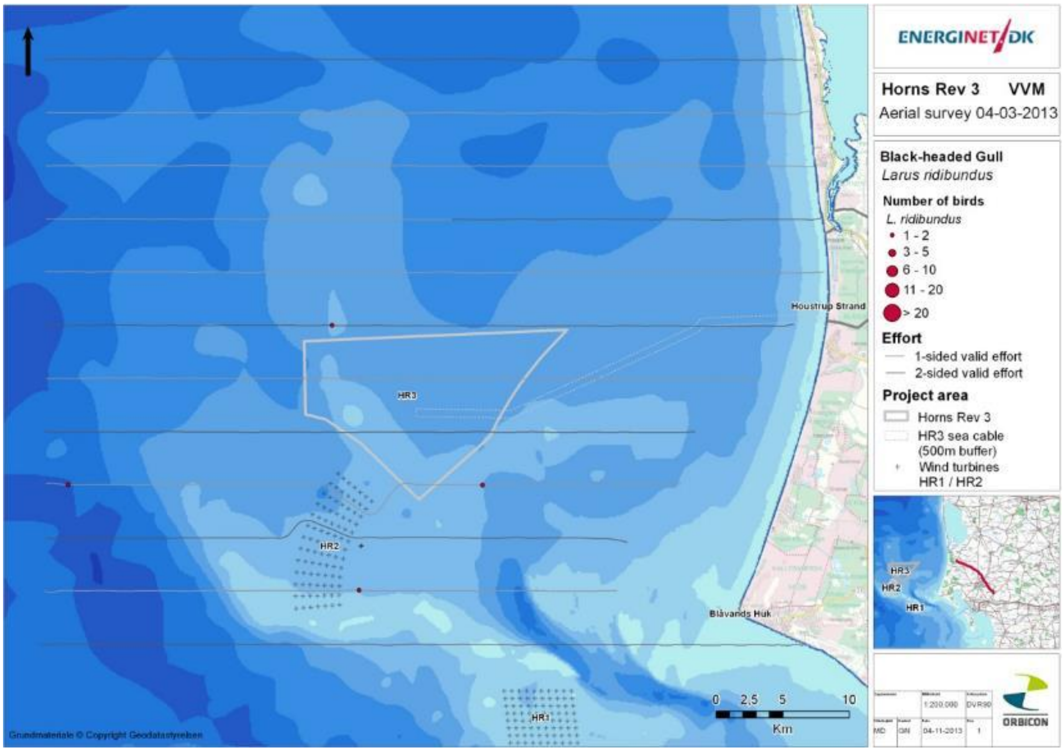


Figure 0.42 Observed Black-headed Gull distribution during the aerial survey on 04-03-2013.

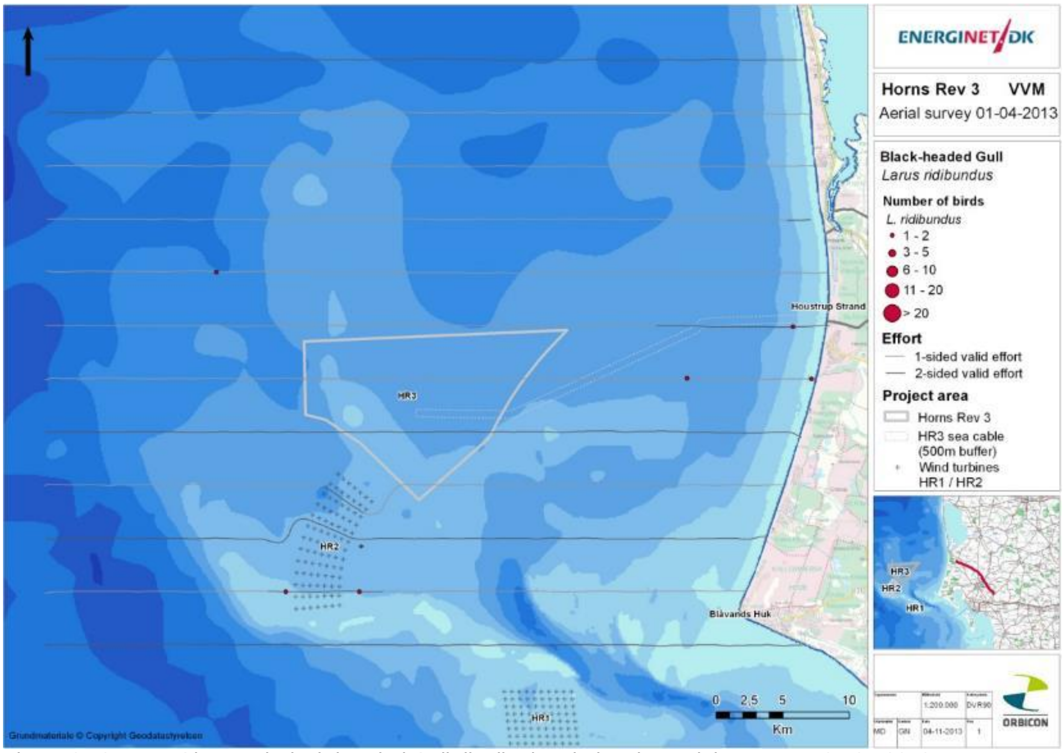


Figure 0.43 Observed Black-headed Gull distribution during the aerial survey on 01-04-2013.

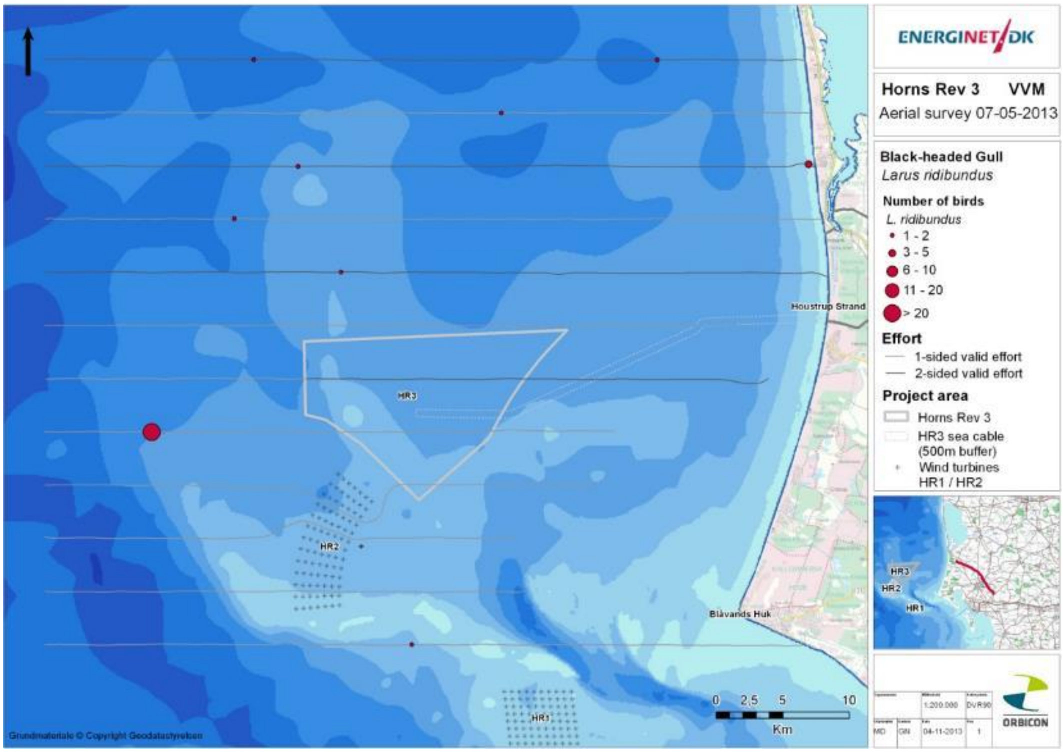


Figure 0.44 Observed Black-headed Gull distribution during the aerial survey on 07-05-2013.

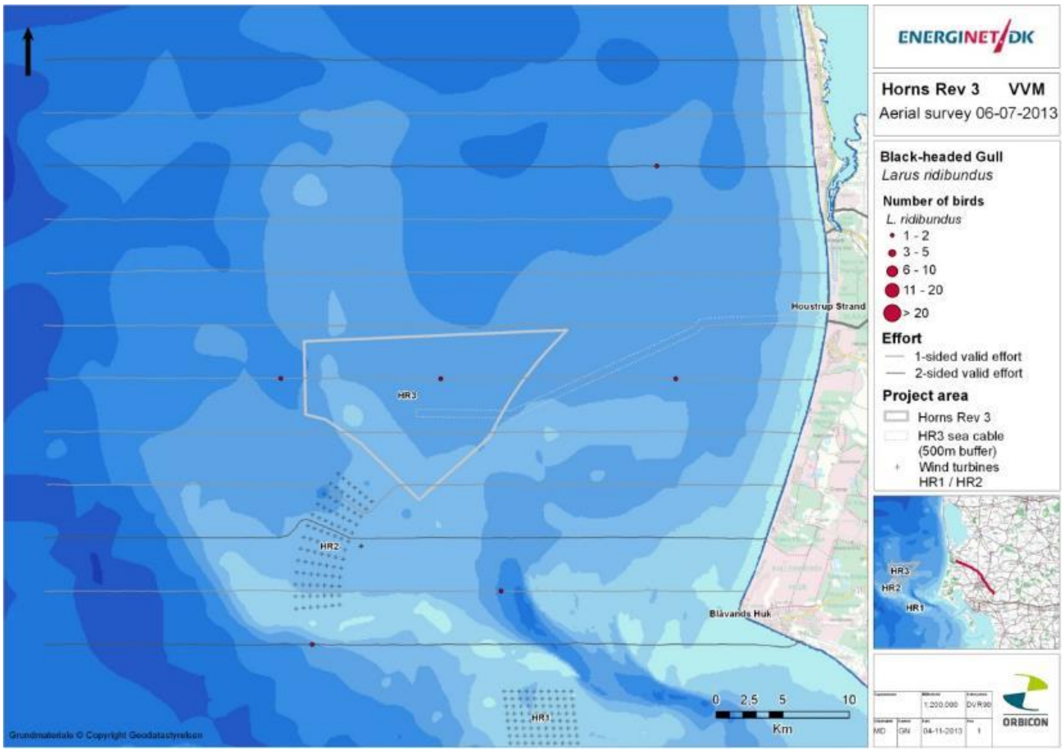


Figure 0.45 Observed Black-headed Gull distribution during the aerial survey on 06-07-2013.

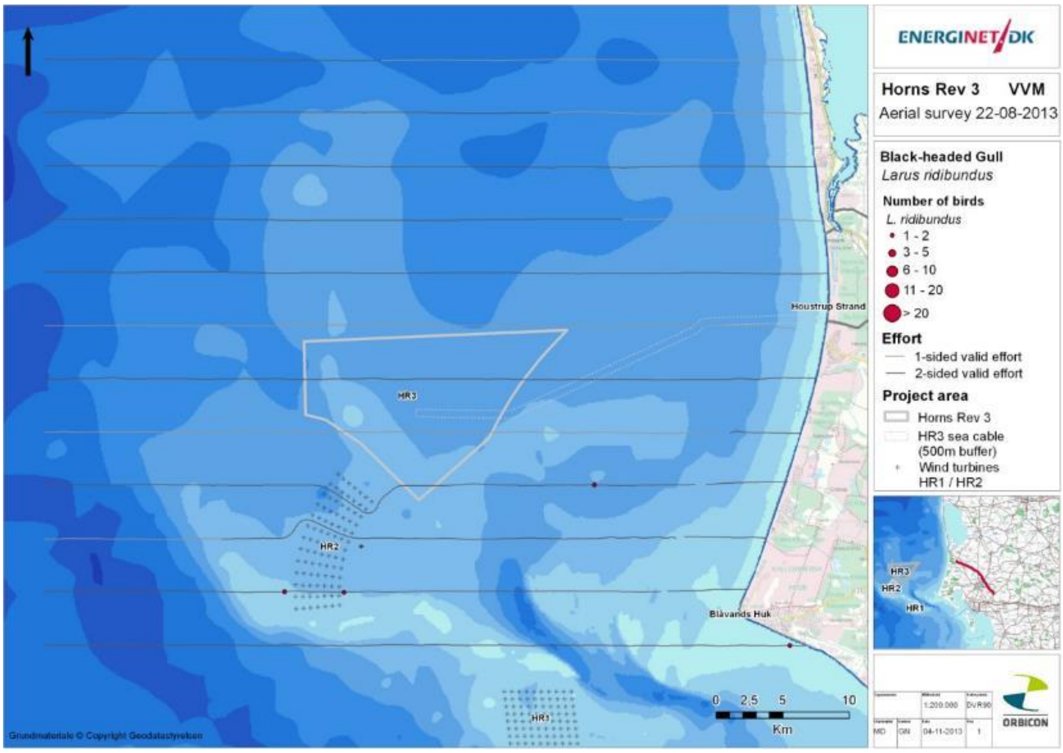


Figure 0.46 Observed Black-headed Gull distribution during the aerial survey on 22-08-2013.

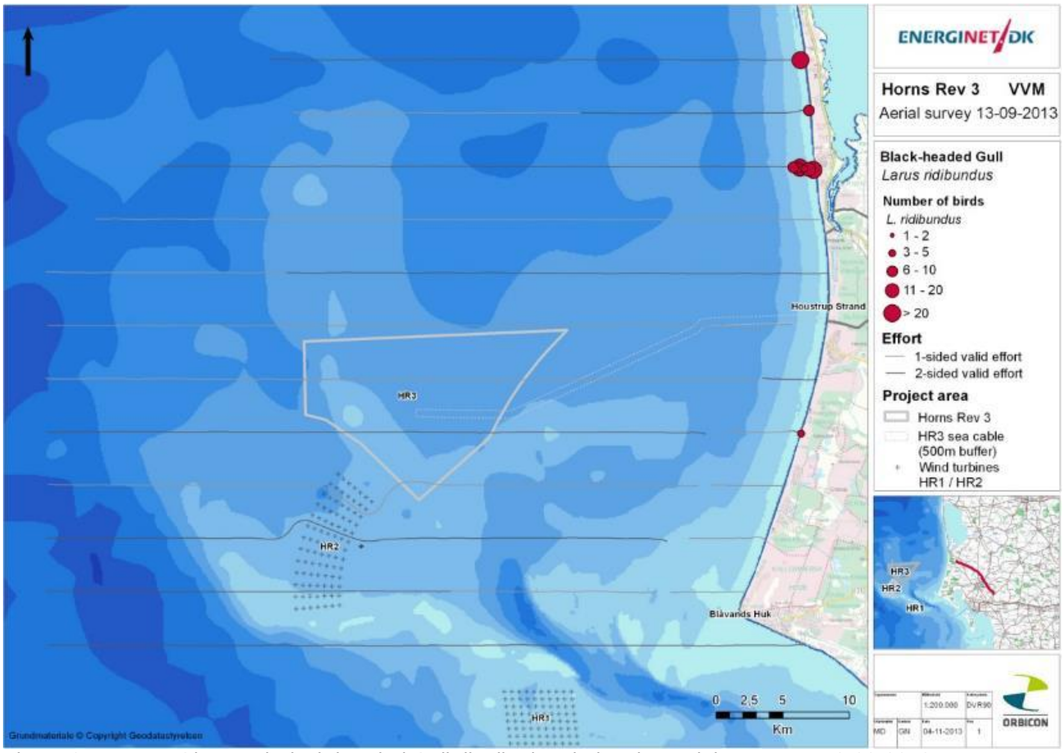


Figure 0.47 Observed Black-headed Gull distribution during the aerial survey on 13-09-2013.

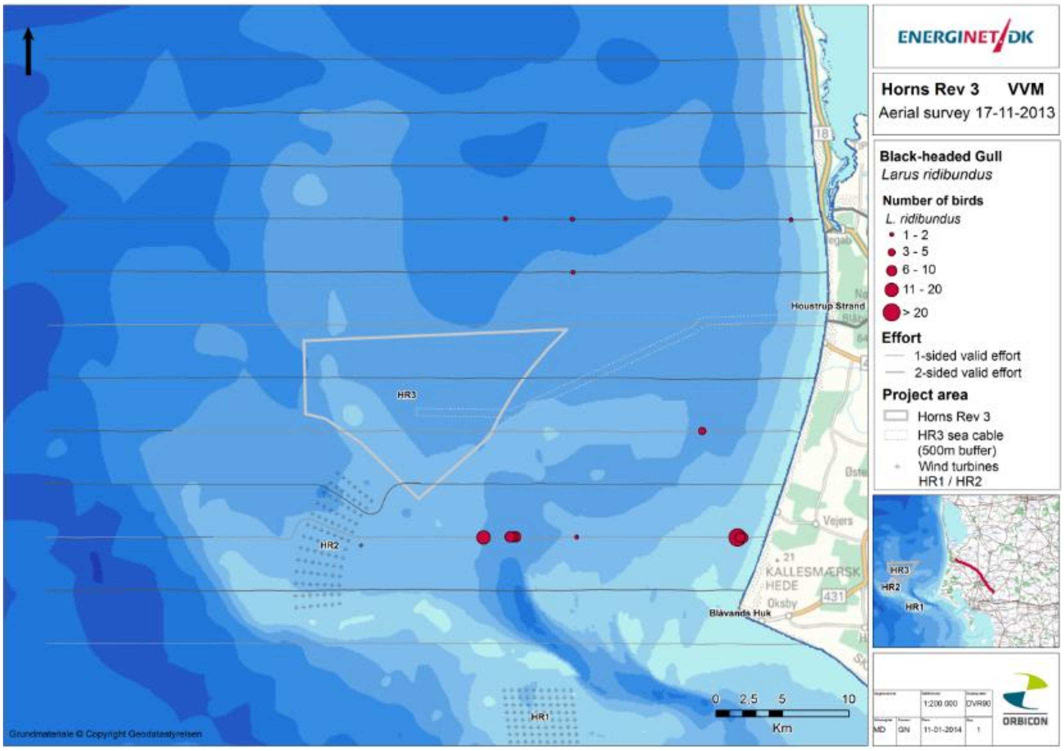


Figure 0.48 Observed Black-headed Gull distribution during the aerial survey on 17-11-2013.

Common Gull / Herring Gull

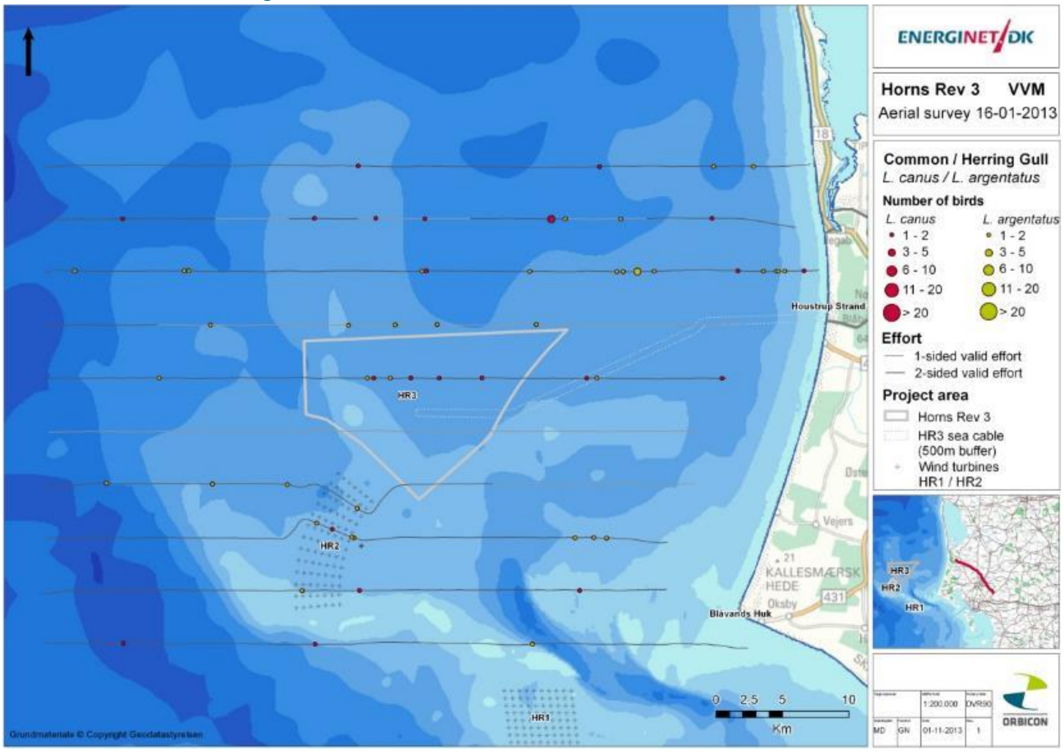


Figure 0.49 Observed distribution of Common Gull and Herring Gull during the aerial survey on 16-01-2013.

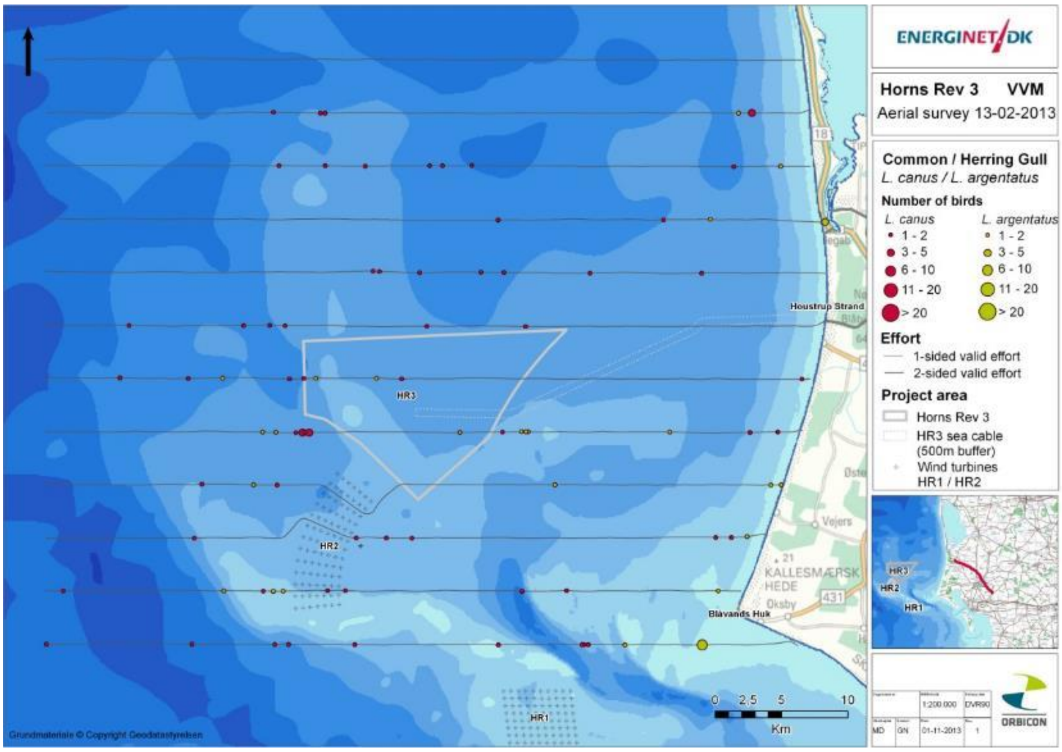


Figure 0.50 Observed distribution of Common Gull and Herring Gull during the aerial survey on 13-02-2013.

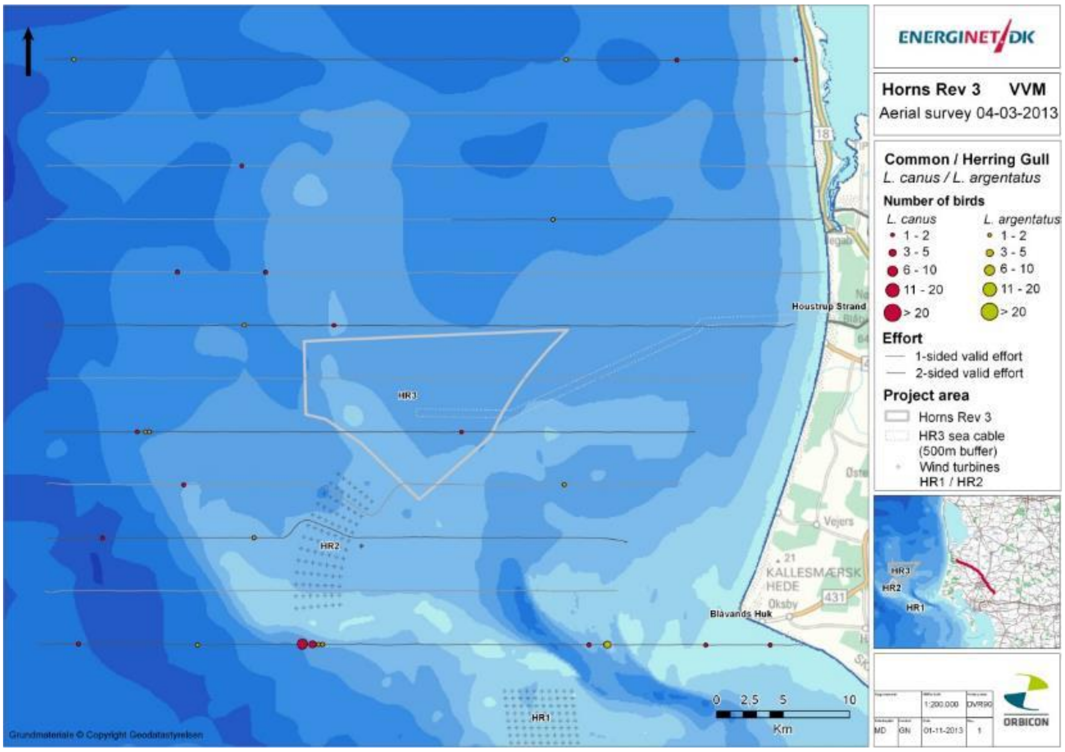


Figure 0.51 Observed distribution of Common Gull and Herring Gull during the aerial survey on 04-03-2013.

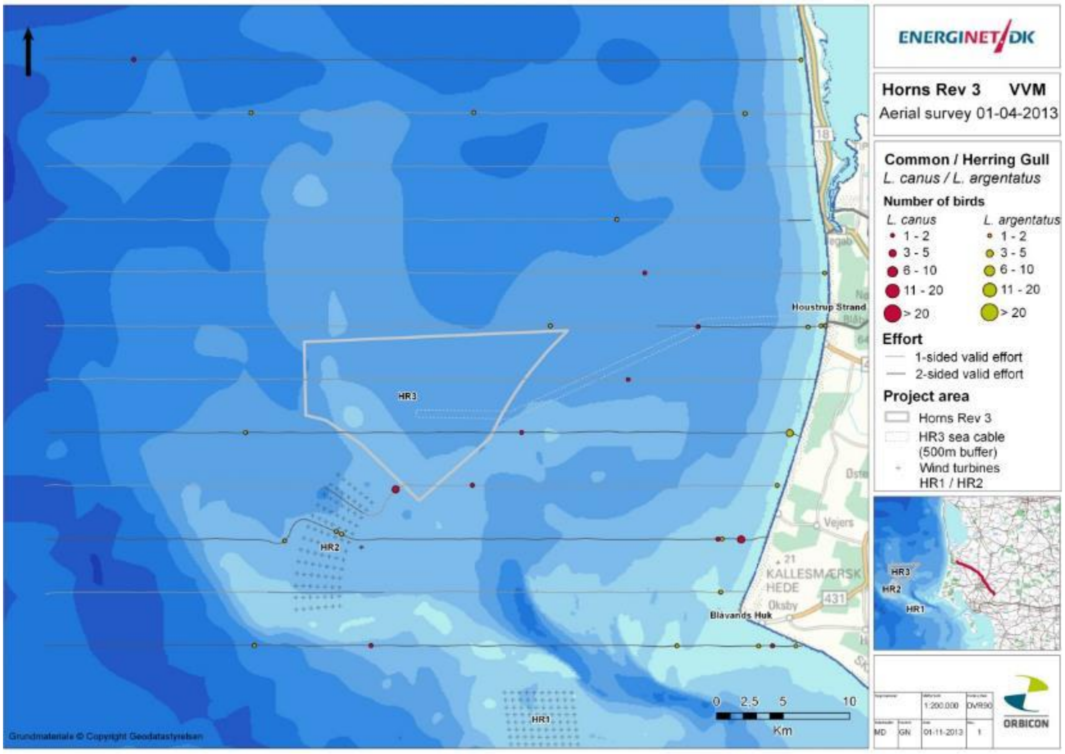


Figure 0.52 Observed distribution of Common Gull and Herring Gull during the aerial survey on 01-04-2013.

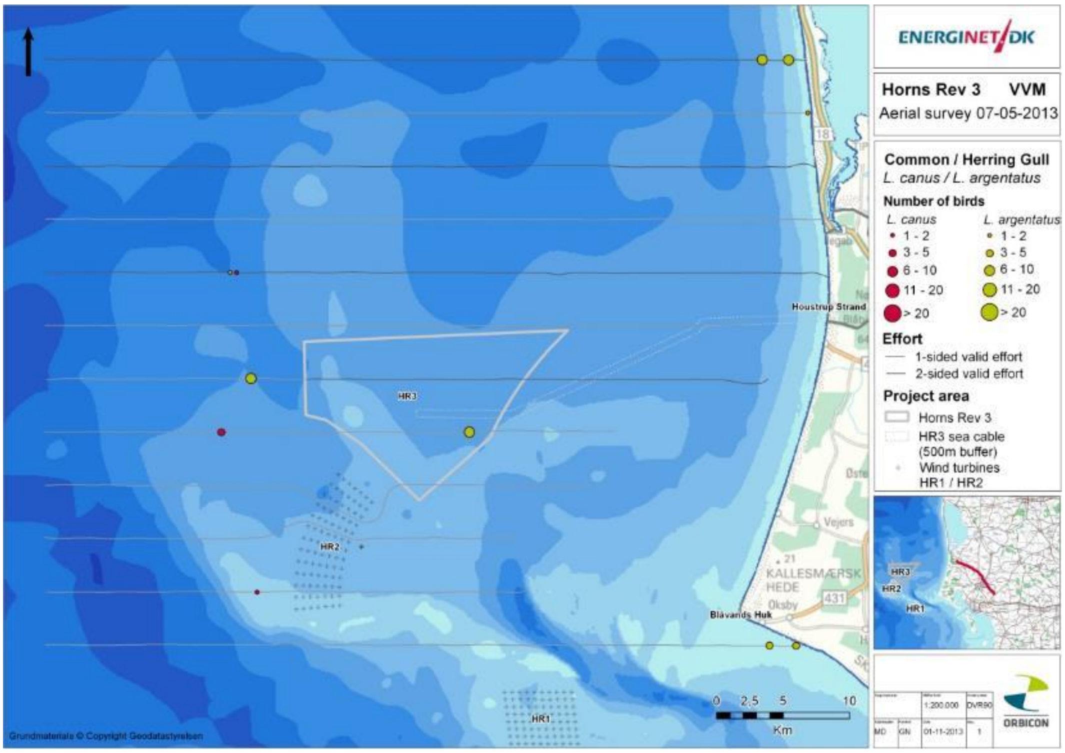


Figure 0.53 Observed distribution of Common Gull and Herring Gull during the aerial survey on 07-05-2013.

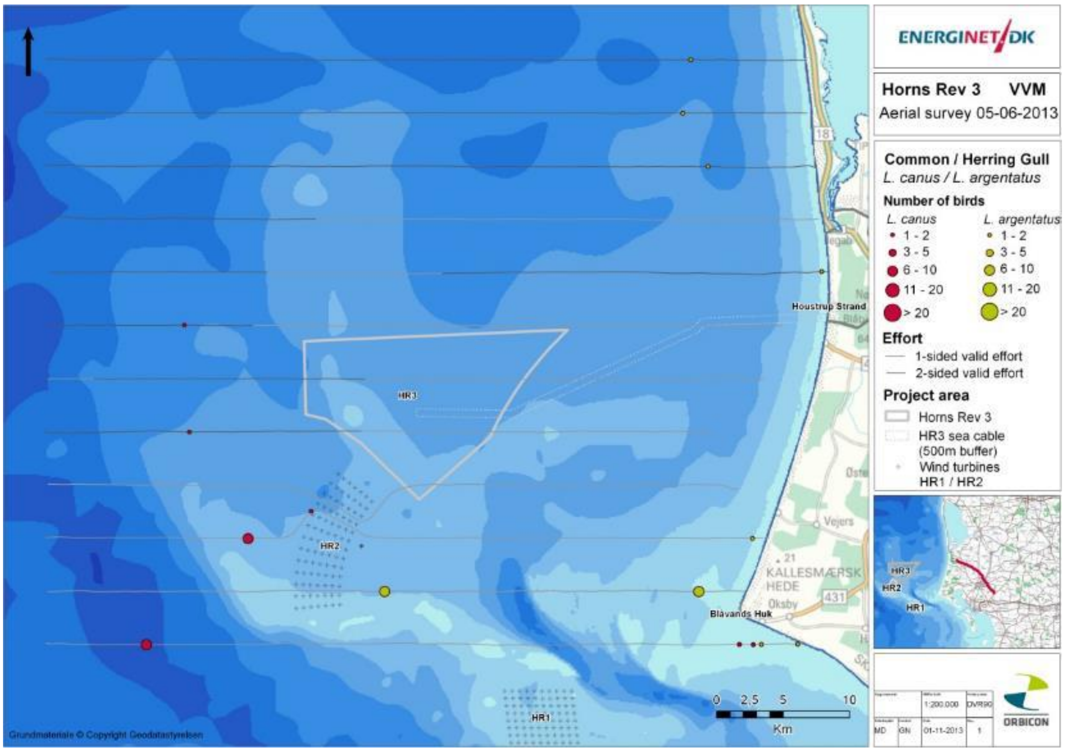


Figure 0.54 Observed distribution of Common Gull and Herring Gull during the aerial survey on 05-06-2013.

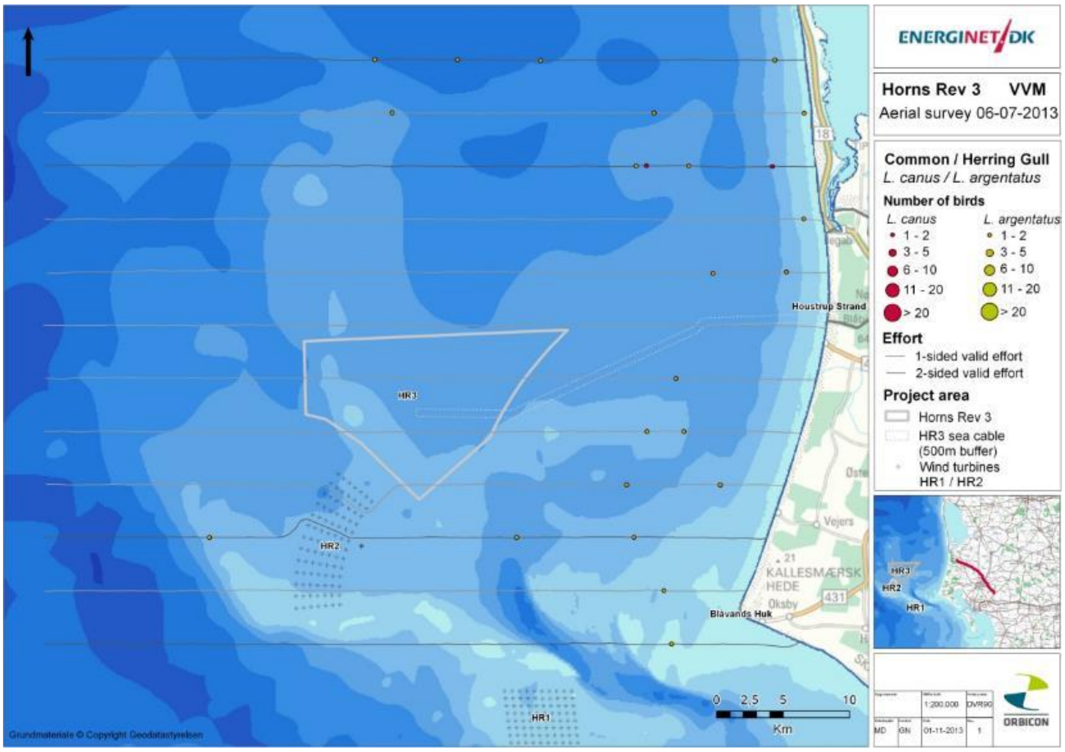


Figure 0.55 Observed distribution of Common Gull and Herring Gull during the aerial survey on 06-07-2013.

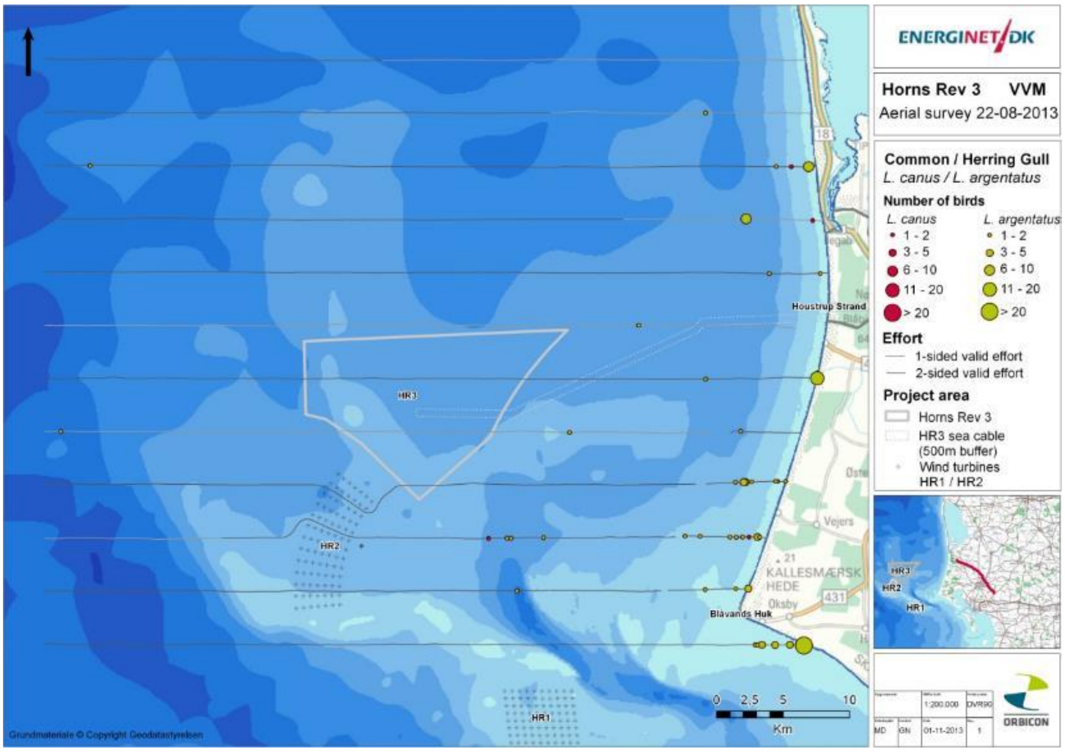


Figure 0.56 Observed distribution of Common Gull and Herring Gull during the aerial survey on 22-08-2013.

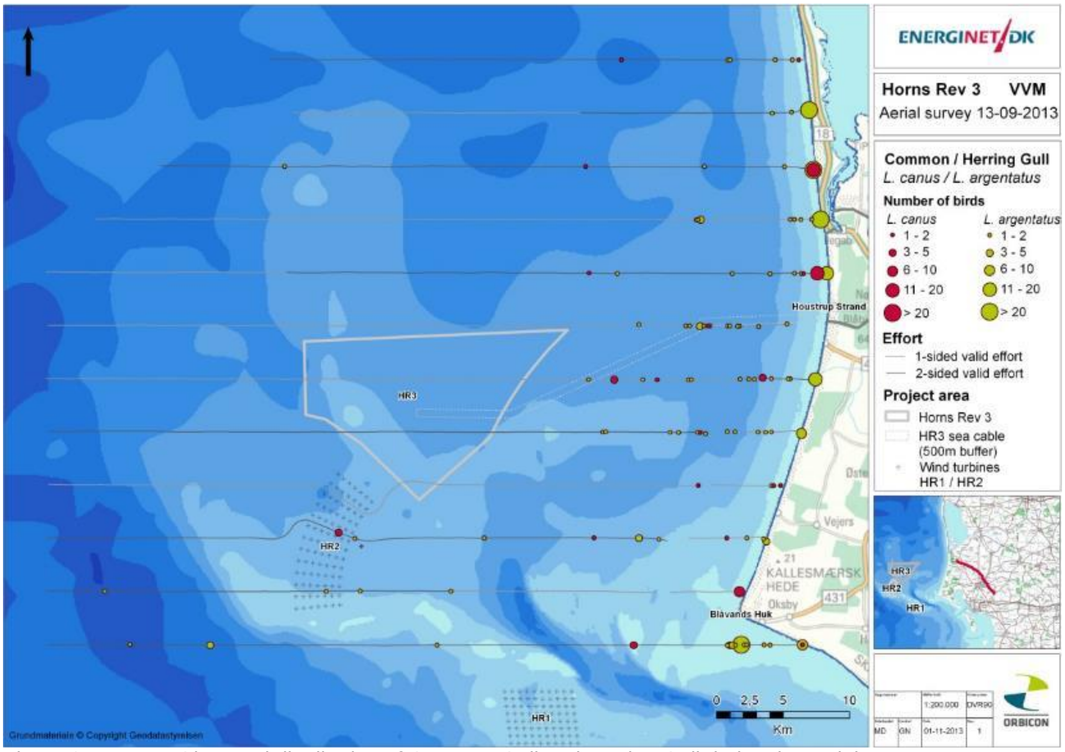


Figure 0.57 Observed distribution of Common Gull and Herring Gull during the aerial survey on 13-09-2013.

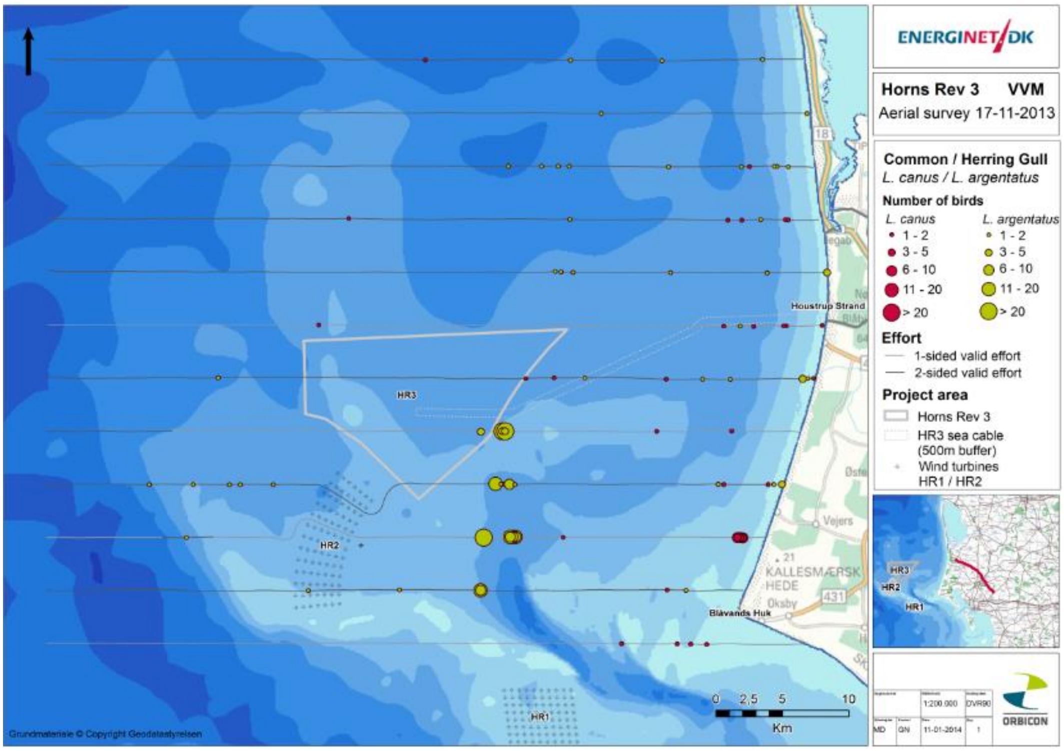


Figure 0.58 Observed distribution of Common Gull and Herring Gull during the aerial survey on 17-11-2013.

Lesser Black-backed Gull / Great Black-backed Gull

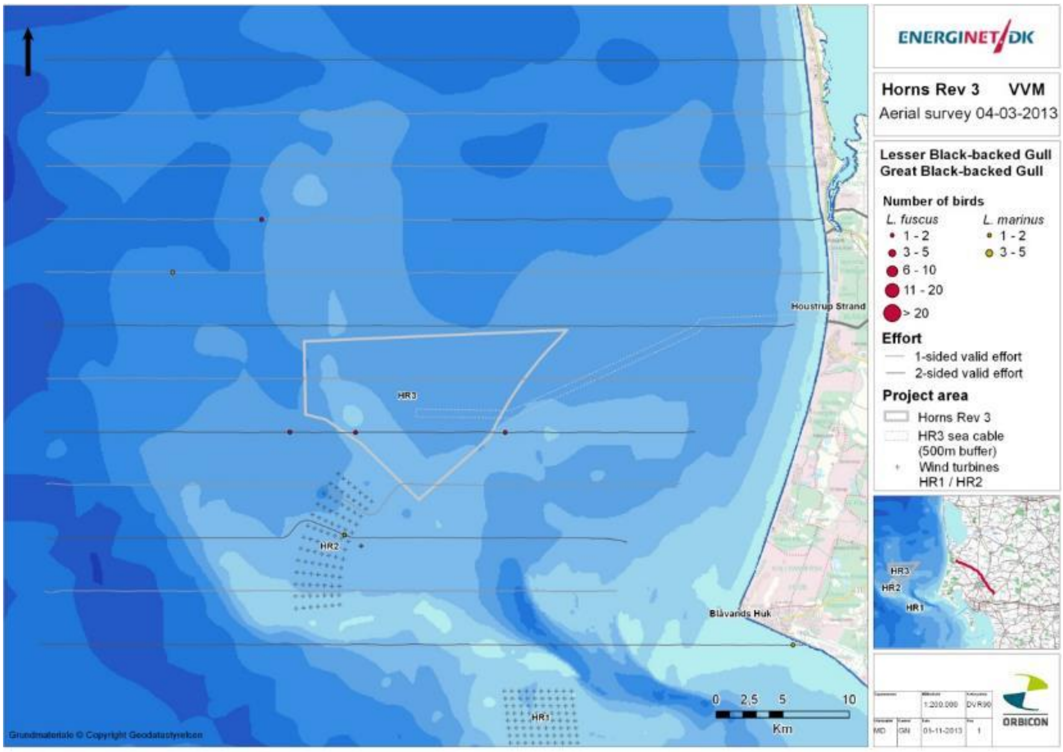


Figure 0.59 Observed distribution of Lesser Black-backed Gull and Great Black-backed Gull during the aerial survey on 04-03-2013.

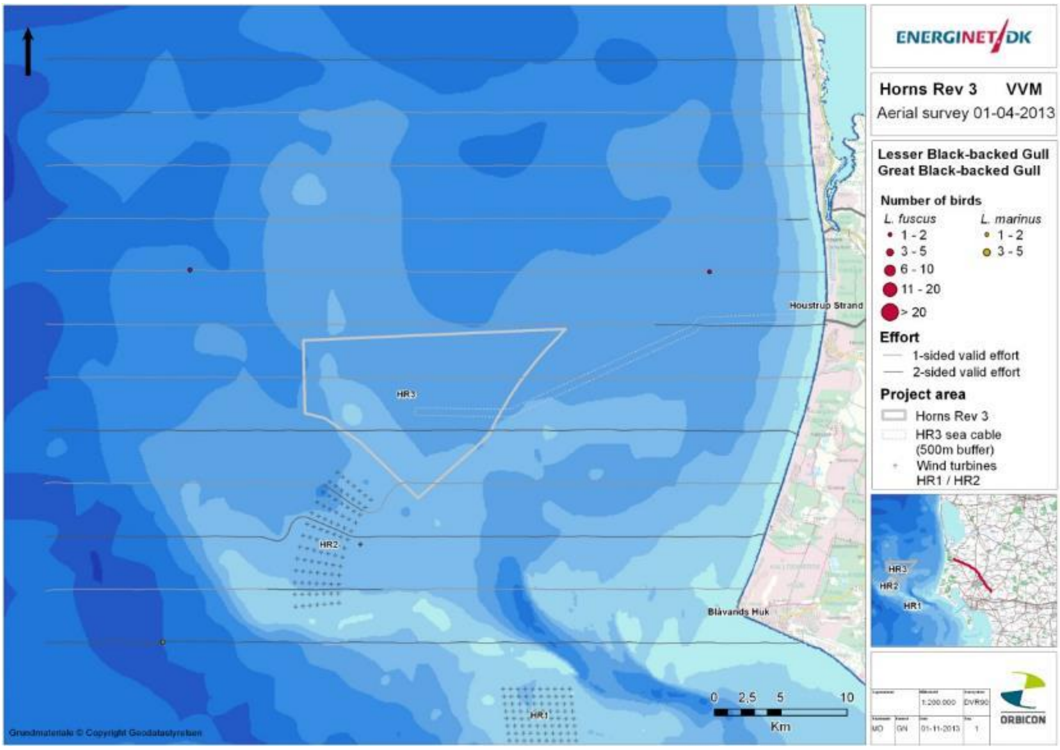


Figure 0.60 Observed distribution of Lesser Black-backed Gull and Great Black-backed Gull during the aerial survey on 04-03-2013.

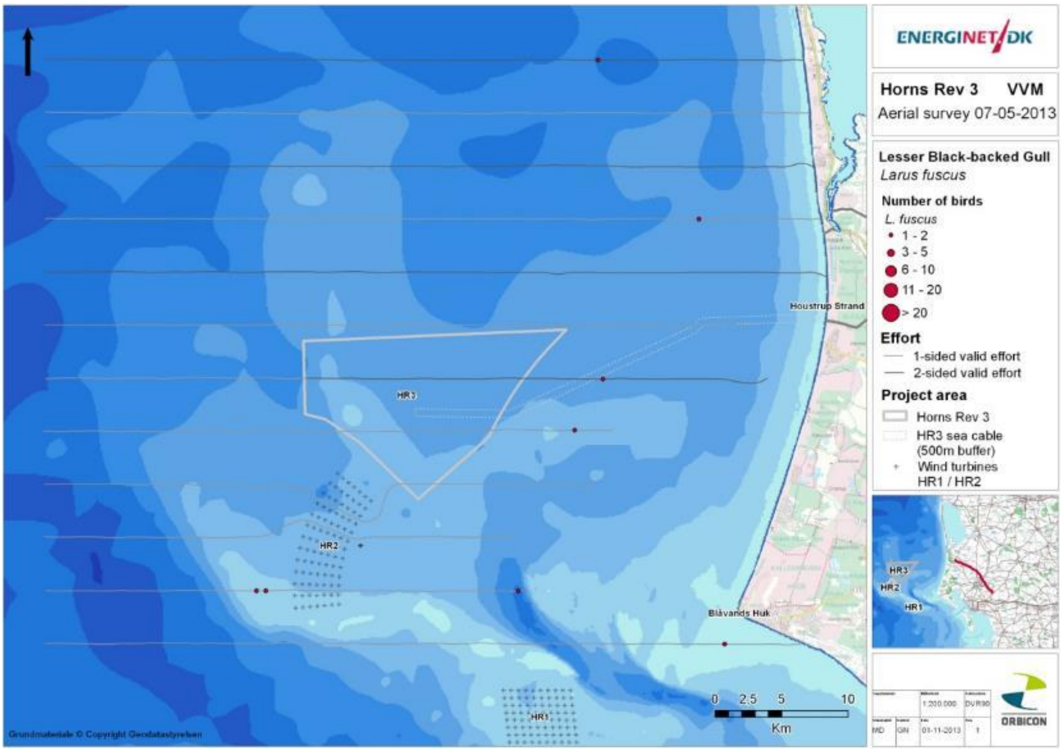


Figure 0.61 Observed Lesser Black-backed Gull distribution during the aerial survey on 07-05-2013.

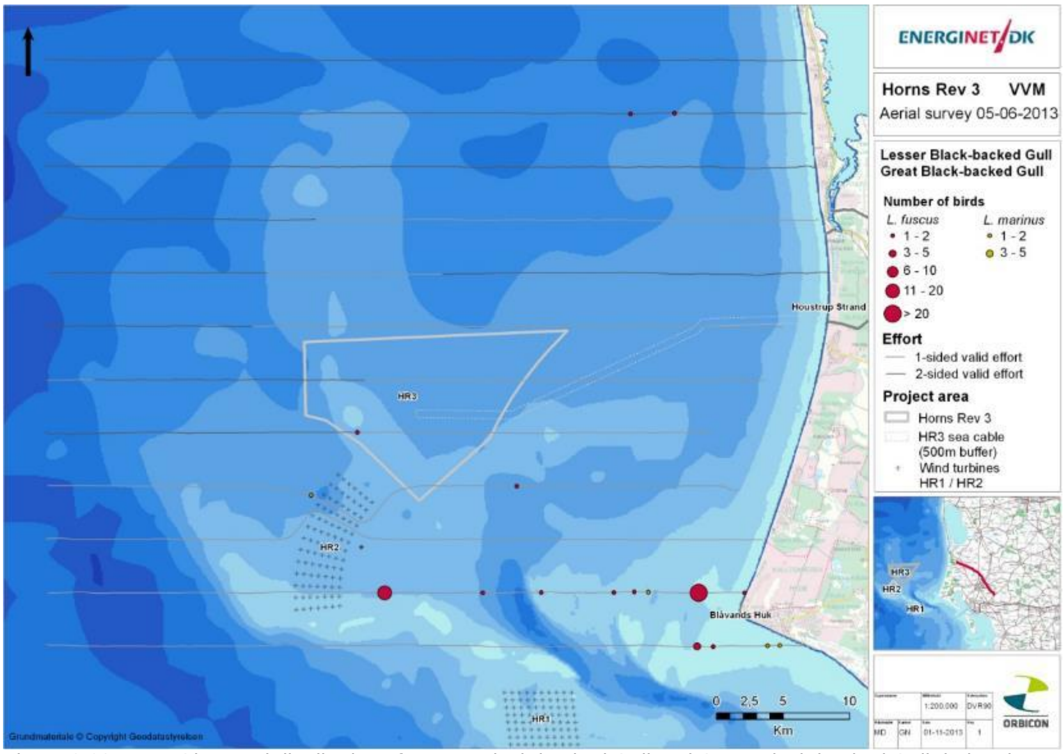


Figure 0.62 Observed distribution of Lesser Black-backed Gull and Great Black-backed Gull during the aerial survey on 05-06-2013.

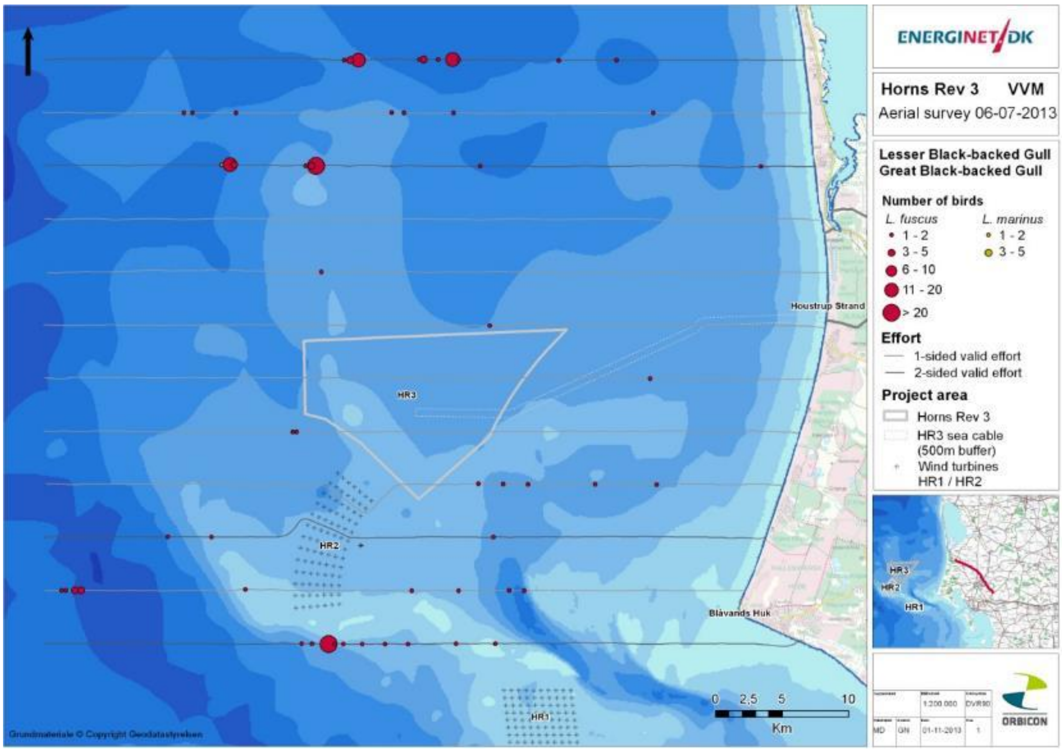


Figure 0.63 Observed distribution of Lesser Black-backed Gull and Great Black-backed Gull during the aerial survey on 06-07-2013.

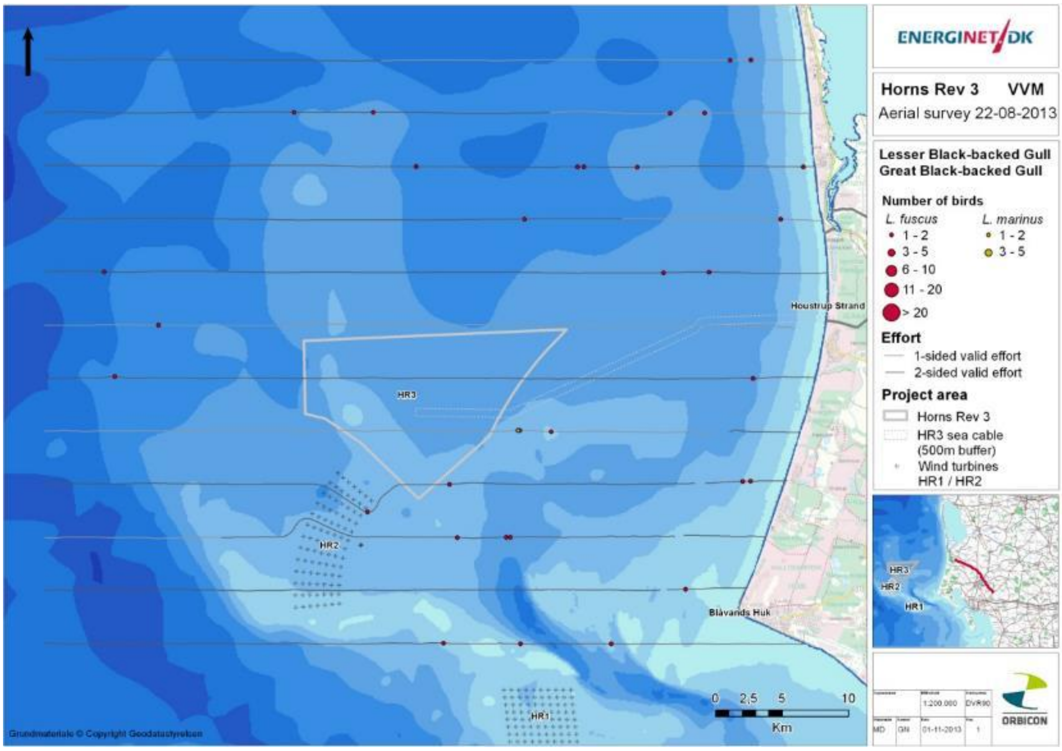


Figure 0.64 Observed distribution of Lesser Black-backed Gull and Great Black-backed Gull during the aerial survey on 22-08-2013.

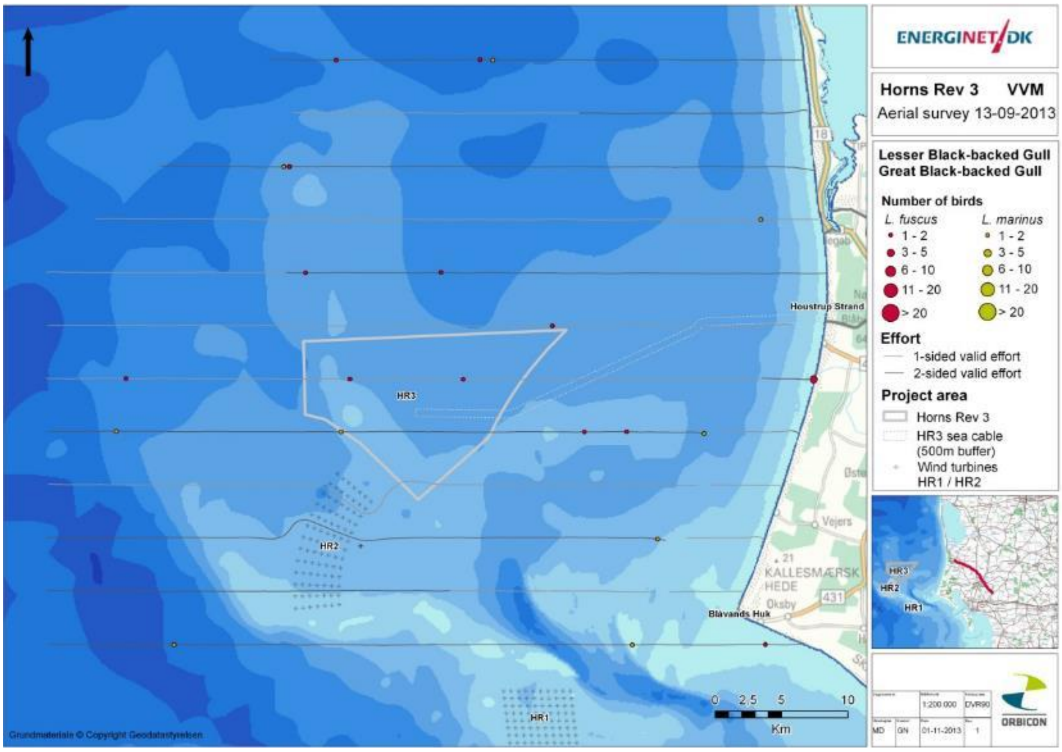


Figure 0.65 Observed distribution of Lesser Black-backed Gull and Great Black-backed Gull during the aerial survey on 13-09-2013.

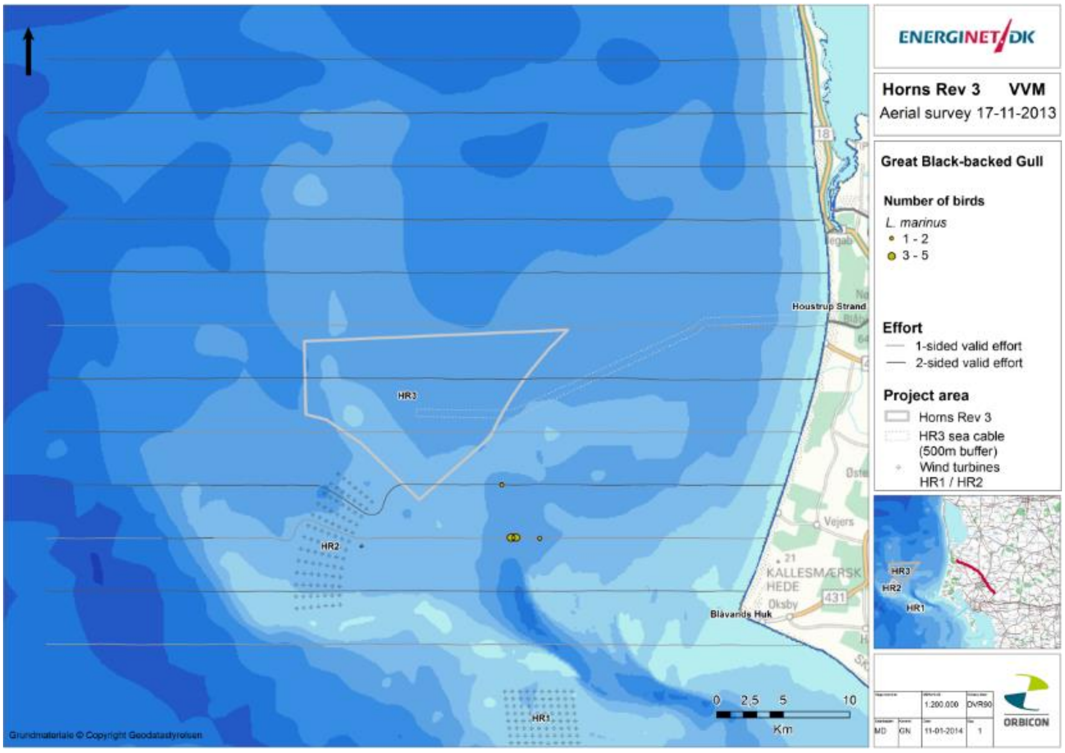


Figure 0.66 Observed distribution of Great Black-backed Gull during the aerial survey on 17-11-2013.

Gulls (identified and unidentified gulls)

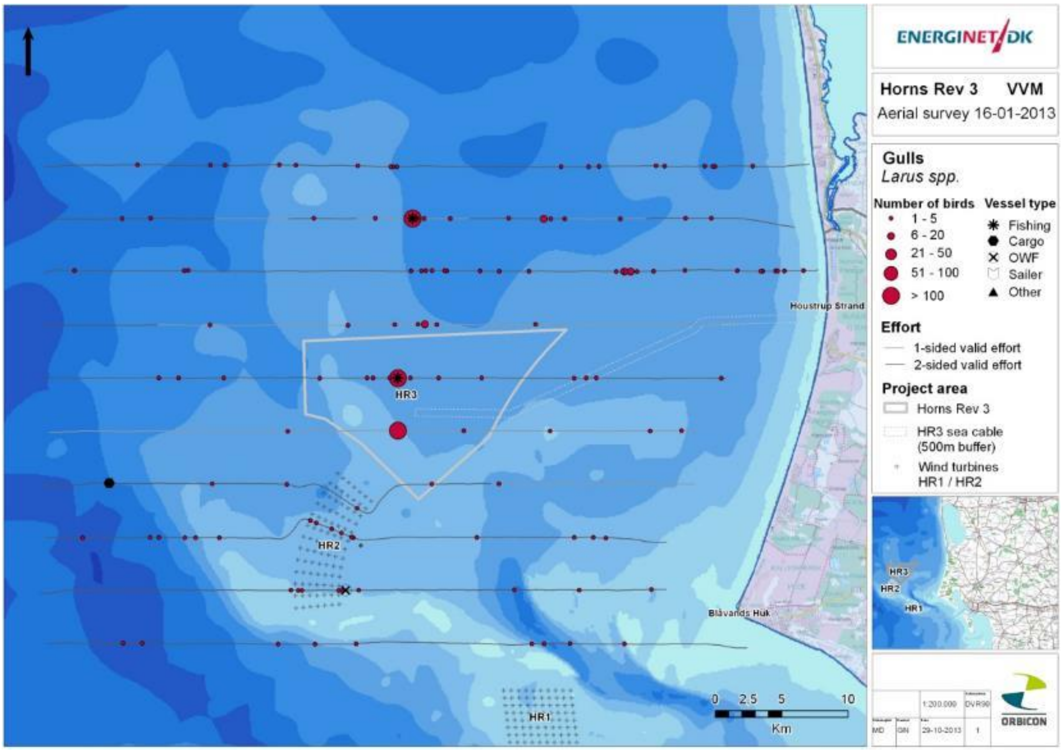


Figure 0.67 Observed distribution of *Larus* gulls and observed ships during the aerial survey on 16-01-2013.

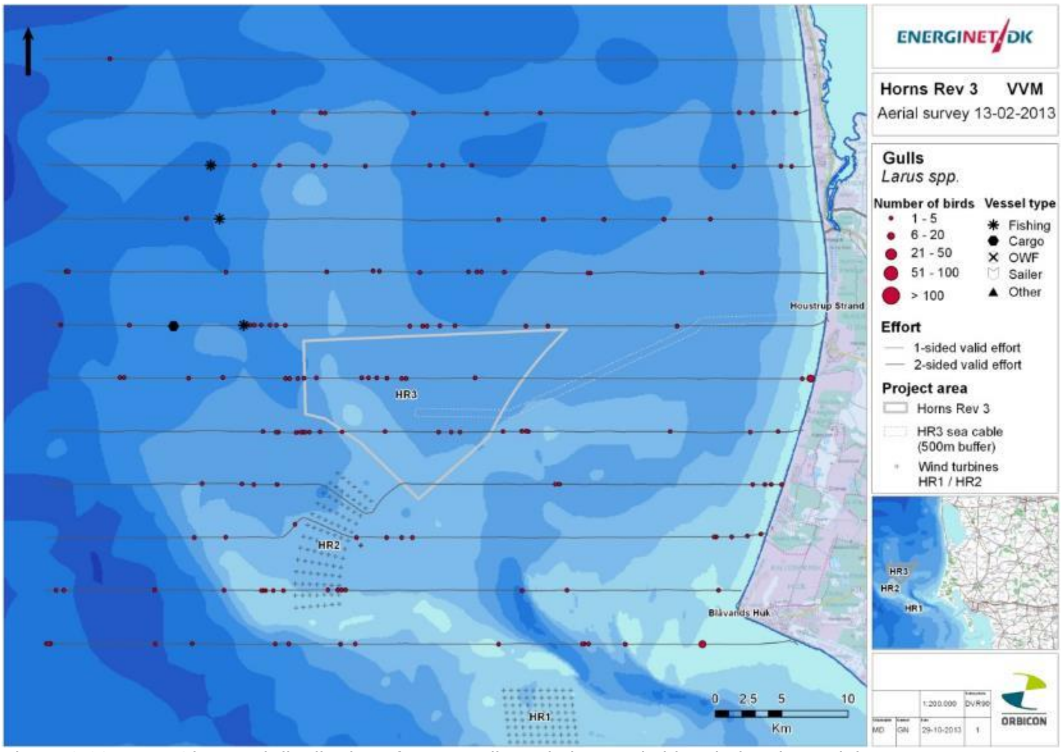


Figure 0.68 Observed distribution of *Larus* gulls and observed ships during the aerial survey on 13-02-2013.

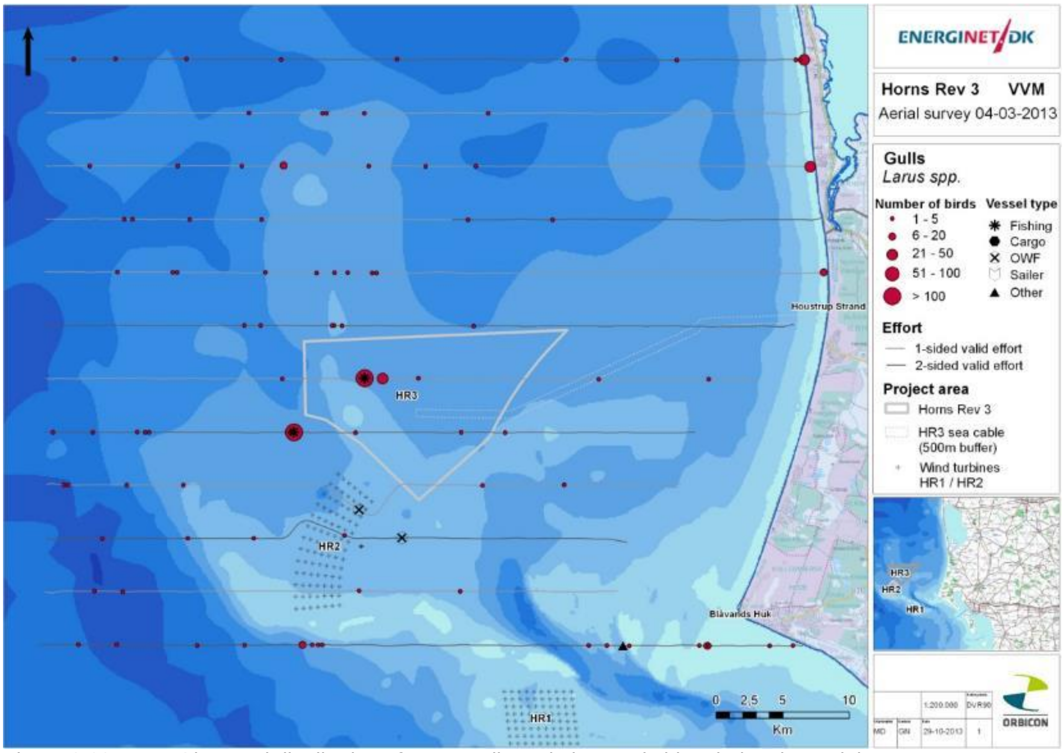


Figure 0.69 Observed distribution of *Larus* gulls and observed ships during the aerial survey on 04-03-2013.

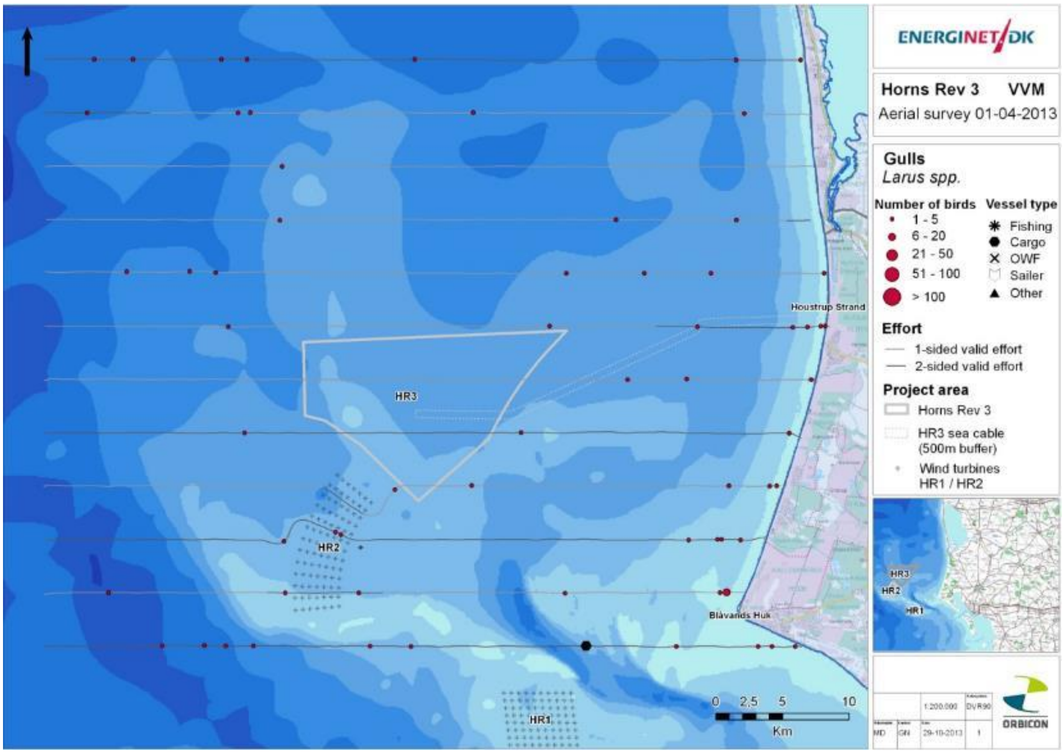


Figure 0.70 Observed distribution of *Larus* gulls and observed ships during the aerial survey on 01-04-2013.

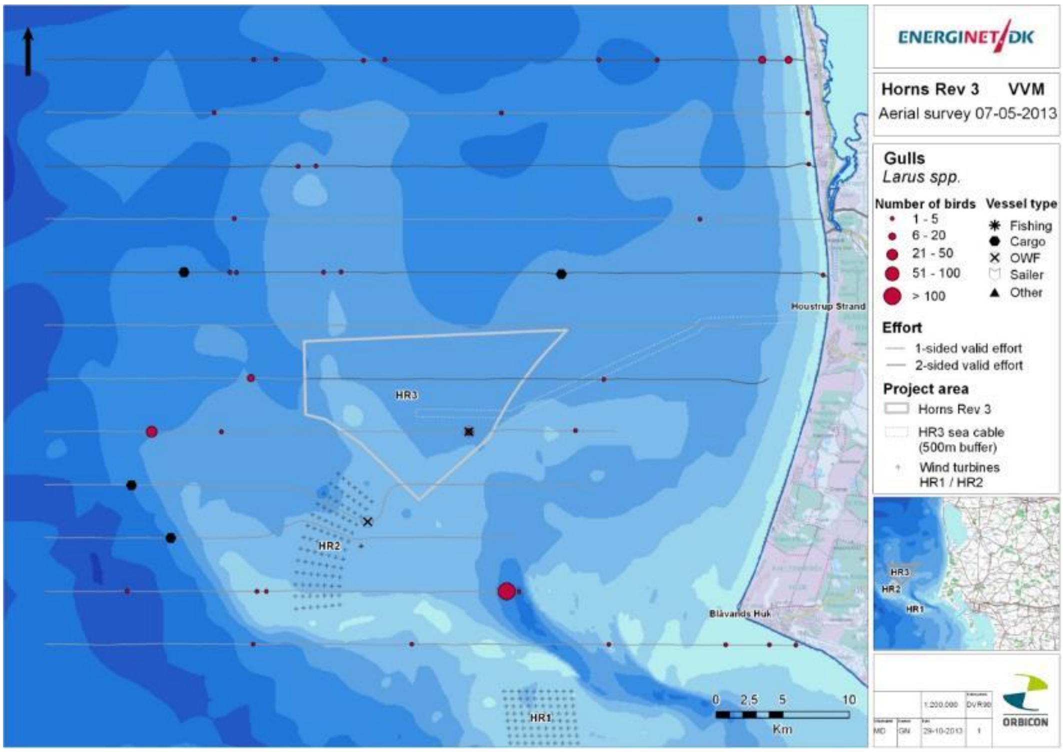


Figure 0.71 Observed distribution of *Larus* gulls and observed ships during the aerial survey on 07-05-2013.

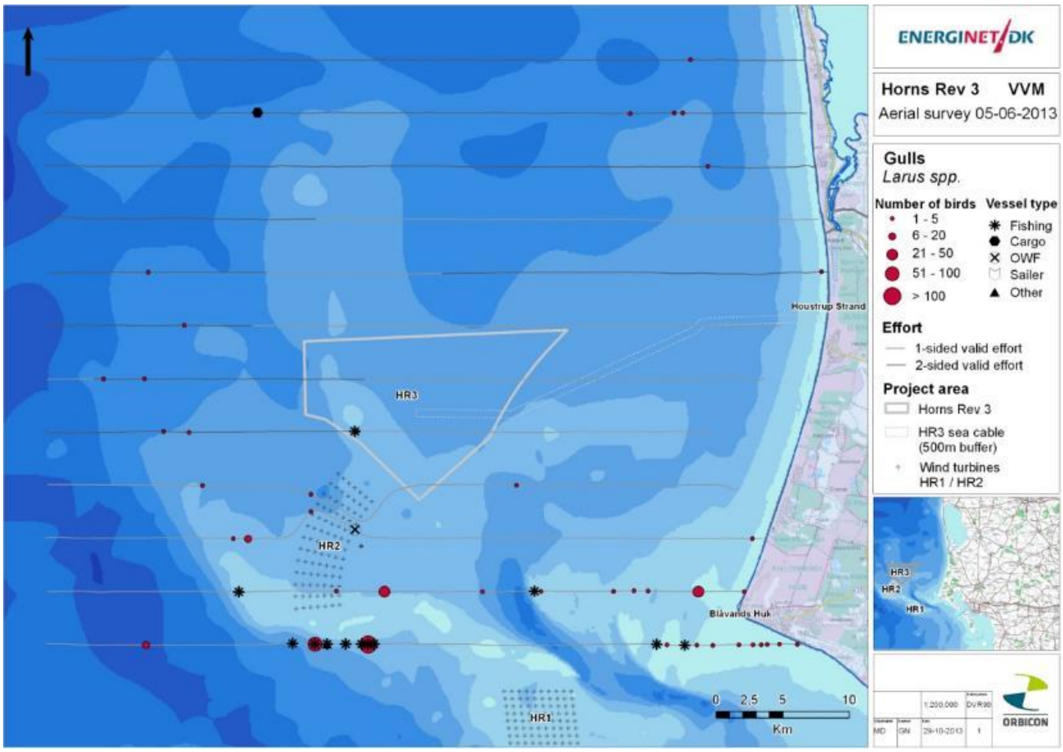


Figure 0.72 Observed distribution of *Larus* gulls and observed ships during the aerial survey on 05-06-2013.

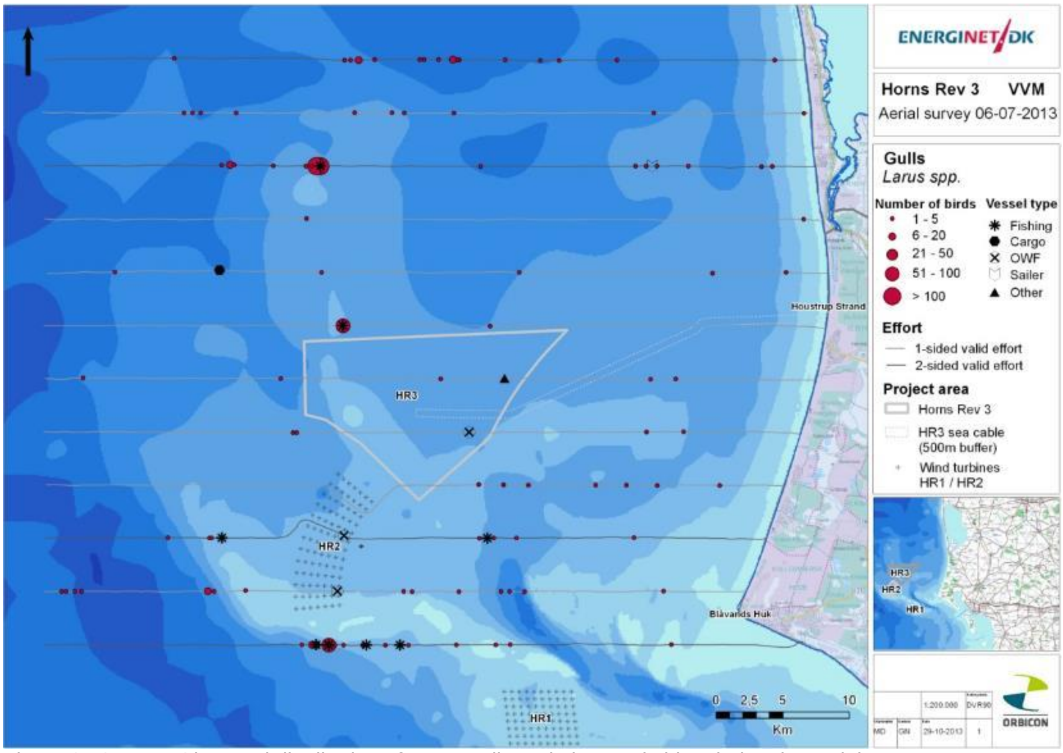


Figure 0.73 Observed distribution of *Larus* gulls and observed ships during the aerial survey on 06-07-2013.

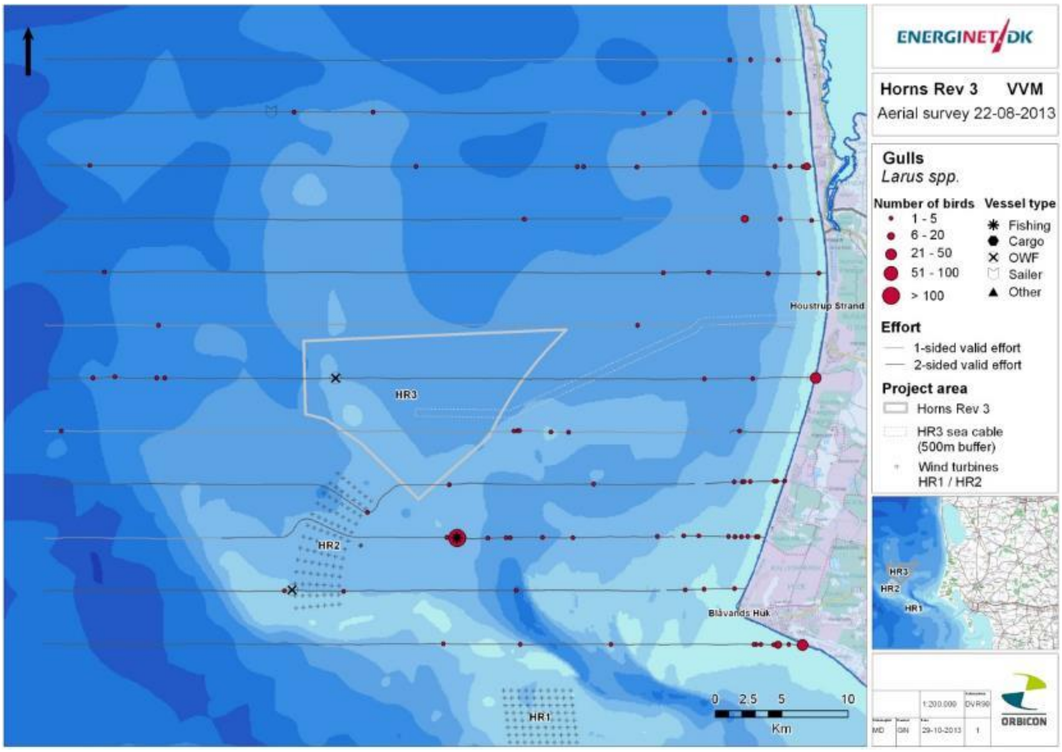


Figure 0.74 Observed distribution of *Larus* gulls and observed ships during the aerial survey on 22-08-2013.

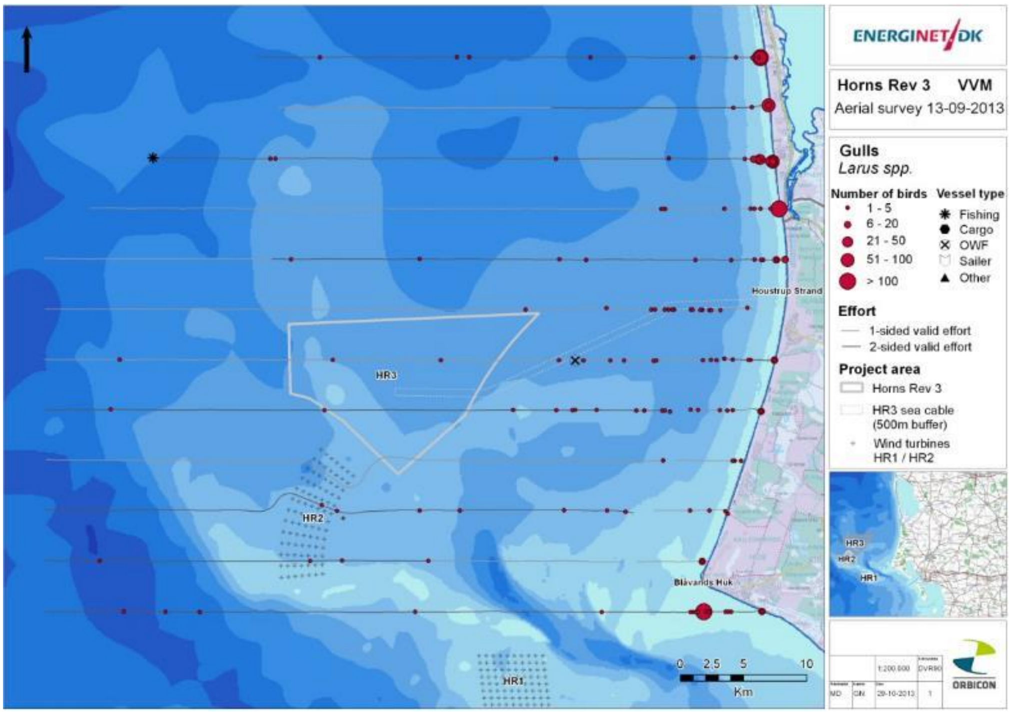


Figure 0.75 Observed distribution of *Larus* gulls and observed ships during the aerial survey on 13-09-2013.

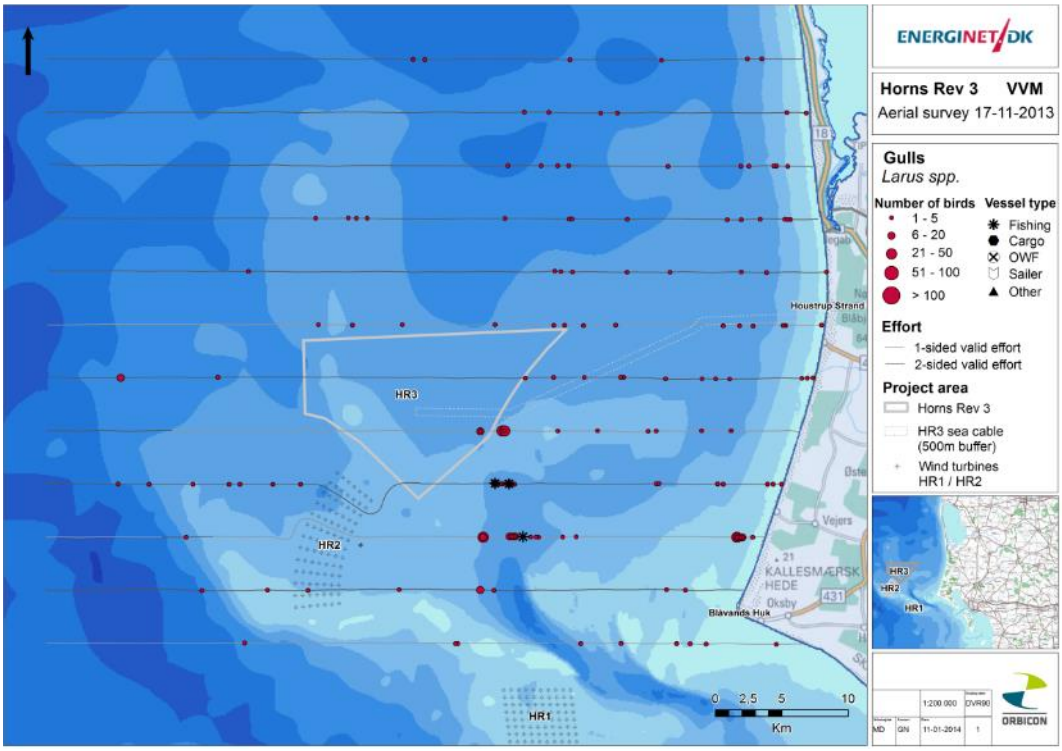


Figure 0.76 Observed distribution of *Larus* gulls and observed ships during the aerial survey on 17-11-2013.

Kittiwake

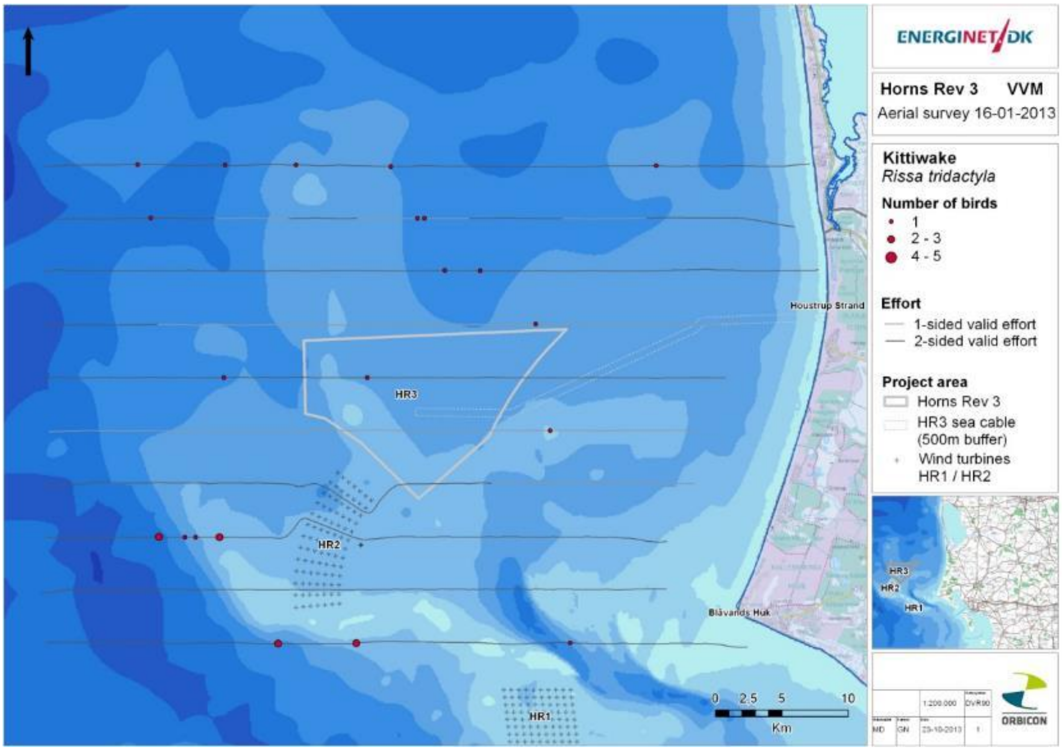


Figure 0.77 Observed Kittiwake distribution during the aerial survey on 16-01-2013.

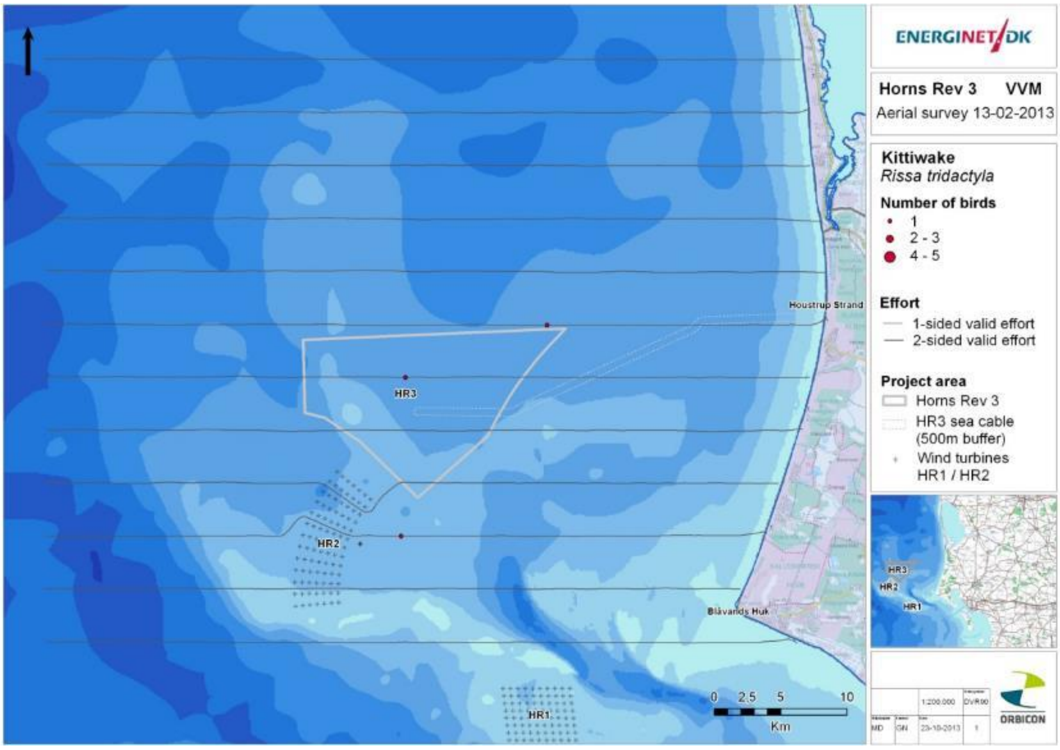


Figure 0.78 Observed Kittiwake distribution during the aerial survey on 13-02-2013.

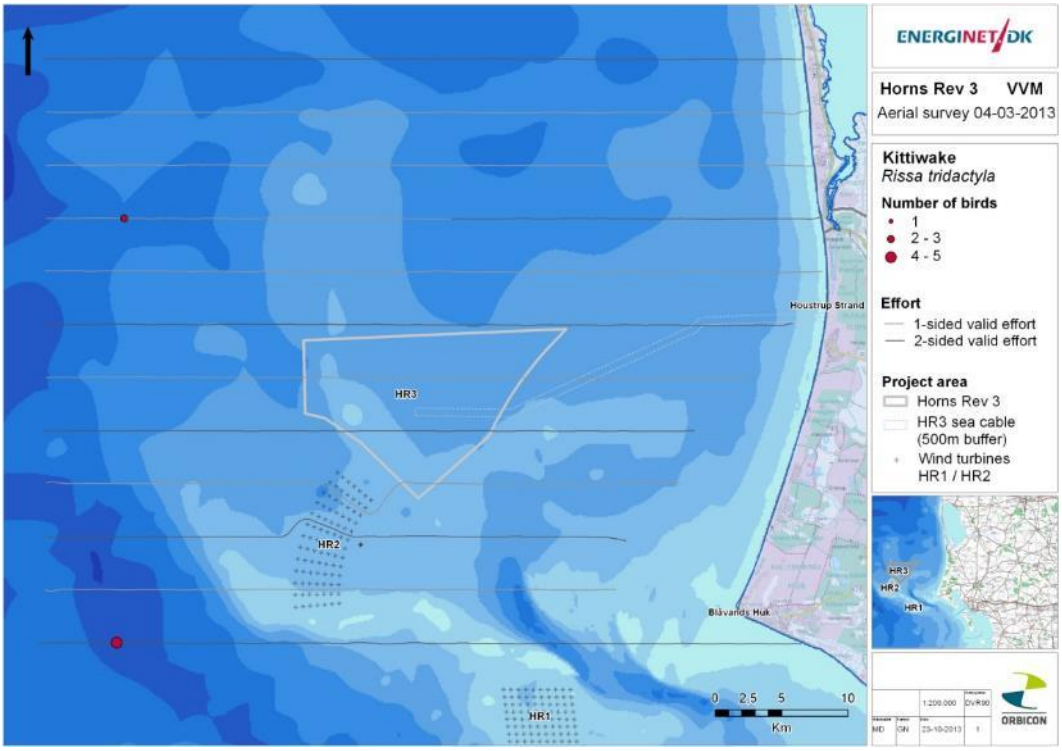


Figure 0.79 Observed Kittiwake distribution during the aerial survey on 04-03-2013.

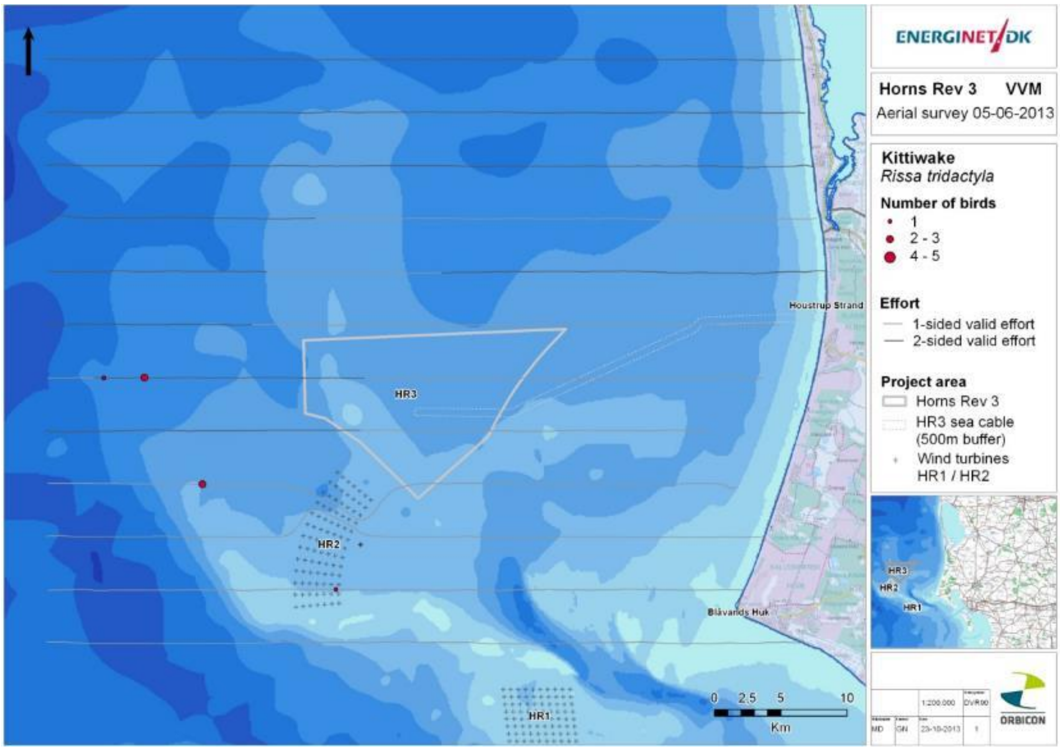


Figure 0.80 Observed Kittiwake distribution during the aerial survey on 05-06-2013.

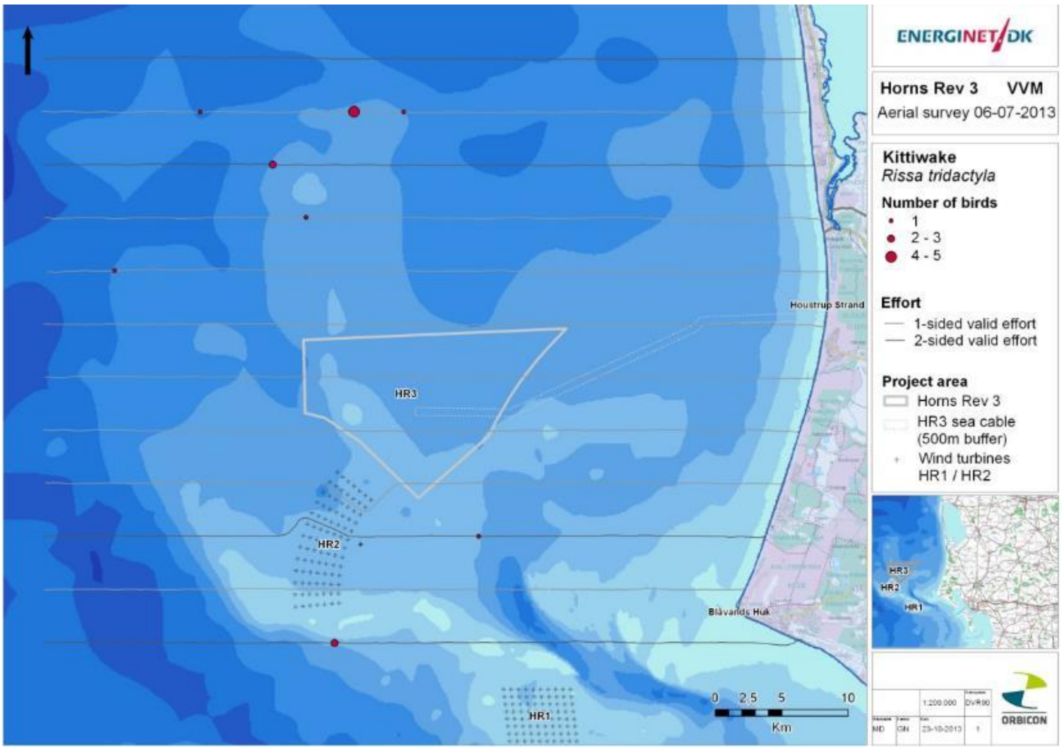


Figure 0.81 Observed Kittiwake distribution during the aerial survey on 06-07-2013.

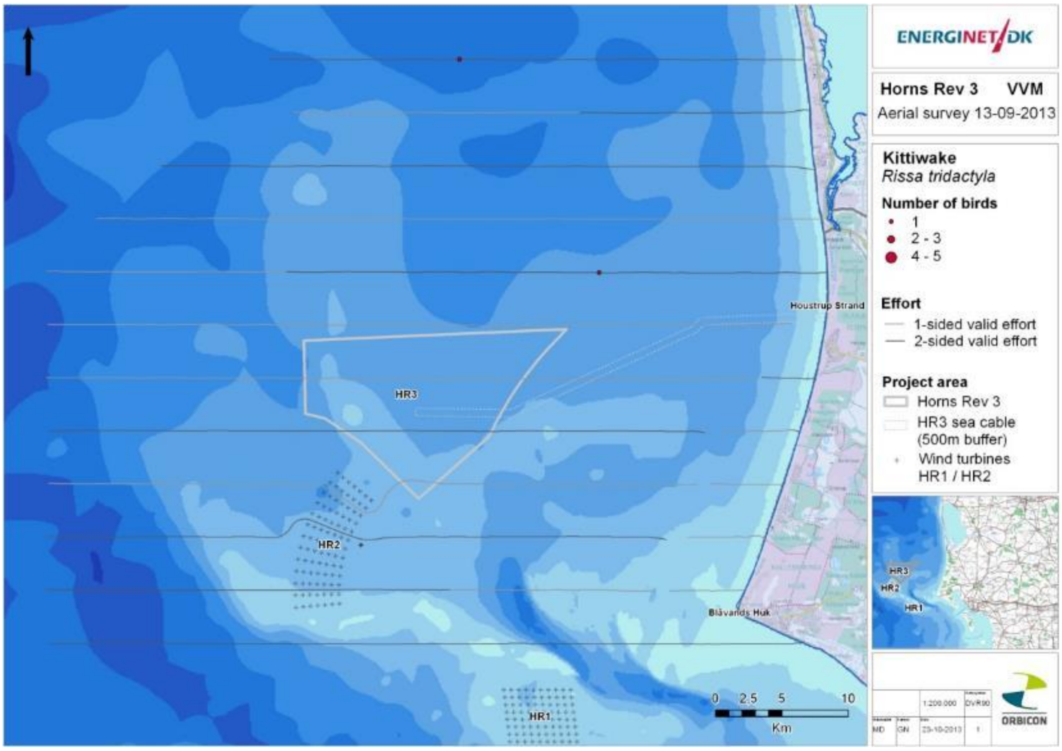


Figure 0.82 Observed Kittiwake distribution during the aerial survey on 13-09-2013.

Terns (Sandwich Tern, Common Tern, Arctic Tern, Little Tern)

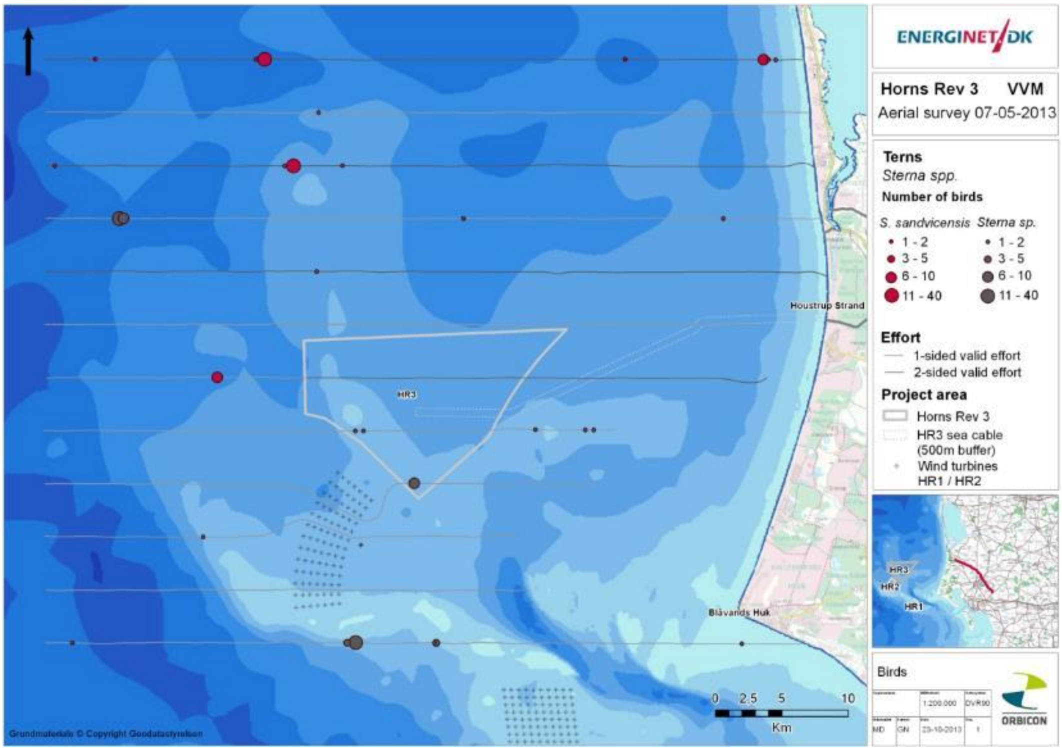


Figure 0.83 Observed distribution of terns during the aerial survey on 07-05-2013.

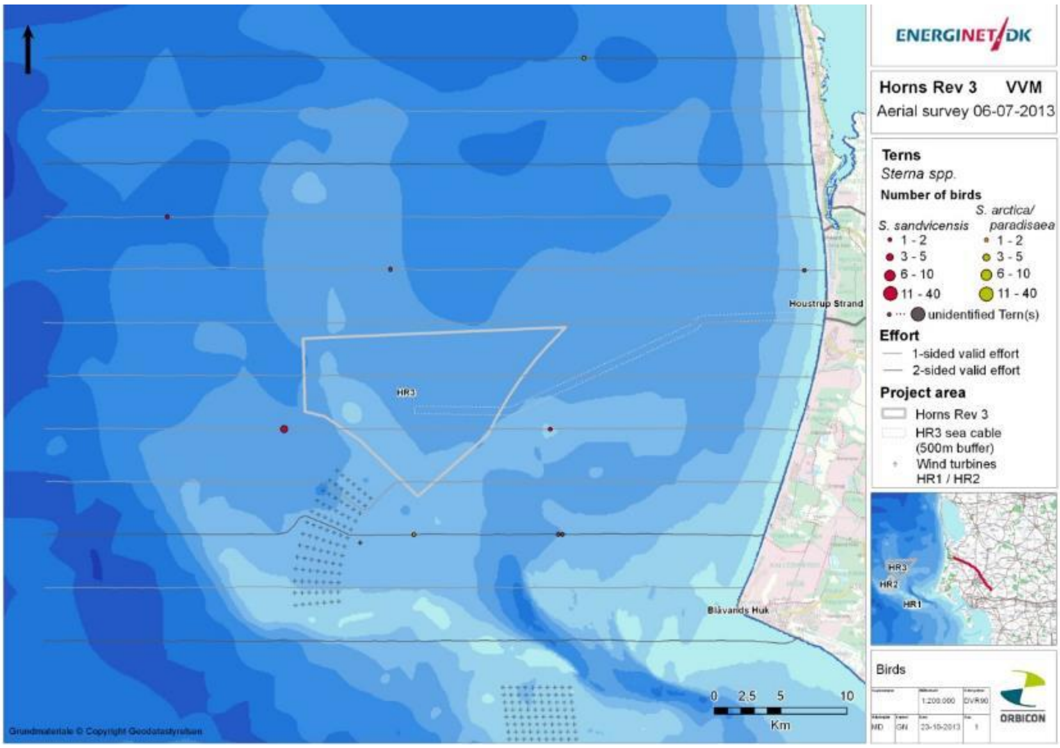


Figure 0.84 Observed distribution of terns during the aerial survey on 06-07-2013.

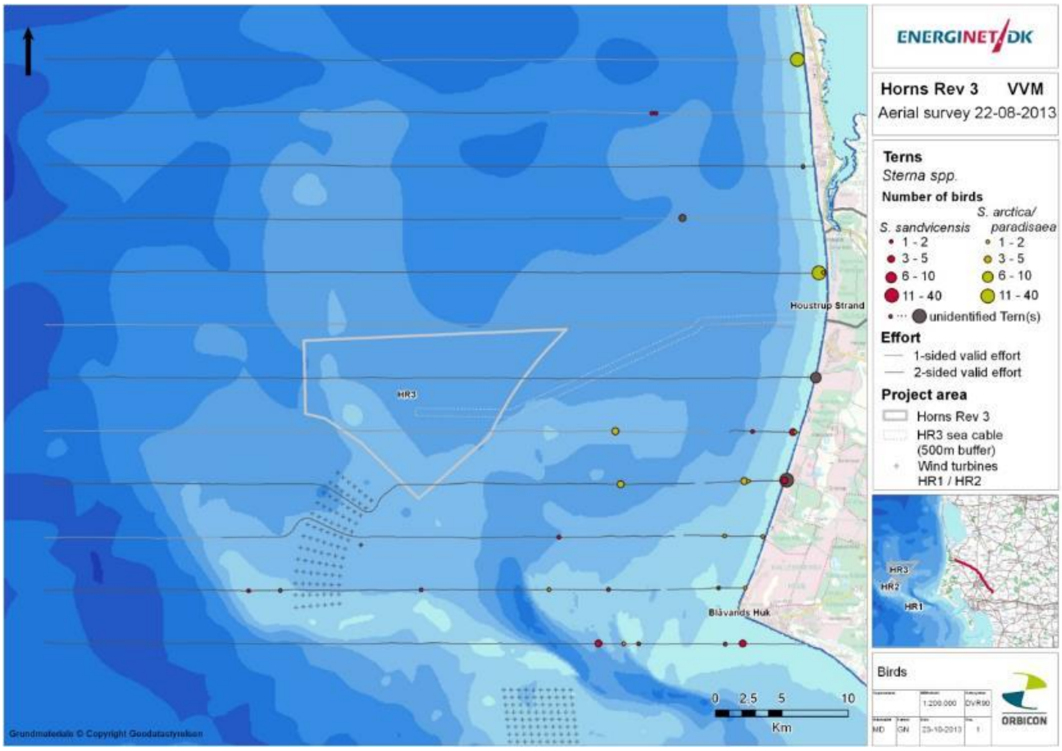


Figure 0.85 Observed distribution of terns during the aerial survey on 22-08-2013.

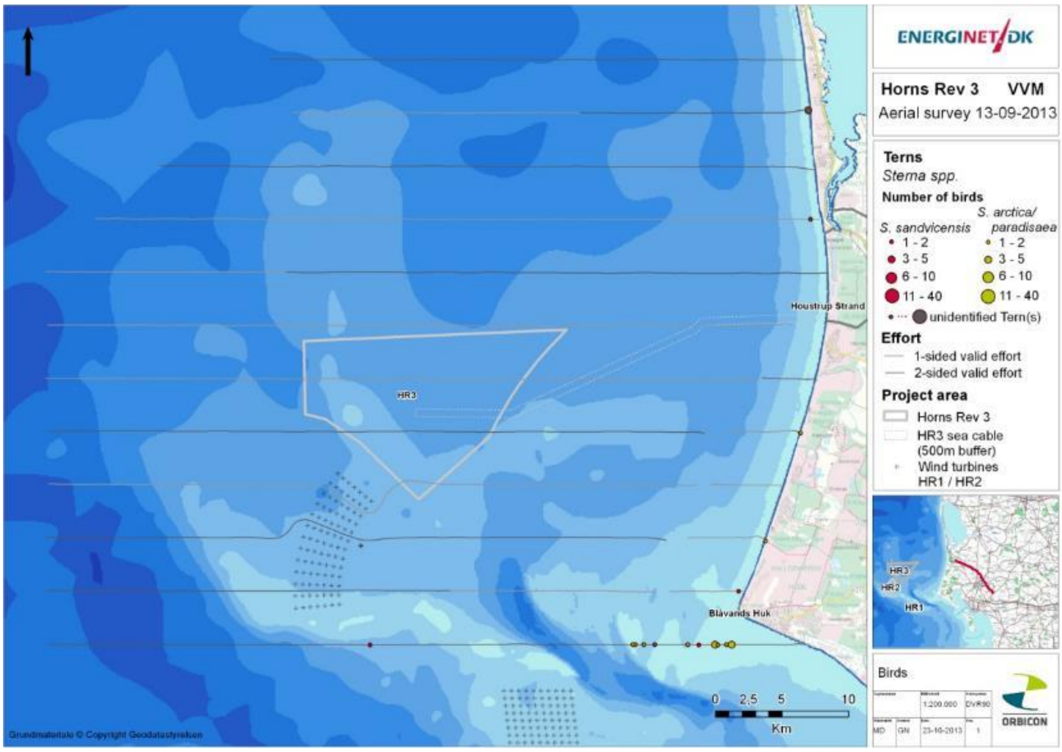


Figure 0.86 Observed distribution of terns during the aerial survey on 13-09-2013.

Auks (Guillemot, Razorbill)

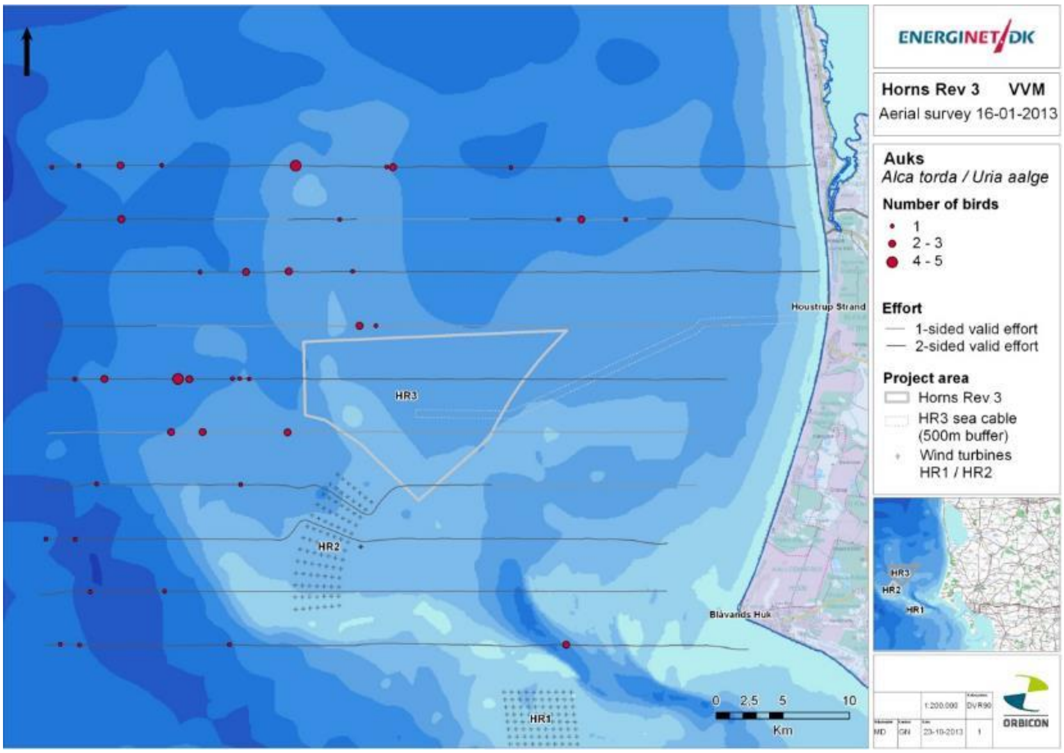


Figure 0.87 Observed distribution of auks (Common Guillemot / Razorbill) during the aerial survey on 16-01-2013.

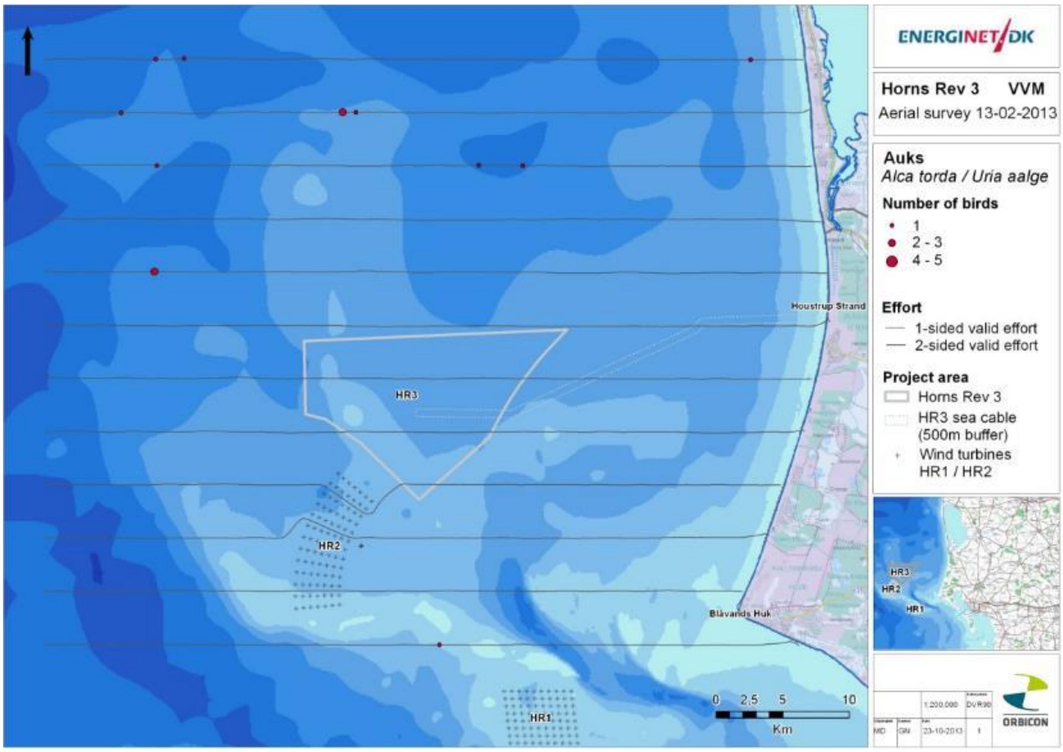


Figure 0.88 Observed distribution of auks (Common Guillemot / Razorbill) during the aerial survey on 13-02-2013.

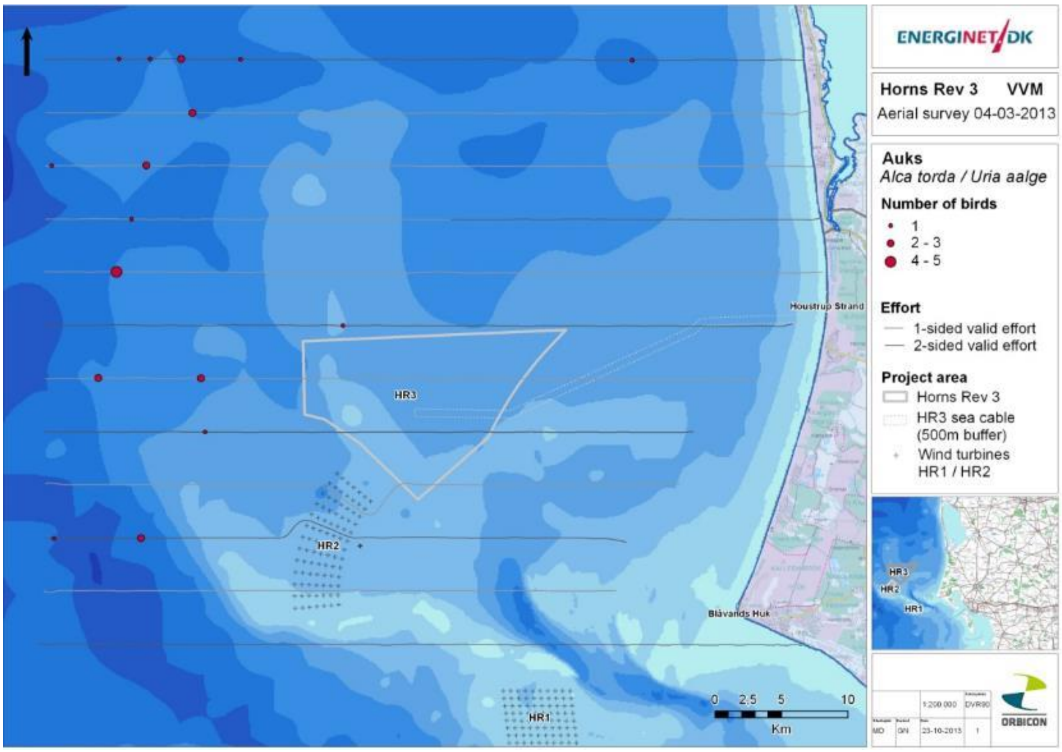


Figure 0.89 Observed distribution of auks (Common Guillemot / Razorbill) during the aerial survey on 04-03-2013.

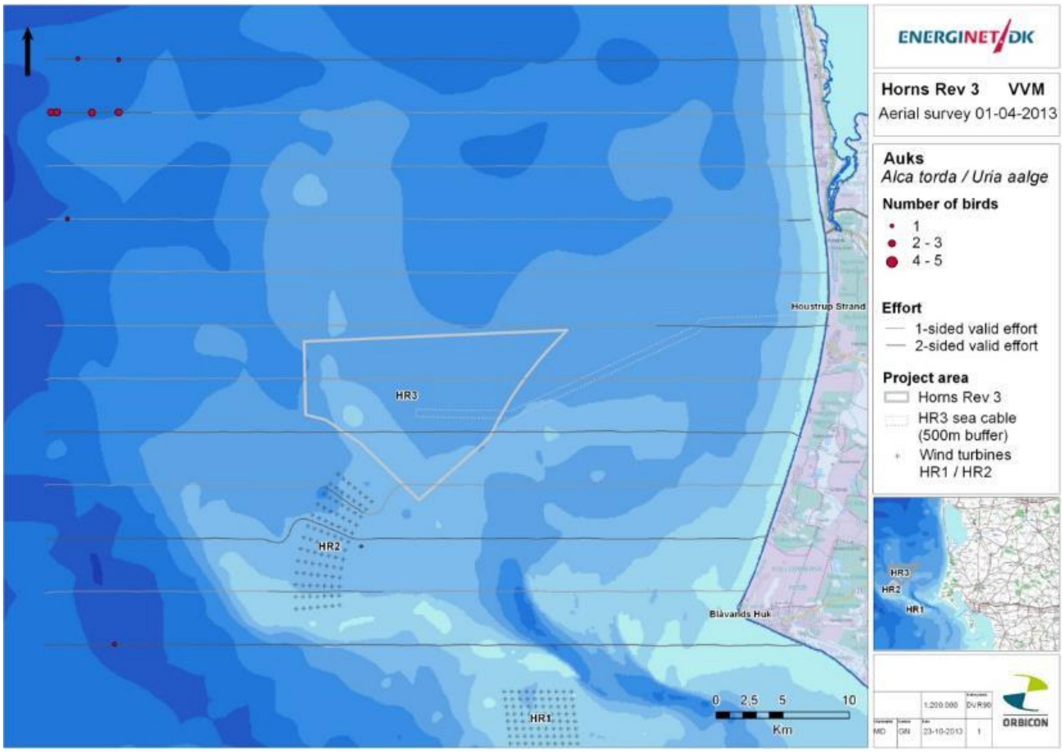


Figure 0.90 Observed distribution of auks (Common Guillemot / Razorbill) during the aerial survey on 01-04-2013.

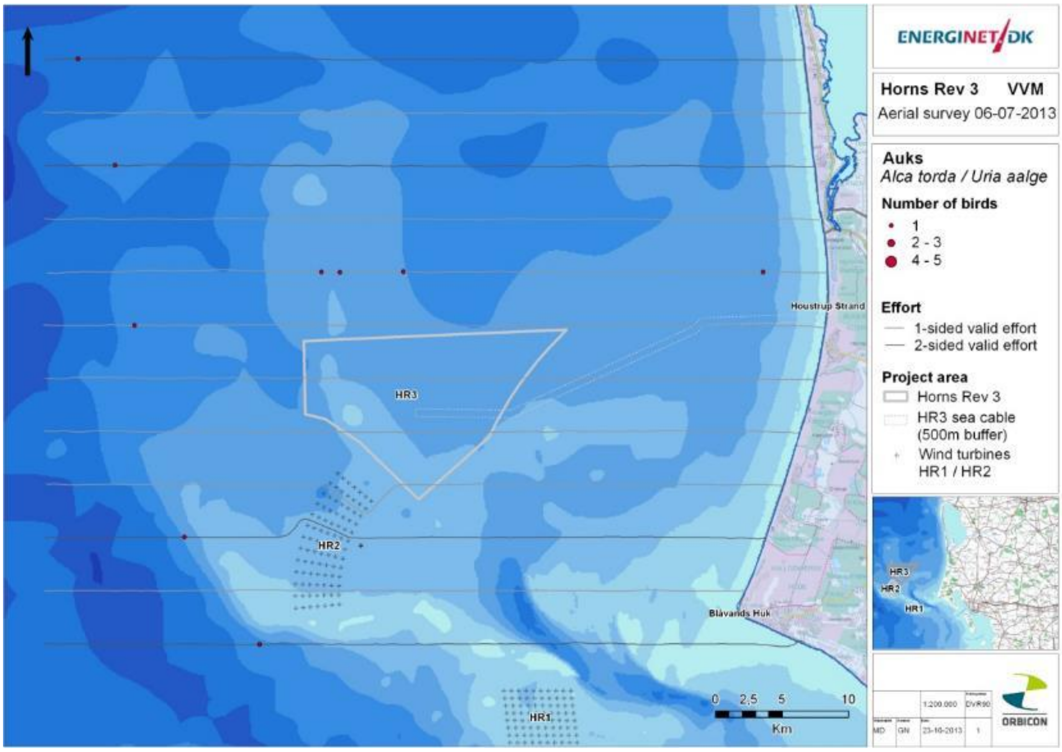


Figure 0.91 Observed distribution of auks (Common Guillemot / Razorbill) during the aerial survey on 06-07-2013.

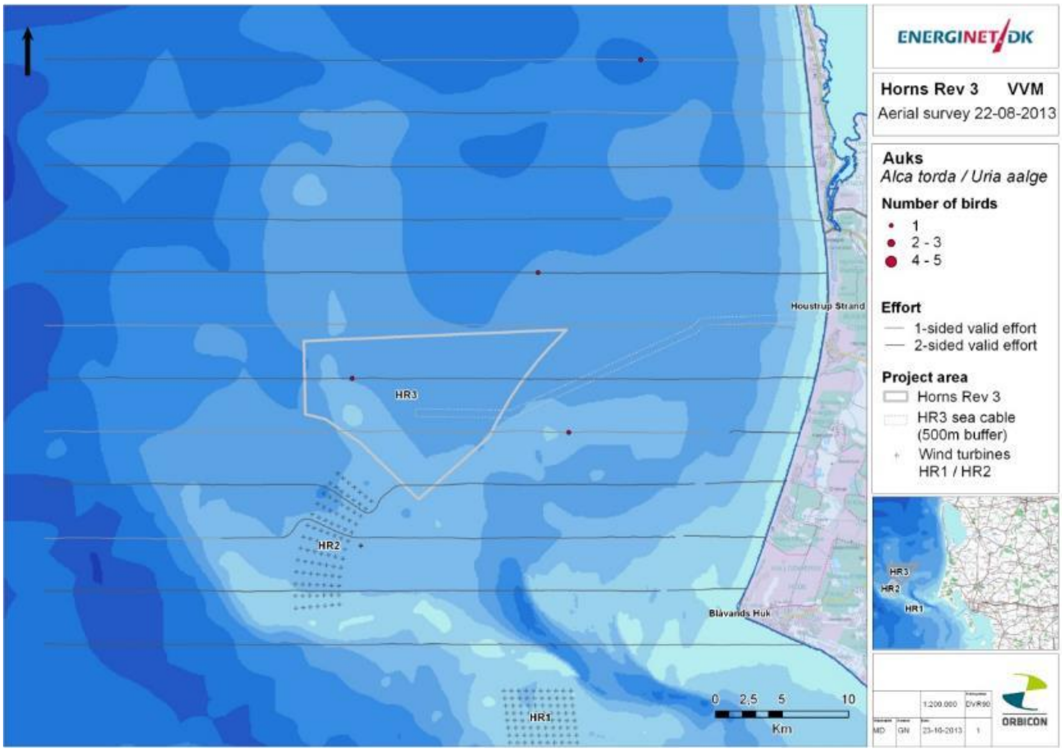


Figure 0.92 Observed distribution of auks (Common Guillemot / Razorbill) during the aerial survey on 22-08-2013.

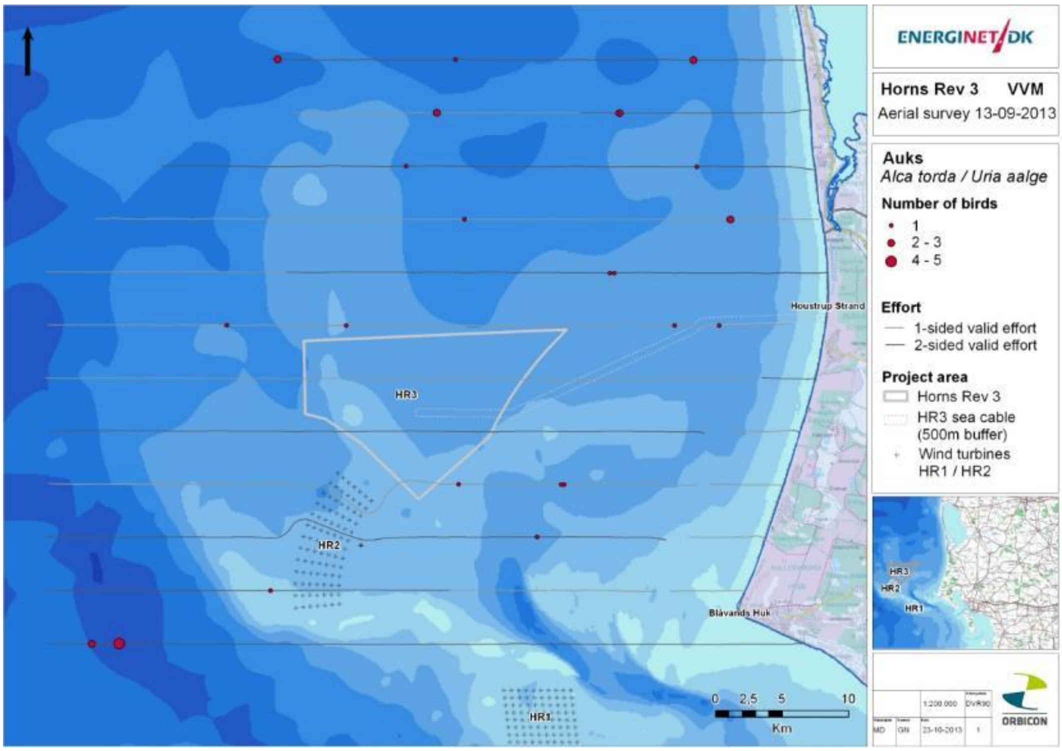


Figure 0.93 Observed distribution of auks (Common Guillemot / Razorbill) during the aerial survey on 13-09-2013.

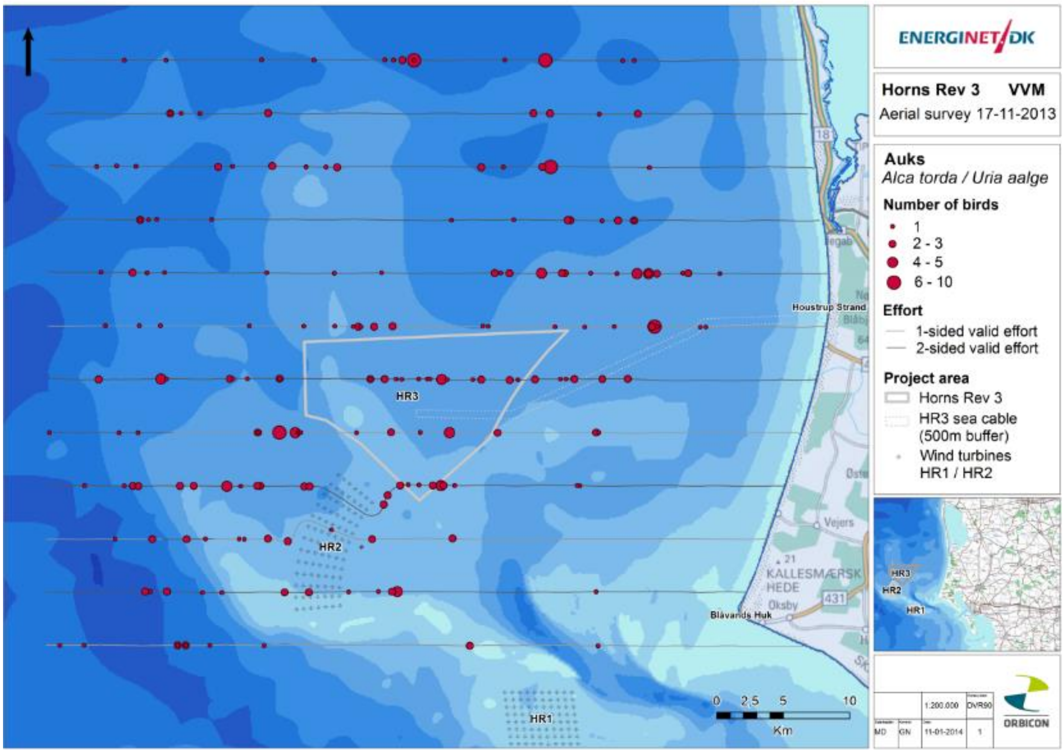


Figure 0.94 Observed distribution of auks (Common Guillemot / Razorbill) during the aerial survey on 17-11-2013.