Offshore wind farms and seabirds in the Dutch Sector of the North Sea:

"What are the best and the worst locations for future development?"

M.F.L. Leopold & E.M.Dijkman

Report number C134/10

IMARES Wageningen UR

(IMARES - Institute for Marine Resources & Ecosystem Studies)

Client:	WE@SEA P/a ECN Postbus 1 1755 ZG PETTEN J. Beurskens

Publicatiedatum: 3 November 2010

IMARES WAGENINGEN UR

IMARES is:

- an independent, objective and authoritative institute that provides knowledge necessary for an integrated sustainable protection, exploitation and spatial use of the sea and coastal zones;
- an institute that provides knowledge necessary for an integrated sustainable protection, exploitation and spatial use of the sea and coastal zones;
- a key, proactive player in national and international marine networks (including ICES and EFARO).

P.O. Box 68	P.O. Box 77	P.O. Box 57	P.O. Box 167
1970 AB IJmuiden	4400 AB Yerseke	1780 AB Den Helder	1790 AD Den Burg Texel
Phone: +31 (0)317 48 09 00	Phone: +31 (0)317 48 09 00	Phone: +31 (0)317 48 09 00	Phone: +31 (0)317 48 09 00
Fax: +31 (0)317 48 73 26	Fax: +31 (0)317 48 73 59	Fax: +31 (0)223 63 06 87	Fax: +31 (0)317 48 73 62
E-Mail: imares@wur.nl	E-Mail: imares@wur.nl	E-Mail: imares@wur.nl	E-Mail: imares@wur.nl
www.imares.wur.nl	www.imares.wur.nl	www.imares.wur.nl	www.imares.wur.nl

Contents

1.

Introduction

Governments of countries around the North Sea are developing plans for extensive use of offshore wind power. The first offshore wind parks are now operational in rather nearshore waters in Denmark, the Netherlands, Belgium and the UK. Many more are planned, both nearshore and offshore. "Green" energy has become a high priority in a world that faces decreasing fossil energy reserves, ever-increasing demands, as well as increasing atmospheric CO_2 levels and rising global temperatures. Wind power is one of the major techniques currently used for generating CO_2-neutral energy, but space on land, where this energy is to be used, is limited. Attention is thus diverted to the vast open space of the sea, that seems to have ample space for large-scale development of wind power. The open sea is not devoid of life, however, and certain natural values that are protected under national and international law (most importantly the EU's Birds and Habitats Directives) may suffer from offshore wind power development. This would be at odds with the idea that wind power is "green".

A surge in offshore wind farm development is expected across the North Sea in the near future. Site selection for future parks in Dutch waters is in full progress (see: www.Noordzeeloket.nl), and depends on a great number of factors. Navigational safety is of prime importance: wind farms need to be outside major and minor shipping lanes, clearways, harbour approaches and military exercise areas. Economical reasoning dictates that offshore wind farms are best situated near land but for aesthetic reasons they might be better put further offshore. Technical restrictions concern water depth and potential hazards in the seafloor (dumped ammunition, shipwrecks, pipes, cables). Apart from these technical and economical considerations, nature conservation needs to be taken into account. Several Nature 2000 areas have been assigned in Dutch offshore waters and these are to be kept free from offshore wind farm development. However, conservation issues are not limited to these sites, and protected wildlife needs to be considered elsewhere as well. Several groups of animals are protected under the EU's Birds and Habitat Directives: all seabirds (being migratory species), the marine mammals that commonly occur in Dutch waters, and certain fish species. There is, at present, insufficient information to deal with the mammals and fish, at the spatial level of prospect sites for offshore wind farms. In contrast, there is a wealth of information on distribution and densities of seabirds across the Dutch Continental Shelf (DCS), across the seasons and for a large number of years.

1. Seabirds, legal considerations, and offshore wind farms

Under the Birds Directive certain species (Annex 1) of seabirds are specifically protected, and in addition, all migratory birds are protected. Migratory birds are birds that breed in one country, and cross national borders to moult or winter in other countries. With very few exceptions, most North Sea seabirds meet this criterion. Moreover, many seabirds are protected in their breeding colonies and developments that interfere with these birds outside the colonies, also have an impact on the protected colonies themselves. There is thus every reason to consider the possible impacts of offshore wind power development on the North Sea's seabirds.

Seabird densities and species assemblies vary across the North Sea, both in space and between seasons (Camphuysen & Leopold 1994; Skov et al. 1995; Stone et al. 1995; Arts & Berrevoets 2006; Arts 2009). It follows, that different areas at sea have different values for birds, both on the species level and on the level of communities (Skov et al. 2007). This value also varies between seasons, as seabirds migrate in massive numbers across the North Sea, exploiting different areas at different times of year. However, an offshore wind farm, once in place, occupies a site year round. This means, that year-round surveys of bird values are needed to assess the importance of sites and that (across-year) average or even maximum values are the most appropriate parameters for assessing the values of sites in relation to offshore wind parks.

2. Not all birds are equal

Different bird species respond differently to offshore wind turbines. Also, the "value" of different birds species may be appreciated differently, depending for instance on their global population size. Because of these differences, birds need to be weighted before a general assessment of the risk of interference between offshore wind parks and seabirds can be made. Garthe & Hüppop (2004) have developed a wind farm sensitivity index (WSI) for seabirds that occur in the German part of the North Sea. The German and Dutch sectors are both situated in the relatively shallow eastern parts of the North Sea and are adjacent to each other. The two sectors are quite similar in many (seabird-related) aspects and the work of Garthe & Hüppop can be extrapolated to Dutch waters. The wind farm sensitivity index takes into account nine factors, that influence a species' vulnerability to offshore wind turbines: flight manoeuvrability (can they easily avoid collisions?); flight altitude (birds can only collide when they fly at rotor height); percentage of time flying (birds cannot collide with rotors while swimming); nocturnal flight activity (birds are more vulnerable at night, when rotors are not visible or when the threat (noise) cannot easily be assessed); sensitivity towards disturbance by ship and helicopter traffic (birds flushed from the water may fly into rotors); flexibility in habitat use (more flexible birds may easier avoid impacted areas); biogeographical population size (fatalities have less impact if population size is large); adult survival rate (demography is impacted more through additional mortality in birds with high natural survival rates); and European threat and conservation status (birds already severely threatened may be extra vulnerable to additional stress factors). Each factor was scored on a 5-point scale from 1 (low vulnerability of seabirds) to 5 (high vulnerability of seabirds) and (weighted) summed values were used to make comparisons between species.

3. Adding up apples and pears: the wind farms sensitivity index WSI

The WSI developed by Garthe & Hüppop (2004) is a spatial index, that allows for between-area comparisons, while using data on all seabirds that occur in those areas in as single figure. Values for different seasons may be combined to get a single value for the whole year, removing the temporal aspect and thus making spatial comparisons even easier. Note that offshore wind farms are not a seasonal phenomenon, but impact the environment year-round. Garthe & Hüppop (2004) developed their method for German waters , but argued, that their WSI approach should be 'useful in [other] strategic environmental impact assessments (EIA)'. In the Netherlands, we are exactly at this point of time, as several dozens of potential new sites have been assigned on the basis of safety and economical reasons, but have not yet been fully considered in ecological terms. This paper considers the vulnerability of seabirds for offshore wind farms of the entire DCS, following Garthe & Hüppop (2004) and using a combination of aerial and ship-based seabirds survey data for a long range of years (1991-2009).
The first step in calculating the WSI for an area is to assign species-specific sensitivity indices (SSI) to all species of interest. As outlined above, nine (A-I; Table 1) aspects of seabird biology and conservation are taken into account and combined into using the equation:

$SSI = ((A+B+C+D)/4)*((E+F)/2)*((G+H+I)/3).$

From these, the wind turbine sensitivity index (WSI) is calculated, by combining SSI's for all species with local bird densities:

$WSI = \sum_{species} (\ln(density_{species} + 1) \times SSI_{species})$

Bird species	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**SSI**	**Comment**
Red-thr. diver	5	2	2	1	5	4	4	3	5	45.0	Disturbance by shipping put at 5
Black-thr. diver	5	2	3	1	5	4	4	3	5	49.5	Disturbance by shipping put at 5
Gr.Northern Diver	5	5	3	1	5	4	5	3	5	68.3	Not in Garthe & Hüppop
White-billed Diver	5	5	3	1	5	4	5	3	5	68.3	Not in Garthe & Hüppop
Unid. Diver										45.0	Most are Red-throated
Gr. Crested Grebe	4	2	3	2	3	4	4	1	1	19.3	Conform Garthe & Hüppop
Red-necked grebe	4	2	1	1	4	5	5	1	1	21.0	Disturbance by shipping put at 4
Northern Fulmar	3	1	2	4	1	1	1	5	1	5.8	Conform Garthe & Hüppop
Northern Gannet	3	3	3	2	1	1	4	5	3	11.0	Disturbance by shipping put at 1
Great Cormorant	4	1	4	1	3	3	4	3	1	20.0	Disturbance by shipping put at 3
Greater Scaup	3	1	2	3	4	4	5	2	5	36.0	Not in Garthe & Hüppop
Common Eider	4	1	2	3	4	4	2	4	1	23.3	Disturbance by shipping put at 4
Long-tailed Duck	3	1	2	3	4	4	2	2	1	15.0	Not in Garthe & Hüppop
Common Scoter	3	1	2	3	5	4	2	2	1	16.9	Conform Garthe & Hüppop
Velvet Scoter	3	1	2	3	5	4	3	2	3	27.0	Conform Garthe & Hüppop
Goldeneye	3	1	2	3	4	4	4	2	1	21.0	Not in Garthe & Hüppop
Red-br. Merganser	4	1	2	3	4	4	4	2	1	23.3	Not in Garthe & Hüppop
Pomarine Skua	1	3	5	1	2	2	4	3	2	15.0	Not in Garthe & Hüppop
Arctic Skua	1	3	5	1	2	2	4	3	1	13.3	Disturbance by shipping put at 2
Long-tailed Skua	1	3	5	1	2	2	4	3	1	13.3	Not in Garthe & Hüppop
Great Skua	1	3	4	1	2	2	5	4	2	16.5	Disturbance by shipping put at 2
Unid. skua										14.0	Not in Garthe & Hüppop
Mediterranean Gull	1	3	2	3	1	2	5	2	1	9.0	Not in Garthe & Hüppop
Little Gull	1	1	3	2	2	3	5	2	4	16.0	Disturbance by shipping put at 2
Black-headed Gull	1	5	1	2	1	2	1	3	1	5.6	Disturbance by shipping put at 1
Common Gull	1	3	2	3	1	2	2	2	4	9.0	Not in Garthe & Hüppop
Lesser BB Gull	1	4	2	3	1	1	4	5	2	9.2	Disturbance by shipping put at 1
Herring/LBB Gull										8.3	Not in Garthe & Hüppop
Herring Gull	2	4	2	3	1	1	2	5	1	7.3	Disturbance by shipping put at 1
Great BB Gull	2	3	2	3	1	2	4	5	2	13.8	Disturbance by shipping put at 1
Unid. BB Gull										11.5	Not in Garthe & Hüppop
Kittiwake	1	2	3	3	1	2	1	3	1	5.6	Disturbance by shipping put at 1
Unid. gull										8.3	Not in Garthe & Hüppop 5920
Sandwich Tern	1	3	5	1	1	3	4	4	4	20.0	Disturbance by shipping put at 1
Common Tern	1	2	5	1	1	3	3	4	1	12.0	Disturbance by shipping put at 1
Arctic Tern	1	1	5	1	1	3	3	4	1	10.7	Disturbance by shipping put at 1
Commic Tern										11.3	Not in Garthe & Hüppop
Little tern	1	1	4	1	2	3	4	4	4	17.5	Not in Garthe & Hüppop
Black tern	1	1	4	1	2	3	4	4	4	17.5	Conform Garthe & Hüppop
Common Guillemot	4	1	1	2	2	3	1	4	1	10.0	Disturbance by shipping put at 2
Razormot										11.6	Not in Garthe & Hüppop
Razorbill	4	1	1	1	2	3	2	5	2	13.1	Disturbance by shipping put at 1
Black Guillemot	3	1	1	2	2	4	3	4	2	15.8	Not in Garthe & Hüppop
Little Auk	3	1	1	3	2	4	2	5	1	16.0	Not in Garthe & Hüppop
Atlantic puffin	3	1	1	1	3	3	2	5	5	18.0	Disturbance by shipping put at 3

Table 1. *Summed wind farm sensitivities (last column) for the main North Sea seabirds (first column), based on underlying factors A-I: A: flight maneuverability, B: flight altitude, C: percentage flying, D: nocturnal flight activity, E: disturbance by ship traffic; F: habitat use flexibility, G: biogeographical population size, H: adult survival rate, I: European Threat and Conservation Status (see text). Deviations from and additions to the values in Garthe & Hüppop (2004) are indicated.*

4. Materials and Methods

Two databases

The DCS has been independently surveyed for seabirds by two parties, using different methods:

1. The governmental body RIKZ uses aerial survey techniques (strip transects), to estimate seabird densities across the entre DCS, every other month (Baptist & Wolf 1991; 1993). The plane follows pre-set survey lines (roughly the same over the years). Important strengths are the total and repeated coverage, and low heterogeneity. Weaknesses are that some areas consistently missed, such as some military shooting ranges that are closed for small aircraft or very nearshore waters that are not surveyed); some problems with species identification (auks) and observer swamping (large gull flocks).

2. Other parties, joined in the European Seabirds at Sea (ESAS) Database Group used ship-based survey techniques (strip-transects, much like in the aerial surveys; see Tasker et al. 1984; Skov et al. 2005). Strengths are that no areas were off limits, better specific identification possibilities and less swamping, due to lower survey speeds. Weaknesses are a highly irregular coverage, with areas with much survey effort (coastal, central Frisisan Front) and areas of low coverage.

Special, dedicated surveys for concentrations of seaduck (scoters and eiders) have been conducted by both parties (Leopold et al. 1995 and subsequent reports of aerial surveys, e.g. Arts 2010). Seaduck concentrations may be very large (maximum in the order of 200,000; Leopold 1993). Such concentrations may cover a rather large area, but always in nearshore waters that are of little relevance to future (offshore) wind farm development in the Netherlands. Spatial precision is low compared to other counts, as ducks were often counted per stretch of coast, e.g. one Wadden Island (Leopold et al. 1995). A direct comparison with other seabirds at sea data is therefore difficult, while the seaduck data are not very relevant, and given the high numbers of birds often involved, would dwarf values for all other birds combined. For this reason, the seaduck counts are treated separately.

Database amalgamation

Both databases have a similar base: strip transects where units are individual counts of finite length and width (and hence area), with geolocation, time, surface area and a given number of birds. Aerial Surveys were always conducted in six seasons: Aug/Sep ,('Season 1'), Oct/Nov, Dec/Jan, Feb/Mar, Apr/May, Jun/Jul ('Season 6'). Survey effort is confined to within the limits of the DCS. Ship based surveys were not limited to the DCS, but covers the greater North Sea. Any data within Kriging distance across the borders of the DCS (7 km, see below) are included in the joint dataset. All data, aerial and ship-based, were subdivided into the six "seasons" used in the aerial survey design.
Seabirds survey data typically contain many zero-values, followed by many low values and a tail towards higher values. The data points are thus usually is not normally distributed. Therefore, the data were transformed to achieve normality. A double-square root transformation was used (rather than a log-transformation, to facilitate back-transformation of data). A plot of the data-distribution (Figure 1) shows that the outcome of either transformation is quite similar and that normality is achieved (with the exception of the zero-values).

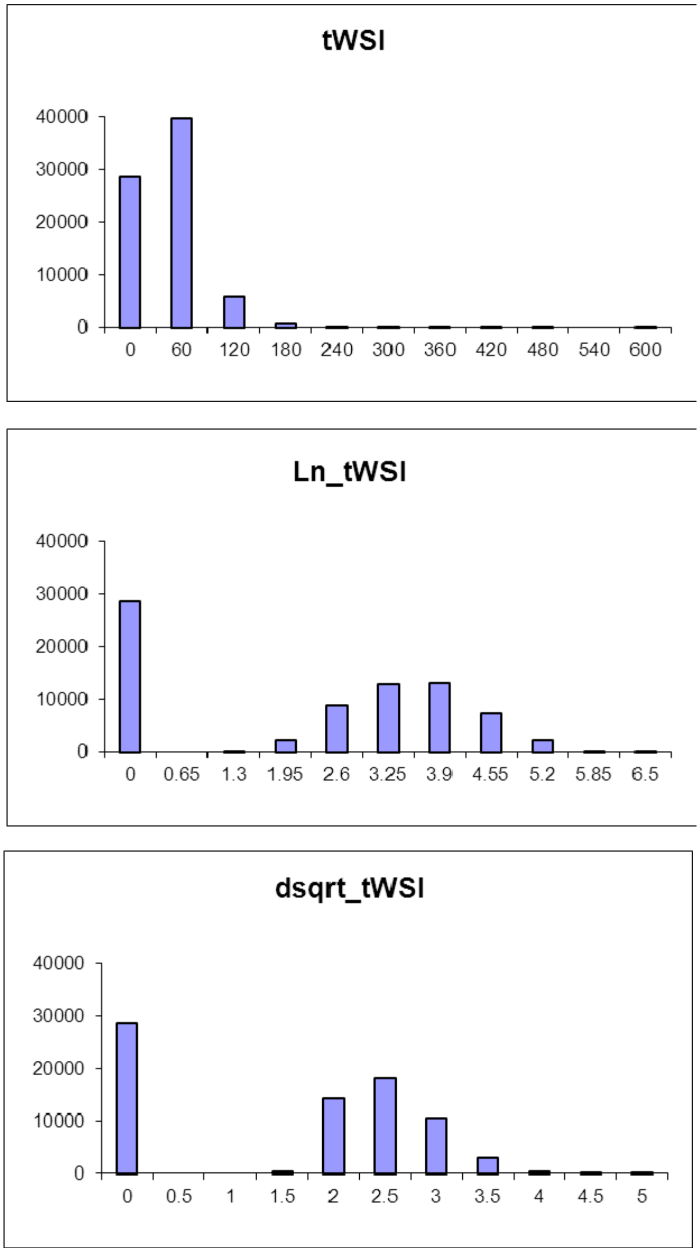
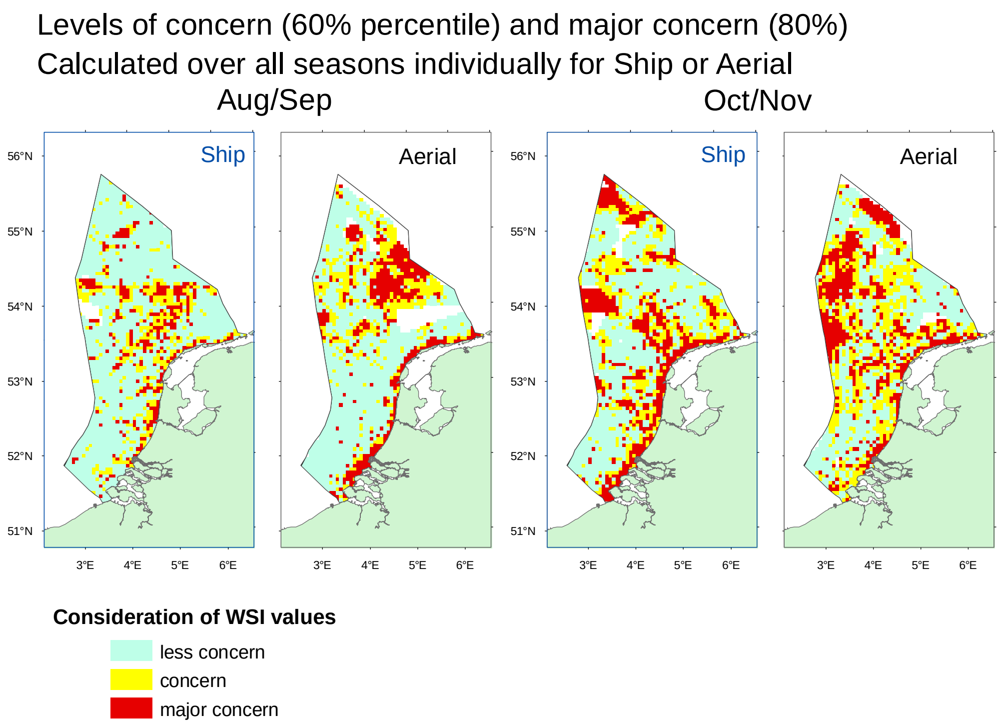
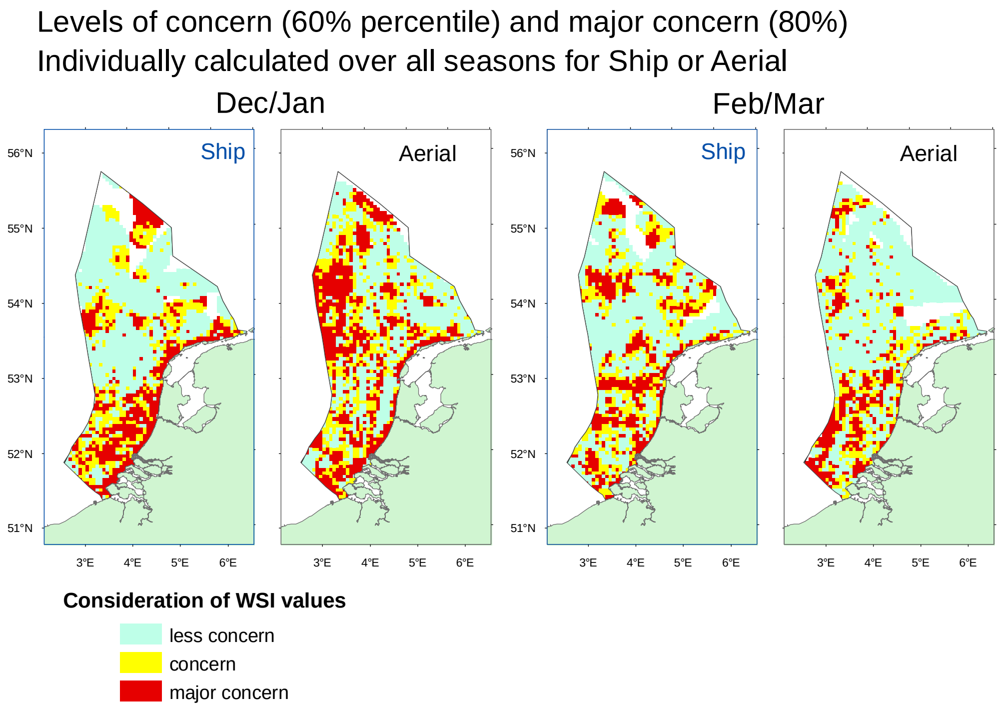


Figure 1*. Distribution of data point values, across all seasons and grid cells, for aerial and ship-based survey combined. Top panel shows data without transformation, central panel shows data after log-transformation, lower panel shows data after double-square root transformation*

In both the aerial and the ship-based database, individual strip counts were converted to WSI values (using all birds seen within the counting strips, their SSI's and the surface area of the strip counted). WSI values were then grouped in a grid of 5*5 km cells. The DCS has a total of 2370 such cells, that were not always all covered in each season. Geostatistical interpolation techniques (Ordinary Kriging) were used to extend predictions beyond actual coverage, as long as this was deemed feasible. Inspection of the semi-variograms resulted in a lag size (for Kriging 5x5 km^2 cell-averaged WSI values) of 7 km and 2-5 neighbours included per quarter circle-segment around each central point . In other words, the final (seasonal) WSI value for each cell within the DCS was predicted by using the value for that cell, as well as surrounding values within 7 km around the central point of that cell. Seven km radius circles were drawn around each central cell point and subdivided into 4 quarters. In each of these quarters the closest 2 (minimum) to 5 cell-WSI averages were included in the estimation procedure. If fewer than 2 neighbouring values were available within the lag size of 7 km, no prediction was generated for that cell.

Results are shown in three different colours (Figure 2), following the recommendation by Garthe & Hüppop (2004). The lower 60 percentile of the filled grid cells are considered to be of little concern (green); the next 20% (=60-80 percentile) to be of concern (yellow or orange) and the upper 20 percentile to be of major concern (red). Note that all data, across all 6 seasons were used to determine 60 and 80 percentile cut off points. This was done to identify seasons with high vulnerability and seasons with lower vulnerability (cf Garthe & Hüppop 2004). This means that more than half of the DCS surface area is by definition considered to be of little concern and that only 20% (averaged over the seasons) is of major concern, a conservative approach according to Garthe & Hüppop (2004).
Data for seaduck are presented separately (Figure 3).


Levels of concern (60% percentile) and major concern (80%)
Calculated over all seasons individually for Ship or Aerial
Aug/Sep
Oct/Nov
Ship
Aerial
Ship
Aerial
56°N
55°N
54°N
53°N
52°N
51°N
3°E
4°E
5°E
6°E
Consideration of WSI values
less concern
concern
major concern


Levels of concern (60% percentile) and major concern (80%)
Individually calculated over all seasons for Ship or Aerial
Dec/Jan
Feb/Mar
Ship
Aerial
Ship
Aerial
56°N
55°N
54°N
53°N
52°N
51°N
3°E
4°E
5°E
6°E
Consideration of WSI values
less concern
concern
major concern

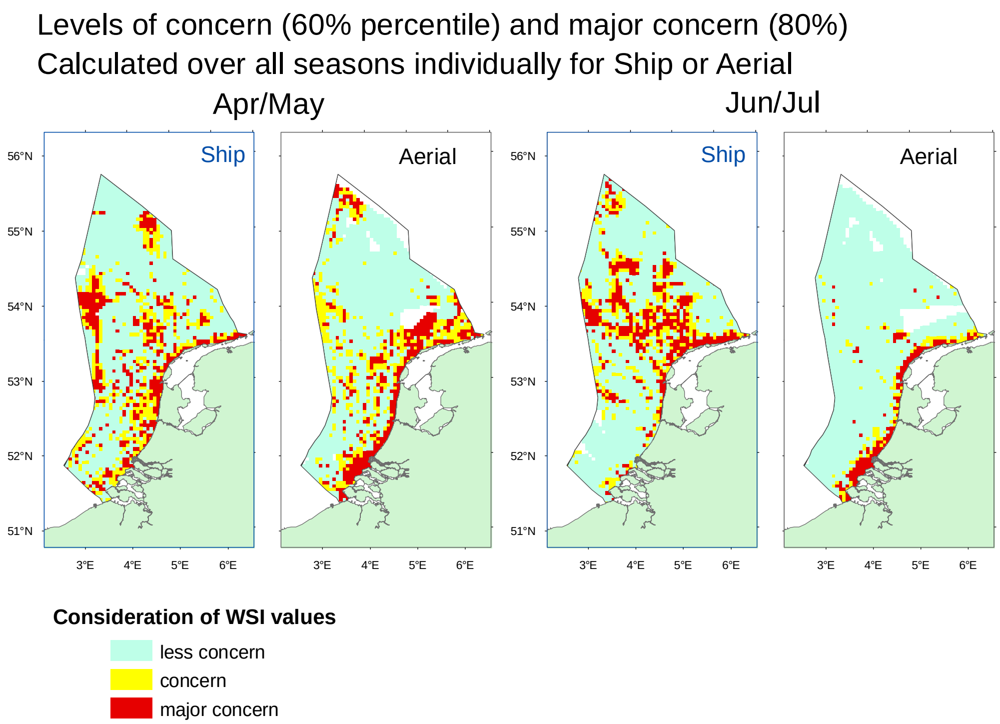


***Figure 2** Comparisons of ship-based and aerial survey results, per season. Within each database, red areas are of major concern, yellow areas are of concern and green areas are of less concern. White areas are data-deficient for that database and season*

Seaduck

Bi-monthly values of common scoter numbers were collated for the entire Dutch coastal waters, and grouped for several segments. These are, from Northeast to Southwest: Rottum and Schiermonnikoog combined, Ameland, Terschelling, Vlieland, Texel, Den Helder-Bergen, Bergen-Katwijk, Katwijk-Maasvlakte and Voordelta. These subdivisions follow Natura 2000 boundaries and apparent differences in local geography and seaduck presence. Only common scoters were used as these were by far the most numerous species within this group, while others (eiders and velvet scoters) would, if present, join the flocks of common scoters. Average numbers present per two-month period were divided by the surface area of each sub-area (from the coast out to the -20 m isobath) to obtain average densities. These were then multiplied with the commons scoter SSI and the result was mapped, at a spatial resolution of the above mentioned sub-areas (Figure 3). Maximum presence (largest flocks recorded per sub-area) are also given.

Most areas have very high WSI values if only the ducks are considered. Two "green" areas stand out: Bergen-Katwijk and Katwijk-Maasvlakte. Some caution is needed here, however. For this analysis we used the same time-span as for the other seabirds data (1991-2009). No (large) flocks were found in these parts in these years but in earlier years, flocks of many tens of thousands have in fact resided here (full account of earlier presence given in Leopold et al. 1995). There is thus no reason to believe that these green areas will always remain green.

Common Scoter

1991-2009

Season	Area	km2	top number	AVG 91-09	WSI Scoters
year	Schier-Rottum	374	56,000	2,843	23.80
year	Ameland	243	40,000	2,336	18.27
year	Terschelling	272	125,000	6,540	43.88
year	Vlieland	207	15,000	352	6.87
year	Texel	279	80,000	1,067	15.95
year	Den Helder-Bergen	390	100,000	1,332	15.11
year	Bergen-Katwijk	853	0	0	0.00
year	Katwijk-Maasvlakte	271	0	0	0.00
year	Voordelta	866	24,245	1,666	15.47

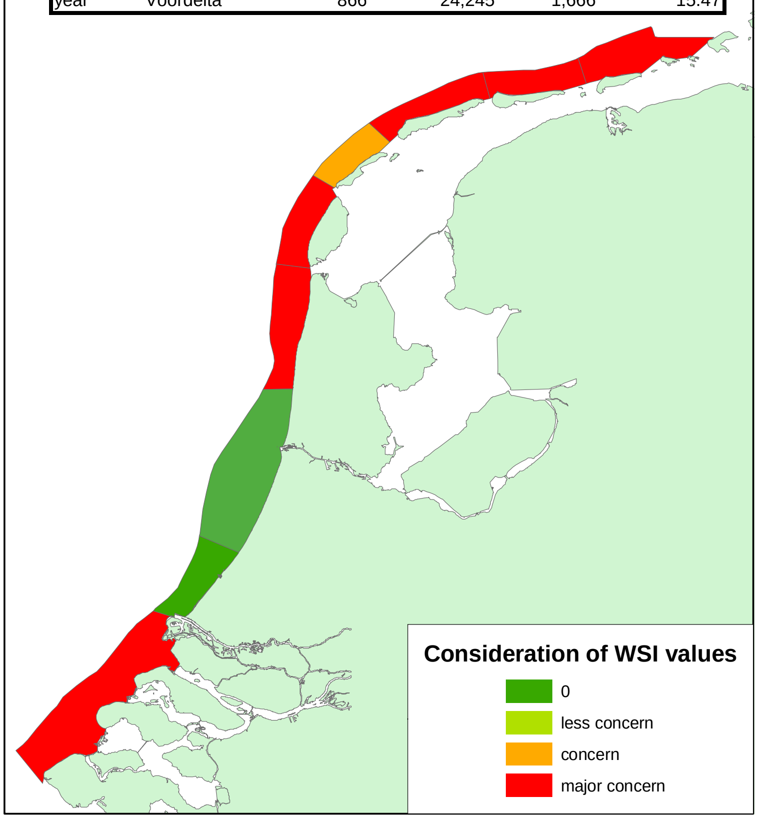


Figure 3. *Presence of common scoters Melanitta nigra along the Dutch coast. Average values across seaons and years are given in the Table inset, as are maximum flock sizes recorded. WSI-values are calculated for entire sub-areas. Note that 50-60,000 scoters wintered in "Bergen-Katwijk" in 1987, while similar numbers were noted for "Katwijk-Maasvlakte around 1930, indicating that the whole Dutch coastline has great potential for seaduck.*

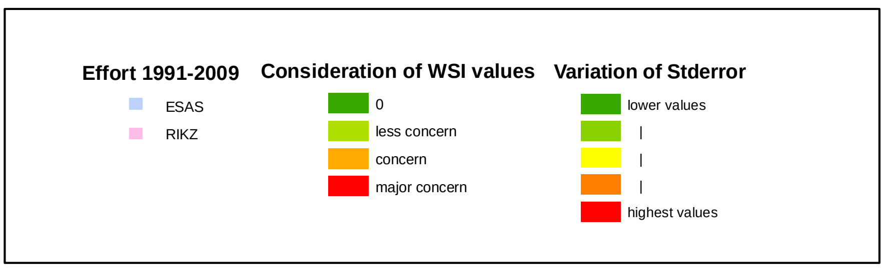
5. Combining aerial and ship-based survey data

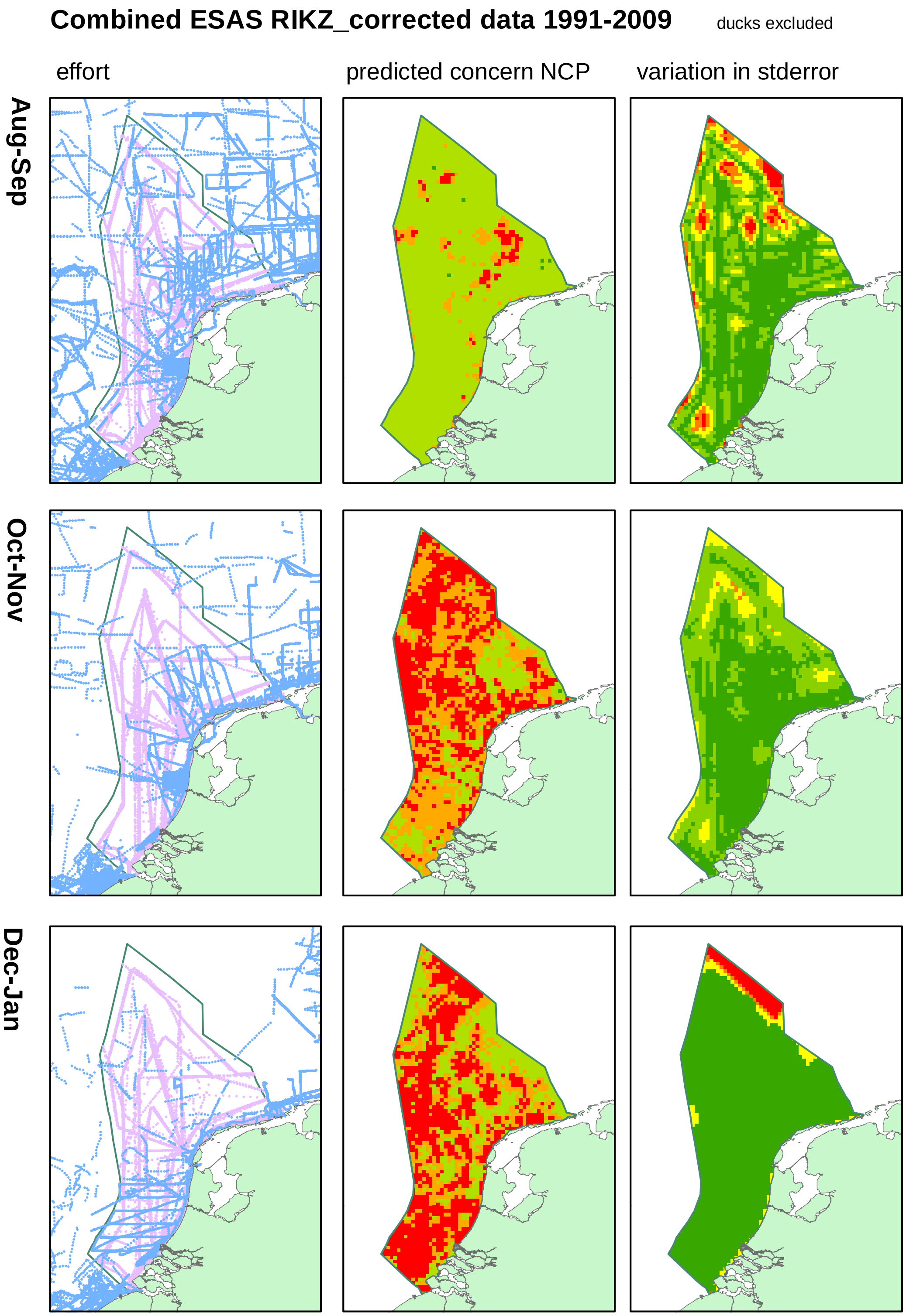
Because the two principal survey methods have intrinsic differences, outcomes (WSI values) may structurally differ between them. A cross check between the two databases was performed. X-Y plots were generated of predicted grid-cel data (WSI-transformed), per season. Potential bias was removed by rescaling the aerial survey data to match the ship-based survey data, using linear regression:

$WSI_{\text{Aerial}} = a \times WSI_{\text{ship-based}} + b$

Next, the two databases were merged, with aerial WSIs adapted as described above. Subsequently, an Ordinary Kriging was done on the combined data, per seaon (lag size = 7000 m; and 2-5 neighbours included per quarter circle-segment around each cell). This resulted in 6 combined seasonal maps of WSI values across the entire DCS (Figure 4). Next to these maps, the effort per season is plotted (in separate colours for aerial and ship-based data). To the right of these maps, an indication of data reliability is plotted. For the latter, the standard option "standard error" within ESRI Geostatistical Analist was used. This produces normalised standard errors (on the double-square root transformed data) that give some indication of reliability, combining errors resulting from variation between datapoints across the area and errors linked to the Kriging process). Inspection of the structure of these distribution of standard errors suggested that high-value predictions are relatively robust, while relatively high standard errors were linked to low-value predictions.

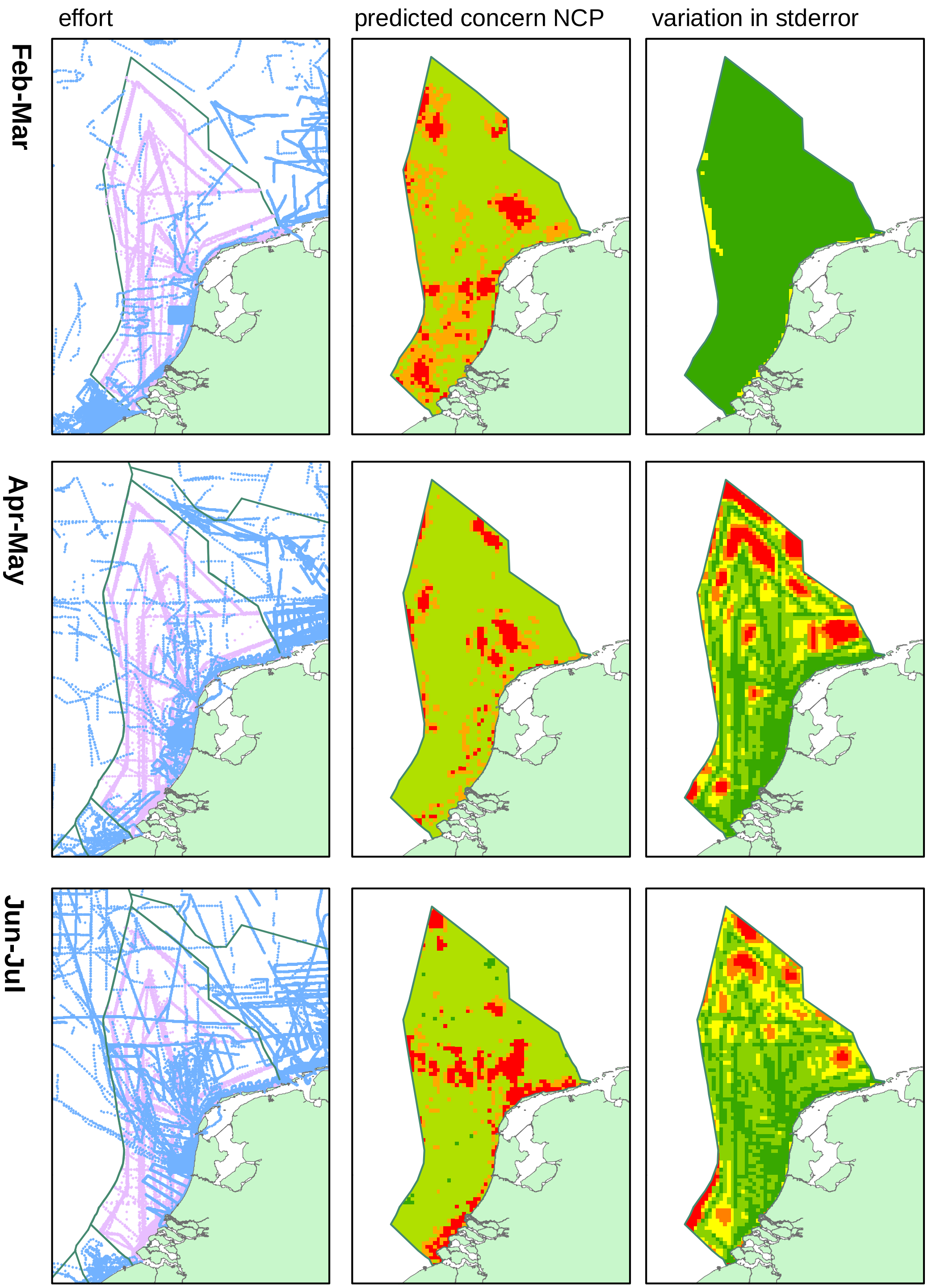
Figure 4 (two pages, overleaf). *Bi-monthly maps of relative WSI values (1991-2009) across the DCS, using a combination of aerial and ship-based survey data (seaducks excluded). Left panels present the distribution of survey effort (blue for ship-based, purple for aerial); central panels give the WSI values (from low, green colours, to "concern" (orange) and "major concern" (red). Right panes give the calculated standard errors, from low tot high (green to red) as depicted below:*





Combined ESAS RIKZ_corrected data 1991-2009
ducks excluded
effort
predicted concern NCP
variation in stderror
Aug-Sep
Oct-Nov
Dec-Jan

Combined ESAS RIKZ_corrected data 1991-2009 ducks excluded



Finally, the six seasonal maps of Figure 4were combined into one year-round map of WSI's across the DCS (Figure 5). To this end, grid cell averages and maximum values were plotted and presented in 20 percentile classes (percentiles based on these data; n=2370 grid cells).

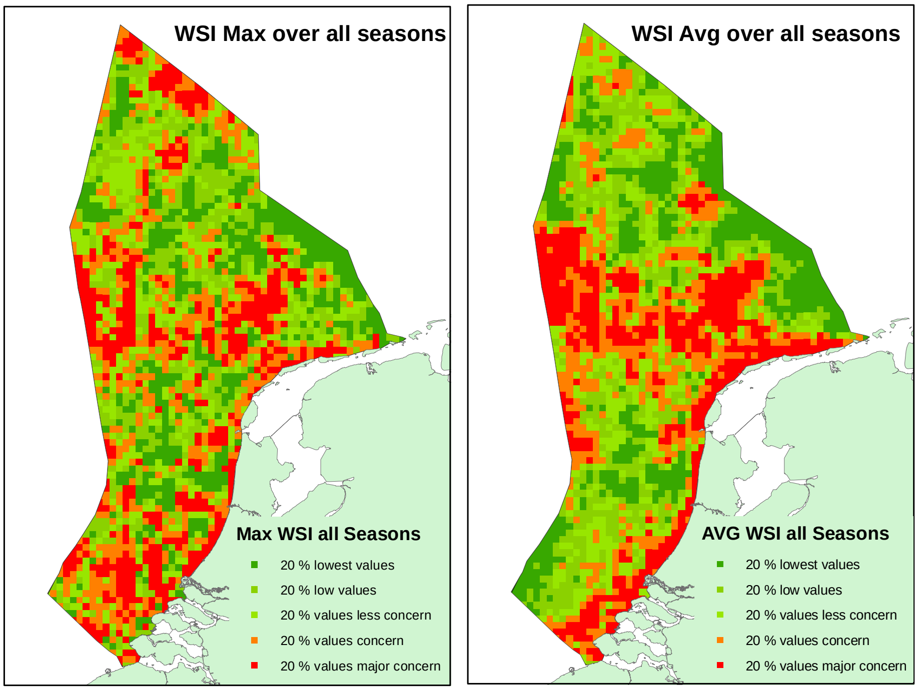


Figure 5*. Year-round maps of seasonal maximum (left) and average WSI values across the DCS, combining aerial and ship-based data (ducks excluded). The data are plotted in five, 20 percentile classes. Areas of concern and of major concern are plotted in orange and red, respectively, while areas of less concern (the lower, 0-60 percentiles) are plotted in various shades of green.*

6. Discussion

This study is the first to combine the full databases of aerial and ship-based seabirds at sea survey data, across the entire Dutch sector of the North Sea. Combining databases poses particular problems of heterogeneity and bias, which were solved as well as possible. A major advantage of including both datasets however, is that coverage increased substantially, reducing the need for extrapolation onto unsurveyed areas. There is clearly much variation in seabird presence at any one location and areas that are poorly surveyed may yield average WSI values that are far removed from the true, or rather, long-term average. In addition to using as many data as possible, such problems were further reduced by taking data from neighbouring cells into account, before predicting cell-averages. Finally, data were smoothed by averaging model results for six bi-monthly "seasons" into one, final map of WSI values across the DCS, and across the whole year, using nearly 20 years of survey data. The final result of this exercise gives a long-term, across-seasons average of the vulnerability of seabirds for offshore windfarms that is rather unsensitive to small-scale variations in survey data, both in time and in space.
The final map of WSI values across the DCS shows a rather clear pattern. Consistently high values, indicating high seabird vulnerability for offshore turbines, are found throughout the neashore waters. Note that these high values were found without incorporating the seaduck data; with these inlcuded, the red would only deepen.

A second and consistant area of high vulnerability is found extending from the northern shores (centered around Terschelling with its large gull colonies) across the Frisian Front to the Cleaver Bank. These areas are all designated Natura 2000 sites (Lindeboom et al 2005); their value as such is thus underpinned by the current analysis.

In addition, areas that have seasonal high WSI values, resulting from seasonal peak seabird occupancy are found in northern parts in late summer and early winter, and in the central southern parts in mid- to late-winter. These result from concentrations of auks, and some other pelagic seabirds. Auks (mainly guillemots and razorbills) should therefore receive special attention in future assessments of offshore wind farm sites (cf Leopold et al. 2010).

We noted that some areas, at the northern outer limit of the DCS, got very high WSI values in some seasons. At present, it is difficult to assess if these high values are real, or (partly) artefacts due to effects of data deficiency at the limits of the study area, and local modelling problems. However the impact of such marginal effects is yet limited, as no wind farms are yet projected at the northern edges of the DCS.

The two existing offshore wind farms in Dutch waters, OWEZ (Offshore Wind Farm Egmond aan Zee) and Princess Amalia Wind Farm, are situated just northwest of IJmuidenm, off the central Dutch mainland coast. As it turns out, these first parks were built in an area of low WSIs (see also Leopold et al. 2010 for a first evaluation of effects of these two parks on local seabirds, that indeed turned out to be limited). Future developments, situated near these first two parks, would render a similar low impact on local seabirds, while parks situated further away run a larger risk of interfering with protected seabirds.

7. Quality Assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 57846-2009-AQ-NLD-RvA). This certificate is valid until 15 December 2012. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Environmental Division has NEN-AND-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 27 March 2013 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

References

Arts F.A. 2010. Midwintertelling van zee-eenden in de Waddenzee en de Nederlandse kustwateren, januari 2010. Report RSW Waterdienst BM 10.16, 25p.

Arts F.A. 2009. Trends en verspreiding van zeevogels en zeezoogdieren op het Nederlands Continentaal Plat 1991-2008. Report RWS Waterdienst BM 09.08, 56p.

Arts F.A. & Berrevoets C.M. 2006. Monitoring van zeevogels en zeezoogdieren op het Nederlands Continentaal Plat 1991-2006. Report RIKZ/2006.018. Rijksinstituut voor Kust en Zee, Middelburg, 40p.

Camphuysen C.J. & Leopold M.F. 1994. Atlas of seabirds in the southern North Sea. IBN Research report 94/6, NIOZ Report 1994-8, Institute for Forestry and Nature Research, Netherlands Institute for Sea Research and Dutch Seabird Group, Texel.

Garthe S. & Hüppop O. 2004. Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. J. Appl. Ecology 41: 724-734.

Leopold M.F. 1993. Spisula's, zeeëenden en kokkelvissers: een nieuw milieuprobleem op de Noordzee. Sula 7: 24-28.

Leopold M.F., Dijkman E.M., Teal L. & the OWEZ Team 2010. Local birds in and around the Offhore Wind Park Egmond aan Zee (OWEZ) (T-0 & T-1, 2002-2010). NoordzeeWind Report OWEZ R_221_T1_20100731_local_birds (submitted to the Dutch Government).

Lindeboom H., Geurts van Kessel J. & Berkenbosch L. 2005. Areas with special ecological values on the Dutch Continental Shelf. Rapport RIKZ/2005.008, Alterra Report nr. 1203, 103p

Skov H., Durinck J., Leopold M.F. & Tasker M.L. 1995. Important bird areas in the North Sea, including the Channel and the Kattegat. BirdLife International, Cambridge, 156p.

Skov H., Durinck J., Leopold M.F. & Tasker M.L. 2007. A quantitative method for evaluating the importance of marine areas for conservation of birds. Biological Conservation 136: 362-371.

Stone C.J., Webb A., Barton C., Ratcliffe N., Reed T.C., Tasker M.L., Camphuysen C.J. & Pienkowski M.W. 1995. An atlas of seabird distribution in north-west European waters. Joint Nature Conservation Committee, Peterborough, 326p.

Tasker M.L., Jones P.H., Dixon T.J. & Blake B.F. 1984. Counting seabirds at sea from ships: a review of methods employed and a suggestion for a standardized approach. Auk 101: 567-577.

Justification

Rapport C134/10
Project Number: 430.250.1309

The scientific quality of this report has been peer reviewed by the a colleague scientist and the head of the department of IMARES.

Approved: MSc. R. van Bemmelen
Researcher

Signature:

Date: 3 November 2010

Approved: Drs. F.C. Groenendijk
Head of department Ecology

Signature:

Date: 3 November 2010