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with contributions of:
F. Arts
B. Aarts
D. Beuker
J. Hartman
M.S.J. Hoekstein
A. Gyimesi
M. Japink
H.A.M. Prinsen
P.A. Wolf

Bureau Waardenburg bv
Consultants for environment & ecology
P.O. Box 365, 4100 AJ Culemborg The Netherlands
Tel. +31 345 51 27 10, Fax +31 345 51 98 49
E-mail wbb@buwa.nl Website: www.buwa.nl

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Authors:	M.J.M. Poot R.C. Fijn R.J. Jonkvorst C. Heunks M.P. Collier J. de Jong P.W. van Horssen With contributions of: F. Arts B. Aarts D. Beuker J. Hartman M.S.J. Hoekstein A. Gyimesi M. Japink H.A.M. Prinsen P.A. Wolf
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Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

Postbus 365 4100 AJ Culemborg
Telefoon 0345 51 27 10, Fax 0345 51 98 49
info@buwa.nl www.buwa.nl

Preface

In the Environmental Impact Assessment (EIA) phase for round 2 permits mainly interpolated data of the current monitoring scheme on seabirds of Rijkswaterstaat Waterdienst/Ministry of Infrastructure and the Environment (the MWTL program) has been used. This aerial program was never designed to deliver the required detailed information that is now requested for fine tuning the risk assessments in the search areas for round 2 and 3 wind farms, and to generate baseline data and, in the future, data for effect study monitoring. Therefore the Ministry of Infrastructure and the Environment has requested that a large-scale and an intensified aerial-based survey design specifically in relation to search areas for new offshore wind energy initiatives in the Dutch part of the North Sea be carried out. Bureau Waardenburg and personnel from Delta Project Management have a vast amount of experience with aerial surveys on seabirds within the Dutch part of the North Sea. This project has been carried out by Bureau Waardenburg under subcontract to IMARES.

The project team of Bureau Waardenburg consisted of and was responsible for:

M.J.M. Poot	project management, fieldwork, data entry, and report;
J. de Jong	database management and GIS analysis;
B. Aarts	data entry;
D. Beuker	fieldwork, data entry;
M.P. Collier	various report text, editing;
R.C. Fijn	fieldwork, data entry, species accounts;
A. Gyimesi	data entry;
J. Hartman	data entry;
C. Heunks	fieldwork, data entry, species accounts;
P.W. van Horssen	GIS analysis;
M. Japink	development GIS-based database;
R.J. Jonkvorst	fieldwork, data entry, species accounts;
H. Prinsen	fieldwork, data entry;

With assistance from Delta Project Management:

F. Arts	analysis and delivery of MWTL data
M.S.J. Hoekstein	fieldwork, data entry;
P.A. Wolf	fieldwork, data entry.

Jaap de Visser and co-pilots Job Kakebeeke and Ilieay van Dam of Zeeland Air are sincerely thanked for the safe flights and excellent operations of the surveys. Sylt Air operated the January survey and is sincerely thanked for the equally high-level of quality in performing the survey.

The transcription of data from tapes was carried out by all field observers; however, the largest part of data entry was done by Bram Aarts, Jonne Hartman and Abel Gyimesi. Quality control on data entry was made by double check of all entries by

Robert Jan Jonkvorst, Ruben Fijn, Martin Poot and Job de Jong. Quality control on reporting was made by Theo Boudewijn and Sjoerd Dirksen.

This project was commissioned by IMARES and coordinated by Tobias van Kooten and Jakob Asjes.

During the different stages of this project feedback has been received from Rijkswaterstaat Waterdienst (Paul Boers, Suzan van Lieshout, Mervyn Roos), Rijkswaterstaat Noordzee (Martine Graafland, Paul Westerbeek) en Rijkswaterstaat Directoraat-Generaal Water (René Dekeling).

Louise Burt and Eric Rexstad of the Centre for Research into Ecological and Enviromental Modelling (CREEM), University of St. Andrews are sincerely thanked for their discussions concerning Distance sampling analyses.

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Contents

Summary

The objective for offshore wind energy in the Dutch part of the North Sea is 6,000 MW and for future wind farm developments search areas have been defined. The concessions for the future development of offshore wind farms to be issued will be accompanied by a set of regulations with regards to prevent possible adverse ecological effects. Although these regulations will depend on the specific location of each concession, proper formulation of such regulations requires structural knowledge of the occurrence of specific species through the year in the entire Dutch Continental Shelf area. For a proper estimation of the potential ecological impacts of building, exploiting and decommissioning of offshore wind farms, a vast amount of ecological information is required. Gathering ecological information at sea is expensive and takes time.

The Dutch government has commissioned a task group of different institutes to develop a ‘Masterplan Ecologische Monitoring Lange Termijn Wind op Zee’. The masterplan identified gaps in the knowledge associated with the ecological impact of offshore wind farms, and laid out a plan to fill these gaps. A number of research projects were identified to fill high-priority knowledge gaps, be available even before the first concessions are to be issued, called the Shortlist Masterplan. The aim of the Shortlist Masterplan project is to fill existing knowledge gaps in order to come to a better-informed set of general and location-specific permit requirements for the concessions to be appointed for development of offshore wind farms in the Dutch North Sea. The following high priority knowledge project were assessed; the presence and distribution of fish eggs and larvae, the mortality effect of the sound and pressure waves generated by piling of turbine foundations on larval fish, the spatiotemporal distribution and density estimates of Harbour Porpoises, the distribution of seabirds over the Dutch North Sea (this study), effects of the planned offshore wind farm concessions on breeding Lesser Black-backed Gulls, and measurement of threshold sound intensity at which a Temporary Threshold Shift occurs in harbour porpoises and harbour seals.

In the Environmental Impact Assessment (EIA) phase for new offshore wind farm permits in the Dutch part of the North Sea mainly interpolated data of the current monitoring scheme on seabirds of Rijkswaterstaat Waterdienst/Ministry of Infrastructure and the Environment (the MWTL program) has been used. This aerial program was never designed to deliver the required detailed information that is now requested for fine tuning the risk assessments in the search areas for new offshore wind farms, and to generate baseline data and in future, data for effect study monitoring. In order to fulfil the urgent need to collect relevant T-zero (baseline) data on seabirds on a large-scale, but with enough spatial detail, in the search areas for new offshore wind farms in the Dutch part of the North Sea a series of aerial surveys with recommended methodology has been carried out in the period May 2010 – April 2011 (a total of nine surveys). As the MWTL program continued, the MWTL monitoring data complement this aerial-based survey project, especially in the far offshore areas

in the northern part of the Dutch North Sea, where at the moment no wind farms are planned. Within the Shortlist Masterplan framework also ship-based surveys have been carried out. The combination of ship-based and aerial data generates the whole picture on seabird occurrences, as the ship-based survey data are used to calibrate the aerial-based survey data on species identification, recorded densities, behaviour and altitudes.

In general, due to the survey design, the Shortlist Masterplan aerial surveys have yielded much more detailed large-scale distribution patterns of seabirds compared to the ongoing MWTL monitoring scheme or to the cumulative ship-based ESAS database. In relation to current search areas for new offshore wind farms, seabird species-specific spatial patters are reported. Coastal species like Common Scoters and divers were not present within the search areas for offshore wind farms, however, during migration passage might occur through the search areas. Northern Gannets were recorded in all search areas, but clearly the least number of Northern Gannets were observed in the most northerly location. Great Cormorants were mainly absent from the defined search areas for new offshore wind farms. Since offshore wind farms provide resting habitat for Great Cormorants in the marine environment, offshore range expansion is likely to occur with newly built wind farms. Only in the most western search area for new wind farms substantial numbers of Northern Fulmars were recorded. In the search area near the Brown Ridge clearly the largest numbers of Great Skuas have been observed. As this species is on a European scale a rather rare seabird species research on potential impacts of new offshore wind farms to be developed in this area should be focussed on this species. Smaller skua species seem to migrate through all search areas. In all search areas Kittiwakes were observed. This study provides detailed information about the distribution patterns of Little Gull throughout the entire study area. Based on this study the distribution of Little Gulls seems to overlap with all search areas for new offshore wind farms. Common Gulls, European Herring Gulls and Lesser Black-backed Gulls were observed in all search areas but were less abundant in the search areas further offshore. Given the widespread distribution of Great Black-backed Gulls in the Dutch North Sea, the species occurs in all search areas. This also holds true for the two species of auks, Guillemot and Razorbill. Remarkably, Sandwich Terns were found in most of the search areas for wind farm development, however, their unexpected wide spread occurrence was restricted to April and August. A similar far offshore occurrence was found in ‘comic terns’ (Common Tern and Arctic Tern together) but the densities in the search areas were much lower.

The MWTL monitoring data complement the Shortlist Masterplan aerial-based survey project outside the study area, with coverage of the far offshore areas in the northern part of the Dutch North Sea. The MWTL results show that for several species and in several periods of the year higher densities of birds occur in the far offshore areas in the northern part of the Dutch North Sea (auks, Northern Fulmar, Kittiwake).

With nine aerial surveys in the period May 2010 – April 2011 the aim of the project to gather the first detailed information on densities and distribution of seabirds in the search area for round 2 and 3 wind farms in the Dutch part of the North Sea was achieved. Despite the geographical scale of the area, data were gathered on seabird distribution and behaviour (including feeding, migration and flying heights) in both the search areas for round 2 and 3 wind farms and the wider Dutch North Sea region. Furthermore, this was achieved year-round and for all species deemed important in relation to offshore wind power. Due to the low flight altitude, species identification in the Shortlist Masterplan aerial surveys has proven to be good. Proportions of species identified within the species groups like divers, terns and auks were comparable to those from the ship-based survey.

The specific chosen survey design of the Shortlist Masterplan aerial surveys has indeed yielded much more detailed large-scale distribution patterns of seabirds compared to both the ongoing MWTL monitoring scheme and the cumulative ship-based ESAS database. The two key features of the Shortlist Masterplan aerial surveys are the extent of coverage that is achieved through the survey design, which has resulted in good density distributions of seabirds at sea, and secondly, the low flight altitude, which for some species groups has enabled a level of species identification beyond that of high altitude aerial surveys.

The methodology of the Shortlist Masterplan aerial surveys has proven to fulfil the aim of collecting data on the distributions and occurrence of seabirds in the Dutch North Sea. An initial year's data has already been collected and has enabled the detailed distribution patterns and densities of seabirds to be established. In order to strengthen these findings, an initial further two years of surveys are recommended for baseline monitoring. This will enable the level of variation in seabird distributions throughout the year to be assessed. Furthermore, increasing the frequency of surveys to two surveys each month would allow the variation within seasons to be better assessed and would provide the level of data needed for comprehensive analyses.

The importance for seabirds of the search areas for offshore wind farms should be further investigated. Here ship-based surveys could provide additional essential information on the behaviour and flight altitudes of birds within these areas and would ensure a complete assessment of the distribution and densities of seabirds.

Nederlandse samenvatting

Het doel voor de offshore windenergie in het Nederlandse deel van de Noordzee is 6.000 MW. Voor de ontwikkeling van deze toekomstige windturbineparken zijn zoekgebieden gedefinieerd. De concessies die voor de toekomstige windturbineparken worden verstrekt, gaan vergezeld met een aantal voorschriften die betrekking hebben op het voorkomen van mogelijke ongewenste ecologische effecten. Hoewel deze voorschriften locatiespecifiek zullen zijn voor iedere consessie, vraagt een goede formulering van dergelijke voorschriften structurele kennis over het voorkomen van specifieke soorten door het jaar heen in het gehele Nederlandse deel van het Continentaal Plat. Voor een goede inschatting van het potentiële ecologisch effect van het bouwen, exploiteren en uit bedrijf nemen van offshore windturbineparken is een grote hoeveelheid ecologische kennis vereist. Hierbij is het verzamelen van ecologische informatie op zee duur en tijdrovend.

De Nederlandse overheid heeft daarom een taakgroep van verschillende kennisinstituten in het leven geroepen voor het ontwikkelen van een 'Masterplan Ecologische Monitoring Lange Termijn Wind op Zee'. Het masterplan identificeert kennisleemten betreffende de ecologische invloed van offshore windturbineparken en stelt een aanpak voor om deze leemten op te vullen. Een aantal onderzoeksprojecten werden benoemd om kennisleemten waaraan een hoge prioriteit werd toegekend in te kunnen vullen voordat de eerste concessies worden verstrekt, het zogenoemde Shortlist Masterplan. Het doel van het Shortlist Masterplan-project is om bestaande kennisleemten in te vullen, zodat een beter gefundeerd stelsel van algemene en locatiespecifieke vergunningseisen voor de toekomstige concessies voor de ontwikkeling van offshore windturbineparken in het Nederlandse deel van de Noordzee kunnen worden opgelegd. Aan de volgende kennisprojecten werd een hoge prioriteit toegekend: het voorkomen en de verdeling van viseieren en –larven, de mate waarin de geluids- en drukgolven door het heien van de funderingen van windturbines sterfte veroorzaken van vislarven, de verspreiding in ruimte en tijd van bruinvissen en dichtheidsschattingen van deze soort, de verdeling van zeevogels over het Nederlandse deel van de Noordzee (deze studie), effecten van de voorgenomen concessies voor windturbinesparken op broedende kleine mantelmeeuwen, en het bepalen van de geluidsintensiteit waarbij een tijdelijke verschuiving in de geluidsgevoeligheid optreedt bij bruinvissen en zeehonden.

In de Milieu-Effect Rapportagefase (MER) voor de vergunningverlening voor nieuwe offshore windturbineparken in het Nederlandse deel van de Noordzee zijn hoofdzakelijk geïnterpoleerde gegevens van het huidige monitoringprogramma voor zeevogels van Rijkswaterstaat Waterdienst/ Ministerie van Infrastructuur en Milieu (het MWTL-programma, Monitoring Waterstaatkundige Toestand des Lands) gebruikt. Dit programma van vliegtuigtellingen is nooit bedoeld om de gewenste gedetailleerde informatie op te leveren, die nu wordt geëist voor het afstemmen van de MER's in de zoekgebieden voor nieuwe offshore windfarms, om basisgegevens aan te leveren en gegevens voor toekomstige effectstudies. Om te kunnen voldoen aan de prangende vraag om grootschalig relevante T-nul gegevens (van de uitgangssituatie) van de zeevogels, maar met genoeg ruimtelijk detail, in de zoekgebieden voor de nieuwe windturbineparken in het Nederlandse deel van de Noordzee is een aantal vogeltellingen vanuit het vliegtuig, conform aanbevolen opzet, verricht in de periode mei 2010 – april 2011 (in totaal 9 tellingen). Aangezien het MWTL-programma gewoon doorloopt, vullen de gegevens uit het MWTL-programma de verzamelde gegevens van de vliegtuigtellingen aan, vooral in de gebieden in het noordelijke deel van het Nederlandse deel van de Noordzee op grote afstand van de kust en in de smalle ondiepe kustzone, waar op dit moment geen windturbineparken zijn gepland. In het kader van het Shortlist Masterplan worden tevens vogeltellingen vanaf het schip uitgevoerd. De combinatie van gegevens van vliegtuigtellingen en scheepstellingen geeft een volledig beeld van het voorkomen van zeevogels. De telgegevens van scheepstellingen zijn gebruikt om de gegevens van de vliegtuigtellingen op soortherkenning, vastgestelde dichtheden, gedrag en vlieghoogten te kalibreren.

Over het algemeen hebben de vliegtuigtellingen van het Shortlist Masterplan, als gevolg van de opzet van de telling, meer gedetailleerde, grootschalige verspreidingspatronen van zeevogels opgeleverd in vergelijking met het lopende MWTL monitoringprogramma of de cumulatieve European Seabirds At Sea (ESAS)-database die gebaseerd is op scheepstellingen. In relatie tot de huidige zoekgebieden voor nieuwe offshore windturbineparken kunnen de volgende specifieke ruimtelijke verspreidingpatronen van zeevogelsoorten worden benoemd: kustgebonden soorten als zwarte zee-eend en duikers waren niet aanwezig in de zoekgebieden voor offshore windturbineparken. Tijdens de trek kunnen de vogels zich door de zoekgebieden verplaatsen. Jan-van-genten werden in alle zoekgebieden vastgesteld, maar in de meest noordelijke locatie werd duidelijk het laagste aantal Jan-van-genten waargenomen. Aalscholvers waren overwegend afwezig in de begrensde zoekgebieden voor nieuwe windturbineparken. Aangezien dat offshore windparken rusthabitat bieden voor aalscholvers in de mariene omgeving, neemt met de nieuw te bouwen windparken ook het gebiedsgebruik om offshore te foerageren naar alle waarschijnlijkheid toe. Alleen in het meest westelijke zoekgebied voor nieuwe windturbineparken werden substantiële aantallen noordse stormvogels vastgesteld. In het zoekgebied nabij de Bruine Bank werden duidelijk de hoogste aantallen grote jagers waargenomen. Aangezien deze soort op een Europese schaal bezien een tamelijk zeldzame soort is, dient in de toekomst in dit zoekgebied specifieke aandacht uit te gaan naar de potentiële effecten van nieuwe windturbineparken op deze soort. Kleinere soorten jagers lijken door alle zoekgebieden te migreren, maar de fluxen van passerende aantallen zijn echter laag. In alle zoekgebieden zijn drieteenmeeuwen waargenomen. Deze studie heeft gedetailleerde informatie opgeleverd over het verspreidingspatroon van de dwergmeeuw in het gehele studiegebied. Op basis van deze studie blijkt de verspreiding van de dwergmeeuw te overlappen met alle zoekgebieden voor nieuwe windturbineparken. Stormmeeuwen, zilvermeeuwen en kleine mantelmeeuwen werden in alle zoekgebieden waargenomen, maar waren minder talrijk in de zoekgebieden verder uit de kust. Op basis van de verspreiding van de grote mantelmeeuw in het Nederlandse deel van de Noordzee, komt de soort in alle zoekgebieden voor. Dit geldt tevens voor de twee alkensoorten, de zeekoet en de alk. Opmerkelijk was dat grote sterns in de meeste zoekgebieden voorkwamen, echter, deze onverwachte ruime voorkomen offshore was beperkt tot april en augustus. De soortsgroep visdief/noordse stern liet een vergelijkbaar voorkomen ver offshore zien, maar de dichtheden in de zoekgebieden waren veel lager.

The MWTL monitoring data completeren het Shortlist Masterplan vliegtuigmonitioring programma buiten het afgebakende studiegebied, met een dekking van de verre offshore gebieden in het noordelijke deel van het Nederlands deel van de Noordzee. De MWTL resultaten laten zien dat in dit gebied verschillende soorten in verschillende perioden van het jaar hogere dichtheden voorkomen dan in het Shortlist Masterplan studiegebied (alkachtigen, noordse stormvogel, drieteenmeeuw).

Met negen vliegtuigtellingen in de periode mei 2010 – april 2011 werd het doel van het project, het verzamelen van de eerste gedetailleerde informatie over dichtheden en de verspreiding in het zoekgebied voor de tweede en derde ronde voor windturbineparken in het Nederlandse deel van de Noordzee, bereikt. Ondanks de geografische schaal van het gebied werden gedetailleerde gegevens verzameld over de verspreiding en het gedrag (waaronder foerageren, migratie en vlieghoogten) van zeevogels in zowel de zoekgebieden voor de ronde twee en drie van de windturbineparken als in het groter geheel van het Nederlandse Deel van de Noordzee. Bovendien, dit werd bereikt op een jaarrond basis en voor alle soorten die vanuit het oogpunt van offshore windenergie belangrijk zijn. De soortidentificatie in het kader van de vliegtuigtellingen van het Shortlist Masterplan bleek door de lage vlieghoogte goed te zijn. Het aandeel van de soorten in de soortgroepen duikers, sterns en alkachtigen dat op soort gebracht kon worden, bleek vergelijkbaar te zijn met het aandeel van de scheepstellingen.

De specifiek gekozen onderzoeksopzet van de vliegtuigtellingen van het Shortlist Masterplan heeft inderdaad veel meer gedetailleerde, grootschalige verspreidingspatronen van zeevogels opgeleverd in vergelijking met zowel het lopende MWTL-programma als de cumulatieve ESAS-database, die gebaseerd is op scheepstellingen. De twee sleutelkenmerken van de vliegtuigtellingen van het Shortlist Masterplan zijn enerzijds de omvang van de gebiedsdekking verkregen door de onderzoeksopzet, dat heeft geresulteerd in goede dichtheidsverspreidingen van zeevogels op zee, en anderzijds door de lage vlieghoogte, waardoor een beter niveau van soortherkenning bij een aantal soortsgroepen mogelijk is dan bij vliegtuigtellingen van grotere hoogte.

De gehanteerde methodiek van de vliegtuigtellingen van het Shortlist Masterplan blijkt te voldoen aan het streefdoel om gegevens te verzamelen over de verspreiding en het voorkomen van zeevogels in het Nederlandse deel van de Noordzee. Gegevens van een eerste jaar zijn verzameld, waarbij gedetailleerde verspreidingspatronen en dichtheden van zeevogels zijn vastgesteld. Om deze gevonden patronen te kunnen bevestigen wordt aanbevolen om minimaal nog twee jaar T-nul gegevens van de uitgangssituatie te verzamelen. Hierdoor is het mogelijk om de mate van variatie in de verspreiding van zeevogels in de loop van het jaar in te schatten. Bovendien biedt de toename van de frequentie van de tellingen naar twee tellingen per maand de mogelijkheid om de variatie binnen seizoenen beter in te kunnen schatten en levert dit het dataniveau benodigd voor uitvoerige analyses.

Het belang van de zoekgebieden voor offshore windturbineparken voor zeevogels dient verder onderzocht te worden. Scheepstellingen kunnen hierop aanvullend essentiële informatie over het gedrag en de vlieghoogten van vogels in deze gebieden leveren en hiermee een volledige bepaling van de verspreiding en dichtheden van zeevogels garanderen.

1 Introduction

1.1 Overall project description Shortlist Masterplan

Problem definition

On the basis of a generic appropriate assessment of Dutch offshore wind farms (Prins *et al.* 2008), the possibility cannot be excluded that construction, exploitation and decommissioning of offshore wind farms in the Dutch North Sea causes adverse ecological effects on surrounding Natura 2000 areas and protected animal species in general. The generic appropriate assessment of Dutch offshore wind farms gives an indication of possible adverse effects, which on the basis of a precautionary approach have led to very strict requirements on particularly the construction phase of offshore wind farms. Furthermore, several Environmental Impact Assessments carried out in the framework of the so-called Round 2 wind farms have shown that potential ecological impacts might occur when multiple wind farms are constructed in the Dutch North Sea.

The objective for offshore wind energy in the Dutch part of the North Sea is 6000 MW and for so-called Round 3 wind farms search areas have been defined (depicted in blue shading in Figure 1.1.1). The strict demands with regards to the prevention of negative ecological effects may lead to higher financial costs for the exploitation of wind farms. The concessions for the future development of offshore wind farms to be issued will be accompanied by a set of regulations with regards to possible adverse ecological effects. Although these regulations will depend on the specific location of each concession, proper formulation of such regulations requires structural knowledge of the occurrence of specific species through the year in the entire Dutch Continental Shelf area. The location-specific regulations are based on a re-evaluation and adaptation of the regulations based on the generic appropriate assessment, and can result in substantial cost reductions for offshore wind farms if results indicate that less strict regulations can be imposed than those implemented based on precautionary principles.

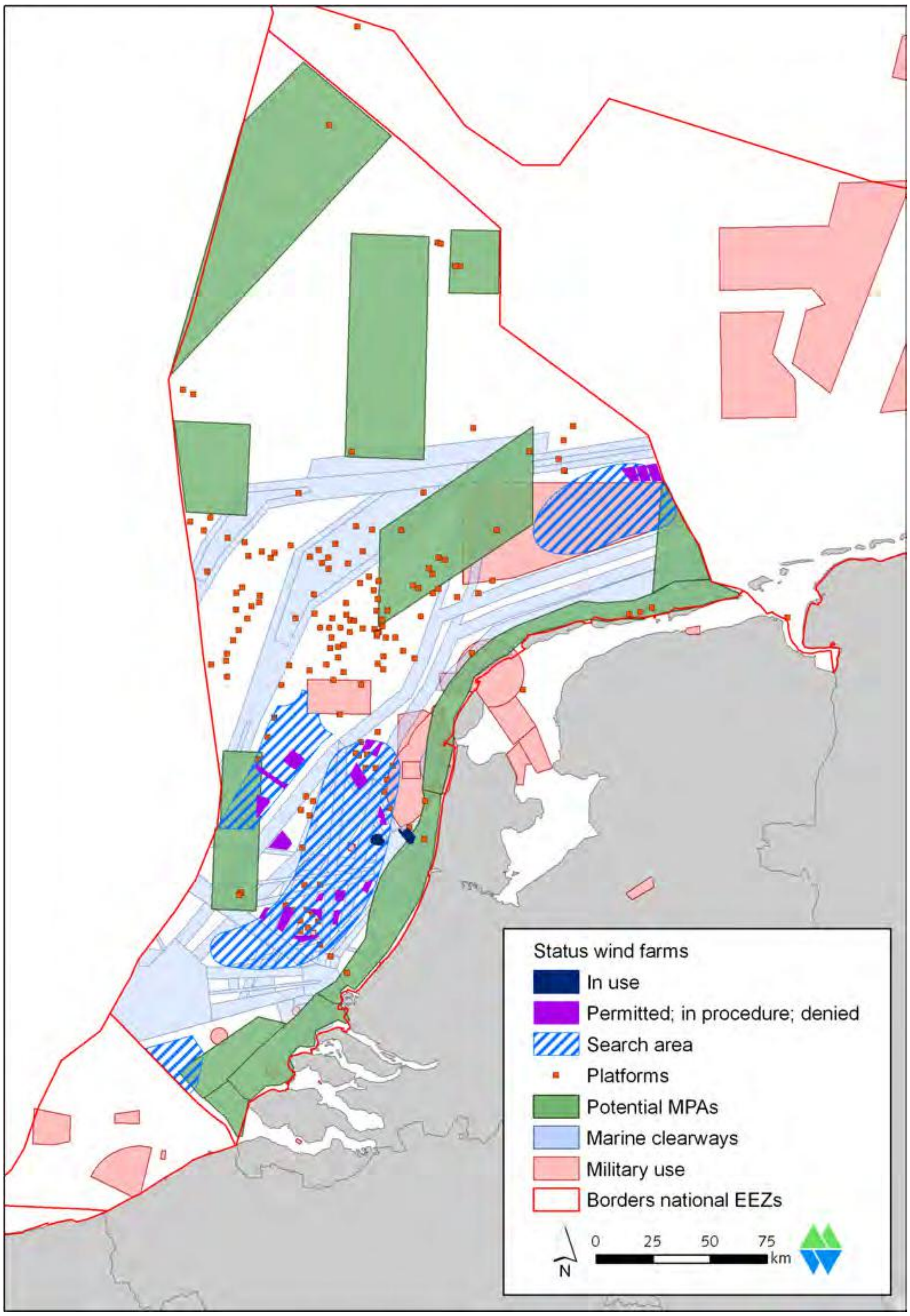


Figure 1.1.1 *Location of search areas for new offshore wind energy developments (Round 3 wind farms) and locations that have been or are planned to be licensed for use. Potential Marine Protected Areas (MPAs) are based on Lindeboom et al. (2005).*

Background – Shortlist Masterplan vs. Masterplan Ecological Monitoring Long year Offshore Wind Energy

For a proper estimation of the potential ecological impacts of building, exploiting and decommissioning of offshore wind farms, a vast amount of ecological information is required. Gathering ecological information at sea is expensive and takes time. The most cost-effective way to collect this information is in one coordinated effort. With this in mind, RWS Noordzee set up a task group led by Deltares, in collaboration with IMARES, TNO and Bureau Waardenburg that developed a 'Masterplan Ecologische Monitoring Lange Termijn Wind op Zee' (Boon *et al.* 2010). The masterplan identified gaps in the knowledge associated with the ecological impact of offshore wind farms, and laid out a plan to fill these gaps. As part of this process, a group of experts was asked to prioritise the necessary ecological research and to define the research that needs to be started on a short-term basis. This group identified a body of ecological information, which should, for an efficient further development of offshore wind energy, be available even before the first concessions are to be issued in mid-2011. The expert group developed a number of research projects aimed to fill these high-priority knowledge gaps. The proposed research recommendations were presented by RWS Noordzee to IDON (Interdepartementaal Directeuren Overleg Noordzee), and which IDON subsequently approved for execution. This process has resulted in a requirement specification for the statement of work called Shortlist Masterplan. This Shortlist Masterplan aims to execute the necessary projects and deliver the information needed most urgently to facilitate a further development of offshore wind energy in the Netherlands.

The aim of the Shortlist Masterplan project is to fill existing knowledge gaps in order to come to a better-informed set of general and location-specific permit requirements for the concessions to be appointed for development of offshore wind farms in the Dutch North Sea. More specifically, the project assesses;

- The presence and distribution of fish eggs and larvae in the water column of the Dutch North Sea throughout the year, with particular attention to the importance of the 18 planned concession areas for offshore wind farms and the possible function of these eggs and larvae as food for birds and marine mammals occurring in Natura 2000 areas.
- The mortality effect of the sound and pressure waves generated by piling of turbine foundations on larval fish, aimed at measuring a relationship between distance to the source of the sound and larval fish mortality.
- The spatiotemporal distribution and density estimates of Harbour Porpoises (*Phocoena phocoena*) in the Dutch North Sea with particular attention for the importance of the planned concession areas for offshore wind farms.
- The distribution of seabirds over the Dutch North Sea, in order to obtain insight into possible habitat loss for seabirds and the introduction of migration barriers for migratory birds, as multiple offshore wind farms are installed (this study).
- Effects of the planned offshore wind farm concessions on the breeding colonies of the Lesser Black-backed Gull in the Natura 2000 areas 'Lage Land

van Texel' and 'Krammer-Volkerak', including estimates for habitat loss, mortality, and the effects on breeding success at the colony-level, taking into account the percentage of 'floaters' associated with the colony.

- Measurement of threshold sound intensity at which a Temporary Threshold Shift occurs in harbour porpoises and harbour seals, in order to obtain a relationship between sound characteristics and the behavioural and physiological responses of marine mammals.

Result of the Shortlist Masterplan project

The results of this project will (partly) reduce the uncertainty surrounding the possible adverse ecological effects of offshore wind farms in the North Sea on nearby Natura 2000 areas or the organisms living there. They will also provide an estimate of the density and distribution of fish larvae, marine mammals and birds over the North Sea before the large-scale development of wind farms, and hence provide a reference point against which to measure possible future changes related to such development. The project is divided into eight subprojects, of which the report presented here is on the subproject aerial surveys.

The Shortlist Masterplan aerial surveys represent the first year of a potential long-term monitoring program. This first year of surveys provided the opportunity to validate the feasibility of undertaking such a program and the methodology employed.

1.2 Aerial surveys Shortlist Masterplan

Aerial surveys of seabirds in relation to the round 2 and 3 offshore search areas serve several goals: from providing the first baseline data for assessing effects (round 2 and 3 wind farms); to providing the first detailed information on seabird distributions for spatial planning (round 3). In the Environmental Impact Assessment (EIA) phase for round 2 permits mainly interpolated data of the current monitoring scheme on seabirds of Rijkswaterstaat Waterdienst/Ministry of Infrastructure and the Environment (the MWTL program) has been used. This aerial program was never designed to deliver the required detailed information on seabird distributions and densities that is now requested for fine tuning the risk assessments in the search areas for round 2 and 3 wind farms, and to generate baseline data and in future, data for effect study monitoring. The main aim of the long-term MWTL seabird program is the monitoring of trends in distribution and numbers of seabirds of the total Dutch North Sea, hence the choice has been made, in order to representatively cover the total area in a limited amount of time, to have a low density but wide transect design in order to have coverage throughout the range of the Dutch North Sea. Furthermore, the applied methodology within the MWTL program has been kept the same for years since the beginning of the program in the early 1990s in order to safeguard strict comparable data and indices.

As an illustration, the preliminary results of ongoing effect studies in and around the location areas of the first two developed wind farms in the coastal zone of the Netherlands have been showing unknown detailed perpendicular distribution patterns of seabirds (Leopold *et al.* 2004, Leopold *et al.* 2010). These detailed consistent patterns in densities of seabirds perpendicular to the Dutch coast and depth contours near the currently operating wind farms were unknown so far because the density of aerial transects of the MWTL program is too low to yield this level of detail (also in the absence of ship-based data in this region). This shows that small-scale information on seabird distribution and densities is of paramount importance during the phase of baseline and effect study monitoring.

In order to fulfil the urgent need to collect relevant T-zero (baseline) data on seabirds on a large-scale, but with enough spatial detail, in the search area for round 2 and 3 wind farms in the Dutch part of the North Sea a series of aerial surveys with recommended methodology was designed and the results of a first year (nine surveys) are presented here.

1.3 Aim of the aerial surveys

The main aim of the Shortlist Masterplan aerial survey program was to gather detailed information on densities and distribution of seabirds in relation to the search areas for round 2 and 3 wind farms in the Dutch part of the North Sea. Given the geographic scale of the problem, data are required on seabird distribution, seabird behaviour, including feeding, migration and flying heights, for all species deemed important in relation to offshore wind power. The need for detailed, year-round information on seabird occurrence is not only restricted to the search areas for round 2 and 3 wind farms, also outside these areas the relative importance of these areas for seabirds in comparison to the surrounding parts of the Dutch inshore waters required investigation. Within the Shortlist Masterplan a combination of two methods was used to achieve this: aerial surveys and ship-based surveys. Both methods have their strengths and weaknesses (see further below). In general, compared to ship-based surveys, aerial surveys are an excellent tool for assessing distributions in large areas within a relatively short time period, but have problems with specific identifications of certain seabird species, generate limited data on behaviour and flying heights. However, the combination of ship-based and aerial data contributes to a more complete picture as the ship-based survey data help supplement and calibrate the aerial-based survey data on species identification, recorded densities, behaviour and altitudes. In the present study, ship-based data are secondary to aerial survey data although provide important complementary information on aspects of bird behaviour. In addition, data from the continuing MWTL aerial surveys are also used to complement the current aerial-based survey project, especially in the far offshore areas in the northern part of the Dutch North Sea where no round 2 and 3 wind farms are planned, and in the narrow coastal zone; for which the MWTL a coast parallel survey transect yields additional data on coastal species.

A further aim of the overall long-term Masterplan project is to develop a tool for re-evaluating the long time series of aerial-based survey data of Rijkswaterstaat Waterdienst/Ministry of Infrastructure and the Environment (MWTL program). In this report the MWTL aerial-based survey data are compared with the Shortlist Masterplan aerial data in the overlapping study area as well as with the ship-based survey data collected over the same period. The comparisons between the different data sets in this report must be regarded as an initial exercise of this evaluation of the aerial-based MWTL program of Rijkswaterstaat Waterdienst/Ministry of Infrastructure and the Environment. The initial comparisons in this report consist of comparing patterns of distribution and densities of different species between the three different data sets (Shortlist Masterplan aerial surveys, MWTL aerial surveys and Shortlist Masterplan ship-based surveys).

Ship-based vs. aerial-based surveys

The effort to cover a substantial piece of the Dutch part of the North Sea to the same extent as with aerial surveys would take an at least ten-fold time investment with a ship. In contrast, aerial surveys can only be conducted during relatively calm conditions (max. 3-4 Bft). At higher sea states and especially in winter with bad light conditions many birds are missed from an aircraft.

On the one hand for some species, aerial surveys provide more accurate counting results as a ship either attracts birds, disturbs at large distances (e.g. divers) or underestimates flying birds like terns (Poot *et al.* 2010 made a comparison of MWTL data and European Seabird At Sea database of ship-based seabird observations for the period 1999-2007). On the other hand, ship-based surveys allow better identification of species, as for some species groups during aerial surveys species identification is limited to species groups, e.g. divers (Red-throated and Black-throated Divers), auks (Guillemots and Razorbills), gulls (especially in large flocks) and terns (Common and Arctic Terns).

Furthermore, ship-based surveys yield much more detailed observations on bird behaviour (Camphuysen & Garthe 2004), although from an aeroplane a part of the behavioural spectrum of birds can be recorded (in categories as swimming vs. flying, but more specifically also plunge diving, birds in search flight, scavenging, as well as flight directions, with indications of altitude (low over water, medium height, high altitude) can be recorded.

In addition to above, ship-based surveys can have the added advantage that environmental data can be gathered simultaneously with bird data (by means of CTD, e.g. salinity, water temperature, turbidity etc.) which can add to the interpretation of distribution patterns, although for some environmental data remote sensing can do the job for aerial surveys.

2 Materials and methods

2.1 General setup

Shortlist Masterplan aerial survey program

The aerial-based survey project counts nine surveys in the period May 2010 – April 2011. The nine surveys were carried out according to a schedule of one each calendar month from May-October inclusive, the period in which Lesser Black-backed Gulls are present, and then two surveys in January-February, for wintering seabirds, and one in April.

In May to October, besides Lesser Black-backed Gulls other species are also well covered, like Guillemots during the post-breeding dispersal with chicks, tern species with same pattern of occurrence as Lesser Black-backed Gulls, the migrations of Northern Gannets in September, Little Gulls in October etc., January and February to cover the wintering occurrence of typical species groups like auks, divers and the large numbers of gulls. The aim of an aerial-based survey in April 2011 is to cover the mass spring migration of Little Gulls, as well as many other species.

A total of 11 ship-based surveys were carried out, of which eight were conducted within the same months as aerial surveys (seven surveys in the same months in the same year and one in the same month but one year later).

MWTL aerial survey program

The MWTL monitoring program is carried out according to a scheme of one survey every two months. Incomplete temporal overlap exists between the Shortlist Masterplan aerial survey program and the MWTL aerial survey program. A total of five surveys of MWTL were carried in the same month as the Shortlist Masterplan. For field methodologies and data analysis including interpolation of density figures obtained with this program we refer to Berrevoets & Arts (2001, 2002 & 2003) and Arts (2010).

Shortlist Masterplan ship-based surveys

The Shortlist Masterplan ship-based program consisted of a total of 11 surveys in the period April 2010 – February 2011. These surveys took place during the so-called "fish eggs and fish larvae" surveys of the Shortlist Masterplan, which covered the entire Dutch Continental Shelf and part of the UK waters. The design of these surveys was aimed at sampling plankton at stations over a fixed grid. The vessel conducting the "fish eggs and fish larvae" surveys within the context of the Shortlist Masterplan project was also manned for additional seabirds and marine mammals surveys. These seabird and marine mammal surveys took place on route between the plankton sampling stations and only during the hours of daylight. No bird counts could be made during the plankton sampling. As the plankton sampling was carried out around the clock, also during darkness, the seabird and marine mammal surveys were restricted to the transects between sampling stations that were travelled during the day. For field methodologies and data analysis we refer to van Bemmelen *et al.* (2011).

Considerations beforehand when comparing results of different survey programs
In relation to comparing results it should be first emphasized that seabird distributions are variable from day to day and even within days large differences can occur under influence of weather, tide and in some species due to activities of fishing vessels. The interpretations of the results and comparisons made in this report are therefore intended to be viewed as preliminary and indicative only. Longer time series of surveys are needed to determine the variability of the data within each survey program.

2.2 Survey design and field methodology

2.2.1 Shortlist Masterplan aerial surveys – line transect methodology

For large bodies of water, birds can be efficiently and reliably counted in transects from aircraft (Dean *et al.* 2003). These transects can later be analysed using statistics and total numbers calculated. Single or multiple observers record birds on either side of the aeroplane and for speed observations are spoken into a dictation machine. The time of each observation is recorded and can be coupled with the aircraft GPS to provide coordinates for each sighting. Birds are recorded in bands, representing different distances from the flight path of the aeroplane (Table 2.2.1.1 and Figure 2.2.1.1). Further information recorded includes species, numbers, behaviour and, where appropriate, flight height, direction and associations. In addition, objects that might affect the occurrence of birds, such as ships, floating matter and fronts (visible lines on the water surface) were also recorded.

The Partenavia P68 survey aeroplane PH-DKI (left) with which the Shortlist Masterplan aerial-based seabird observations were made (Zeeland Air). In January 2011 one survey was conducted with another Partenavia P68 (right) with bubble windows (D-GFPG, Sylt Air). Observations in the so-called 0-strip band have been recorded but excluded from the analyses, see further text.

During the current surveys, a twin engine Partenavia was used, which has the wing above the observers and provides good visibility of the sea below. A total of eight out of the nine surveys were conducted with the Partenavia P68 PH-DKI (Zeeland Air). In January 2011, one survey was conducted with another Partenavia P68 with bubble windows (D-GFPG, Sylt Air). Because of the bubble windows the observers were able to look right under the aeroplane. In order to keep the observations comparable, observations of birds and marine mammals in the so-called 0-band (the area directly under the aeroplane that is not fully visible) have been recorded separately. However, in case birds were flying into band A and could be observed in case the flight would have been conducted with the PH-DKI these observations have incorporated in the analyses. The remaining observations (10.6 % of the total number of observations) were excluded to keep the surveys comparable. The surveys were undertaken at an altitude of 250 ft above mean sea level. In principle seabirds were counted on both sides of the aeroplane, however, for some of the time only one side offered suitable counting conditions. The suitability of the counting conditions were mainly dependent on the glare from the sun, although wind and wave direction also had an influence but to a lesser extent (own observations).

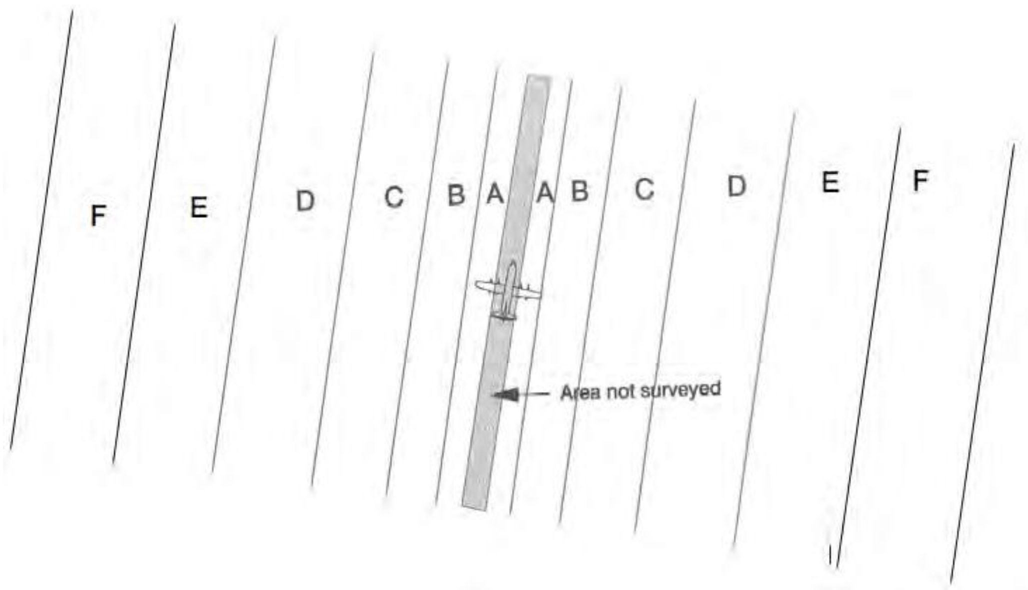


Figure 2.2.1.1 Schematic overview of the distance counting bands to the left and right of the aeroplane (not drawn to scale). The 0-band is shown here in grey. Observations used for Distance analysis were made in bands A to D. In order to register large flocks of birds, including flocks of birds associated with fishing boats and platforms, and (large) ships possibly influencing the occurrence of birds, bands E and F were also used.

Table 2.2.1.1 Boundaries of the distance counting bands perpendicular of the aeroplane as used in recording observations in the Shortlist Masterplan aerial surveys. A, B and C are subdivisions of band A as proposed by Camphuysen et al. (2004). Furthermore, different to Camphuysen et al. a 0-band was used in the Partenavia with bubble windows (declination degrees larger than 65). In order to register fishing fessels, other ships and large flocks of birds associated with fishing boats far away from the track line also a band F was used.

Band	Declination in degrees from the horizontal	Boundary distances (m) perpendicular out from track line inner	outer	middle point band (m)	total band width (m)
A	65-55	38,2	57,1	47,6	19
B	55-40	57,1	97,1	77,1	40
C	40-25	97,1	175,6	136,3	79
D	25-10	175,6	479,4	327,5	304
E	10-4	479,4	1335,3	907,3	856
F	4-0	1335,3	horizon	3667,6	>2000

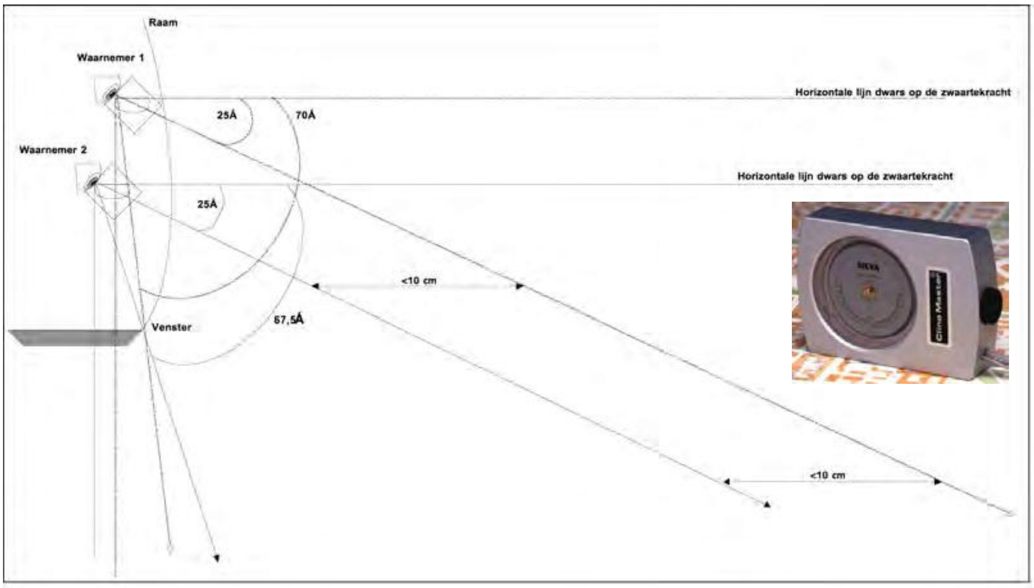


Figure 2.2.1.2 Schematic overview of how two different observers of different size safeguard the use of the same distance bands by delimiting the bands by means of measuring angles with a clinometer (inset). By using a clinometer, different observers with slightly different positions near a window safeguard that the same band delimitation is achieved. This is illustrated by the 10 cm label, which indicates parallel lines of observation of two observers with a different position of the eye relative to the aeroplane window.

By using a clinometer, observers safeguard that the same band delimitation is used (Figure 2.2.1.2), and by applying distance analysis (Buckland *et al.* 1993) observer differences can be accounted for.

The spatial design of the transect routes used in the current survey is presented in figure 2.2.1.3. Depending on the time of year and weather (available time with suitable light conditions) this program could be flown in 3-5 days (figure 2.3.1). Aerial surveys were planned such that the restricted-fly zones could be surveyed with permission.

Aerial surveys enable large coverage in a short time, with more or less constant environmental conditions, at least in comparison to ship-based surveys. However, due to certain environmental conditions like higher sea-states or bad light conditions in winter, birds can be missed from an aircraft. In this study, data were gathered from both sides of the aeroplane during all surveys. Therefore always at least one of the observers will have good observation conditions from a light perspective. On those transects flown in non-cloudy conditions only one side of the transect was counted effectively due to glitter of the water caused by reflection of the sun. Only these sides have been used to calculate densities and used for interpolations (Figure 2.2.1.4).

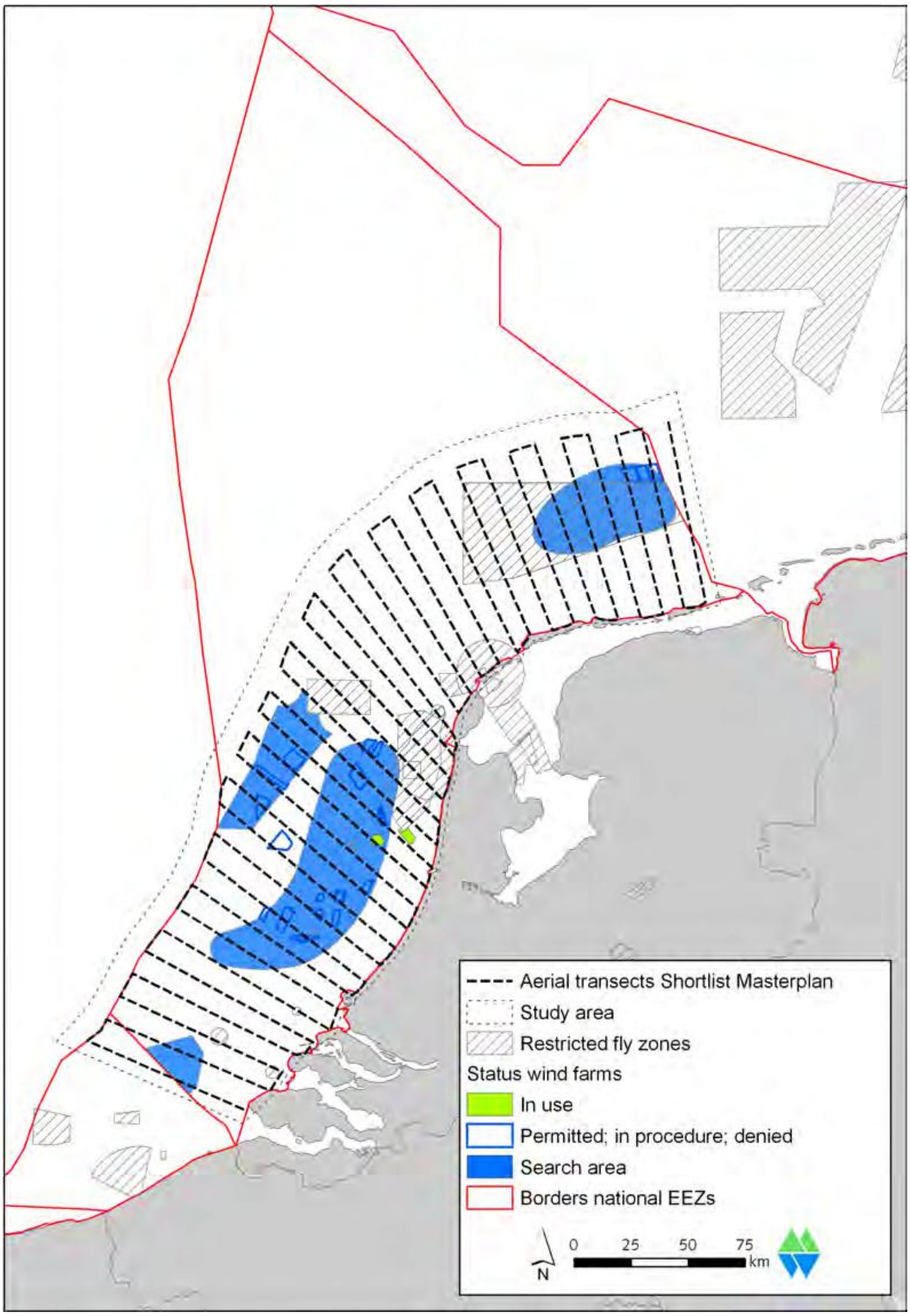


Figure 2.2.1.3 Spatial study design of the Shortlist Masterplan aerial survey program. Depending on time of the year and weather (available time with suitable light conditions) this program was flown in 3-5 days per survey. Aerial surveys are planned such that the restricted fly zones can be surveyed with permission.

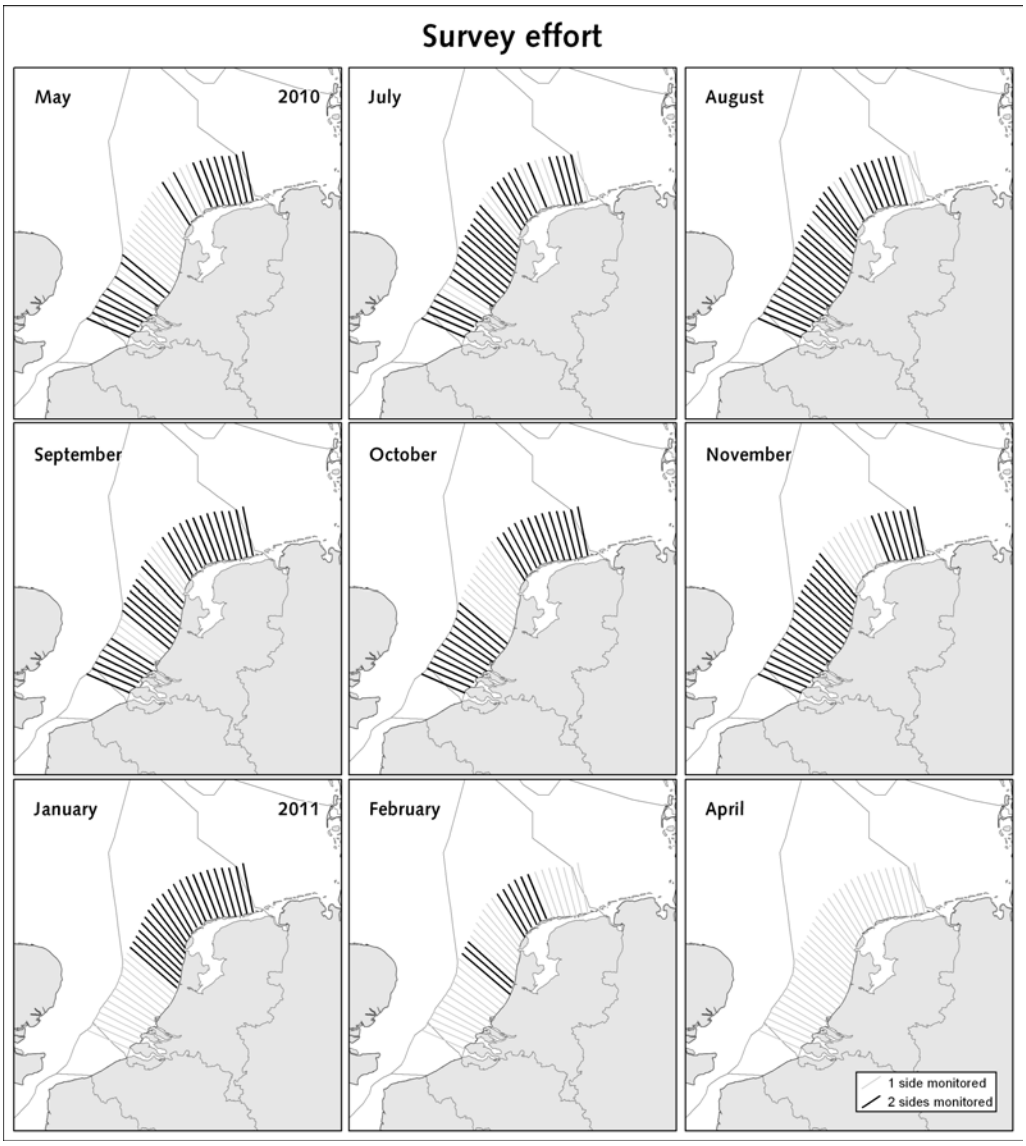


Figure 2.2.1.4 On those transects flown in non-cloudy conditions only one side of the transect was counted effectively due to glitter caused by radiation of the sun. Only these sides have been used to calculate densities and used for interpolations.

Recording of behaviour and flight altitude

In addition to recording bird densities, data were collected on bird behaviour (in principle following Camphuysen & Garthe 2004) and on flying altitudes of birds seen in flight, following methods used for standardised counts of birds migrating over land (LWVT 1985) and using altitude classes as given in Table 2.2.1.2. In areas with high densities of seabirds time can be limited and the recording of behaviour and flight altitudes of all birds is not possible. Therefore, in these aerial surveys there is a bias of recordings towards less busy periods in terms of observation intensity. As an indication of this bias in relation to flight altitudes, the proportion of birds with altitude information is presented in the species accounts. Because the flight altitude of the survey aeroplane was 250 ft (around 80 m) the altitude distribution recorded is biased towards the lower air layers compared to the potential height of offshore wind turbines (around 125 m tip height).

Table 2.2.1.2. Flight altitude classes used to describe the flying height (in meters above sea level) for birds seen in flight.

Altitude Class	Altitude range (m above sea level)
1	0-2 m
2	2-10 m
3	10-25 m
4	25-50 m
5	50-100 m
6	100-200 m
7	> 200 m

2.2.2 MWTL aerial surveys – strip transect methodology

The main difference of the MWTL aerial surveys with the aerial survey methodology of the Shortlist Masterplan program is related to the flight altitude of the survey aeroplane (in MWTL higher; 500 ft or about 165 m) and the recording of observations in fixed strips (Figure 2.2.2.1). These strips are observer specific and also specific for the type of aeroplane and side of the aeroplane (Table 2.2.2.1). In the MWTL monitoring program two types of aeroplane are used. For the long offshore flights this a two-engine aeroplane (PH-TVB) and for the coastal flights a one-engine aeroplane is used (PH-ADE). Strips are determined based on position of the eye relative to the window as dependent on the size of the observer. Strip related figures as the distance of the eye to the window are taken during the flight by the observers and are calibrated during a ground truthing session (see illustrations on the following pages).

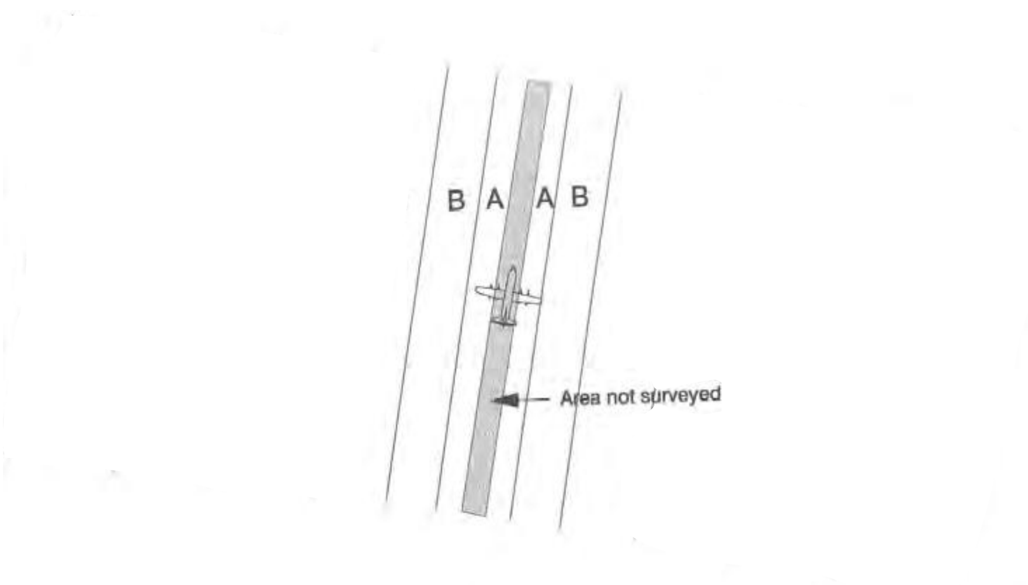


Figure 2.2.2.1 Schematic overview of the strips to the left and right of the aeroplane (not drawn to scale). Only those birds of large flocks of birds, including flocks of birds associated with fishing boats and platforms, were only counted within an A and B strip.

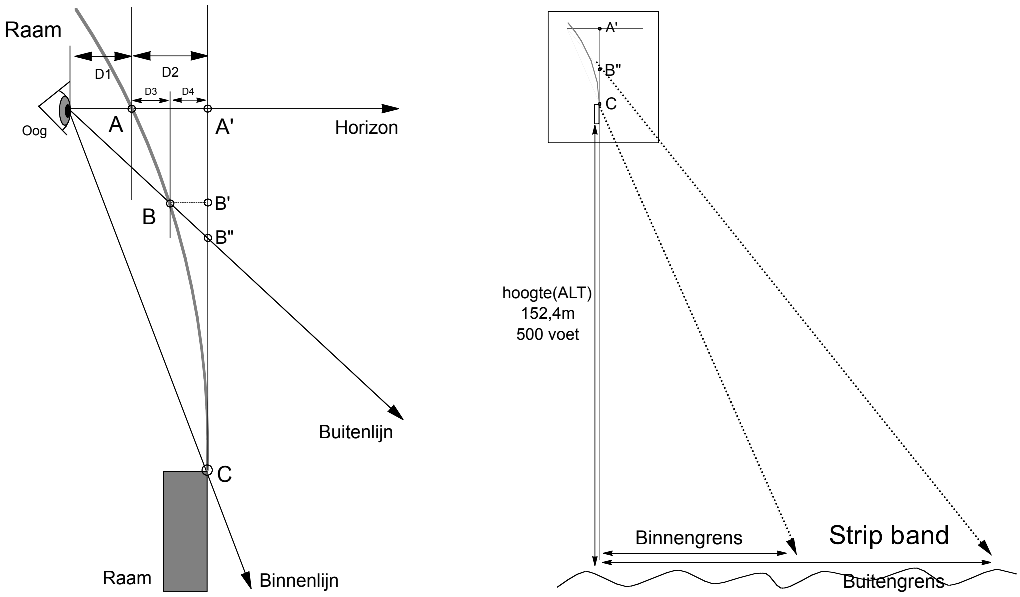


Figure 2.2.2.2 Schematic overview of how the delimitation of the strip of the MWTL aerial survey program is determined (figure is taken from Berrevoets & Arts 2003). In the MWTL monitoring program an observer specific strip is determined, based on measures in the aeroplane during the surveys (measurements of distances and altitude of the eye relative to the window etc.). Comparable measurements are taken on the ground. This ground truthing is extended with the angles of inner- (binnenlijn in the above figure) and outer line (buitenlijn) of the strip based on measurements of observation lines on the ground.

Table 2.2.2.1 Observer specific and aeroplane/side specific total strips (A and B together) as used in the MWTL aerial-based survey program. Strips are determined based on position of the eye relative to the window as dependent on the size of the observer. Strip related figures are taken during the flight and are calibrated during a ground truthing session, see Figure 2.2.2.1 and 2.2.2.2.

Observer	PH-TVB		PH-ADE	
	Left side	Right side	Left side	Right side
MH	110	N.A.	N.A.	92
PW	120	136	176	107
SL	102	157	103	115

Calibration of observer and side specific strips for the two-engine survey aeroplane PH-TVB during an annual ground truthing session. In the upper right picture an observer is determining his strip by drawing his inner, middle and outer line of his strip. Based on goniometric calculations the strip can be determined and compared with the goniometric calculations of the strip measured on the floor of the hangar.

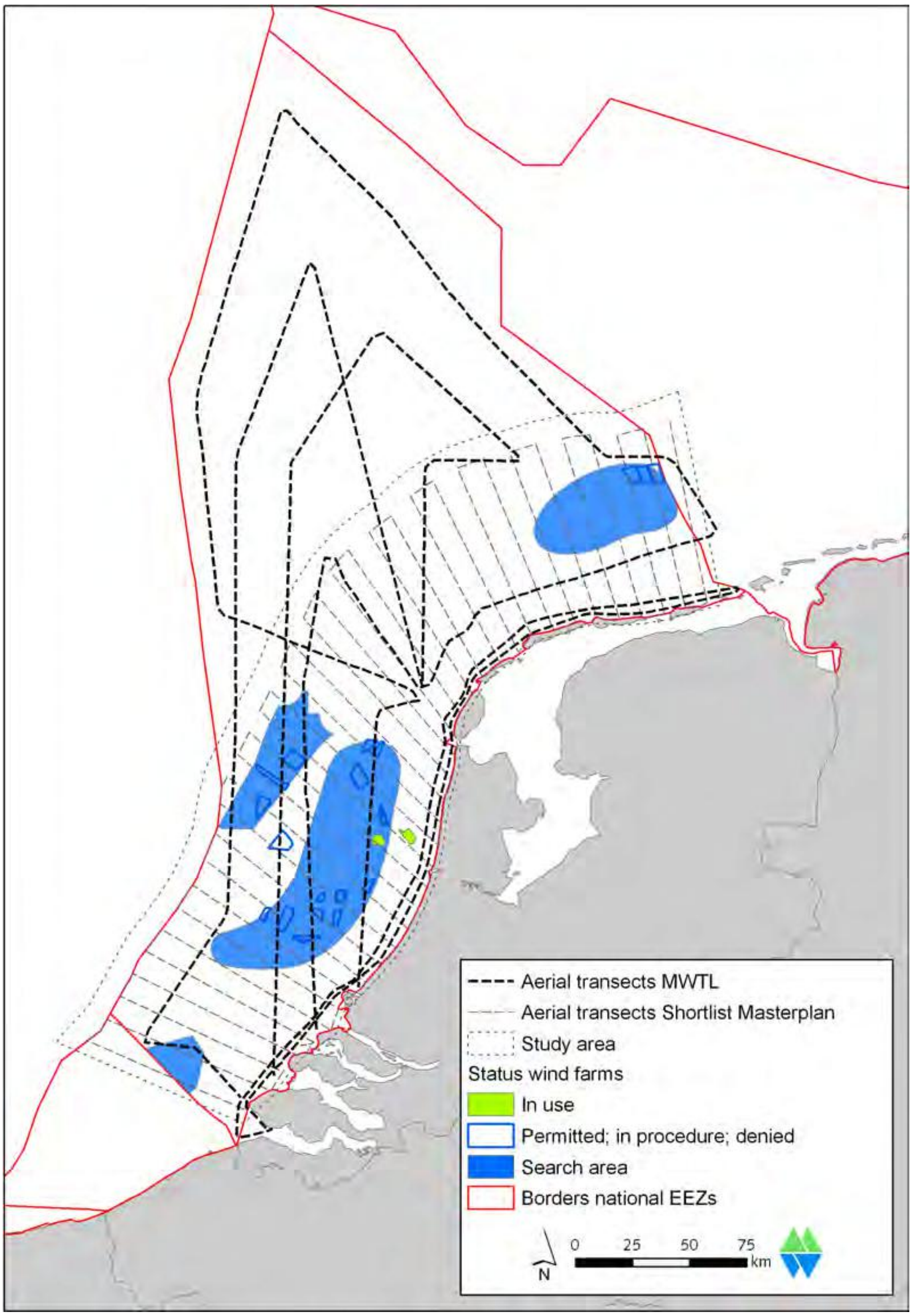


Figure 2.2.2.3 Spatial study design MWTL aerial-based survey program. This program was flown in three days per survey.

2.2.3 Shortlist Masterplan ship-based surveys – strip transect methodology

The following description is taken from van Bemmelen *et al.* (2011): Seabirds and marine mammals were surveyed using standard European Seabirds At Sea (ESAS)-ship-based survey techniques, which are extensively described in Tasker *et al.* (1984) and Komdeur *et al.* (1992). Seabirds were counted in five-minute bouts in a 300 m wide strip at one side of the vessel (the side that offers the best viewing conditions), by two observers working as a team. For each observed individual (group) species, number, distance class, details on plumage, age, sex, associations and behaviour were recorded. In order to prevent double counts of flying birds the ship's speed ideally should not drop below 10 knots.

Survey ship Tridens from which Shortlist Masterplan ship-based seabird observations were made with on top of the bridge the observation box (arrow), observed during the Shortlist Masterplan aerial survey in January 2011.

Table 2.2.3.1. Distance classes for birds seen perpendicular to the ship's trackline.

Distance class	*Distance range (m)*
A	0-50
B	50-100
C	100-200
D	200-300
E	>300
F- Flying birds	1 < 300 m, 2 > 300 m

The observers were seated in a box, placed centrally and forward on the top-deck of the ship. The box offered protection against the wind, seating and a desk for writing down results on pre-designed field sheets. The box was further equipped with a GPS system so that observers could keep track of the position, speed and course of the ship; these parameters were logged by the bird surveyors. Environmental conditions may influence detection probabilities of birds and mammals and were therefore recorded. These include sea-state and visibility. Also the presence of fishing activities was recorded.

These surveys were conducted as a secondary aim of another survey under the Shortlist Masterplan Wind umbrella: the “fish eggs and fish larvae” survey. The vessel conducting the “fish eggs and fish larvae” surveys within the context of the Shortlist Masterplan project was also manned for additional seabirds and marine mammals surveys. These seabird and marine mammal surveys took place on route between the plankton sampling stations and only during the hours of daylight. No bird counts could be made during the plankton sampling. As the plankton sampling was carried out around the clock, also during darkness, the seabird and marine mammal surveys were restricted to the transects between sampling stations that were travelled during the day. For field methodologies and data analysis we refer to van Bemmelen *et al.* (2011).

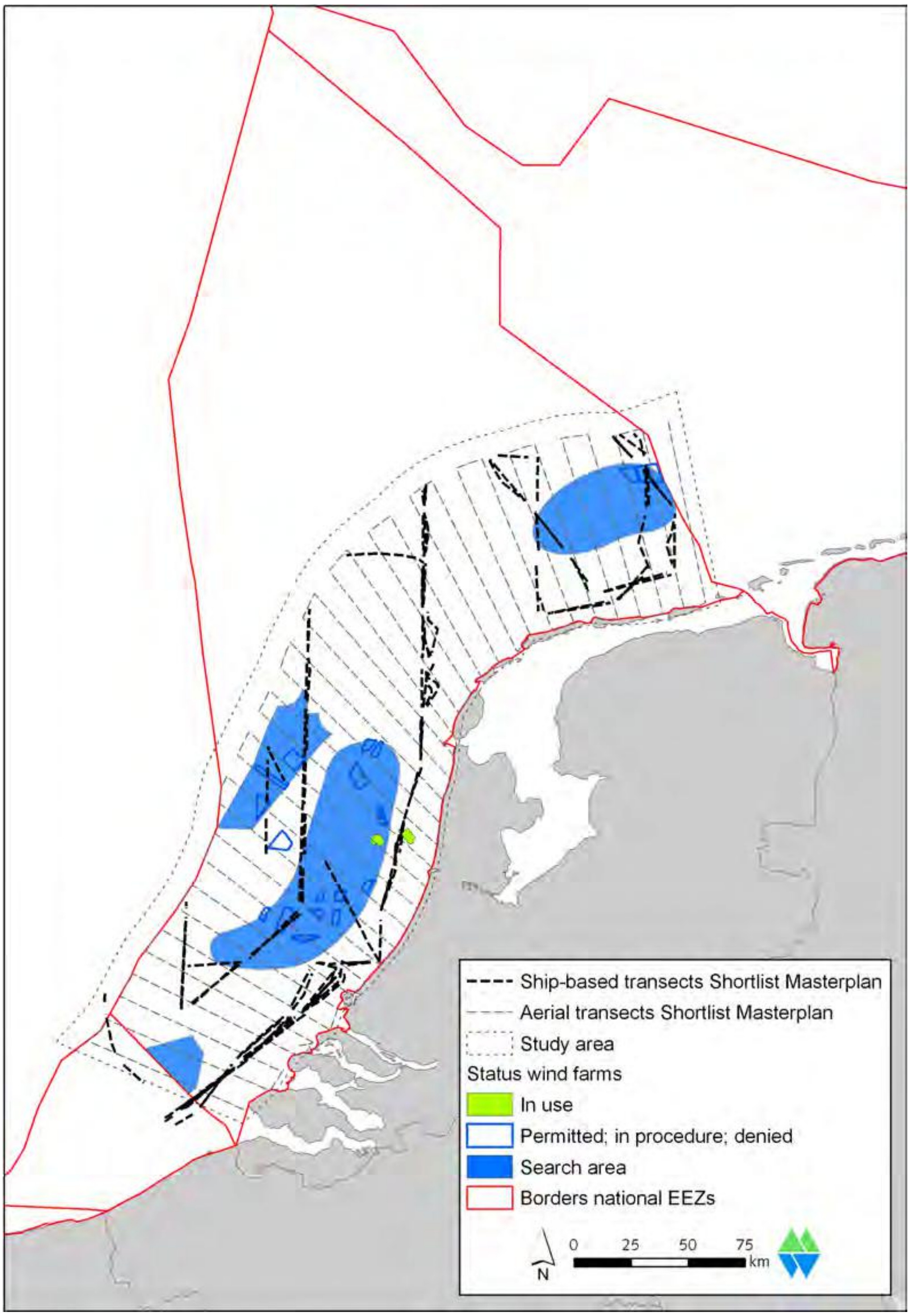


Figure 2.2.3.1 A cumulative picture of survey tracks of the Shortlist Masterplan ship-based survey program within the study area of the Shortlist Mastplan aerial surveys. The ship-based observations were carried out during a 24 hour plankton sampling survey. The bird surveys could only be conducted on the transects between plankton sampling stations covered during daylight. These differed between the different surveys in the period April 2010 – February 2011.

2.2.4 Overview of effort and timing between surveys

In order to interpret the differences and concurrences in results of the Shortlist Masterplan aerial surveys on one hand with the MWTL aerial surveys and the Shortlist Masterplan ship-based surveys on the other hand, below in Table 2.2.4.1 an overview is given of the temporal and spatial overlap of the different surveys. It should be noted that the Shortlist Masterplan aerial survey in April was conducted in another year (2011) than the MWTL aerial survey and ship-based survey (2010). From this table it can be concluded that especially with the MWTL but also with the ship-based surveys not many overlap in effort was achieved. The effort of MWTL and the ship-based surveys in the same study area as the Shortlist Masterplan aerial surveys was respectively 37.3 % and 5.7 %, expressed as kilometres surveyed track line (Table 2.2.4.2).

Table 2.2.4.1 Overview of differences in temporal and spatial overlap of the Shortlist Masterplan of the nine aerial-based surveys with the MWTL aerial-based surveys and the Shortlist Masterplan ship-based surveys.

Year	Month	Day aerial survey Shortlist Masterplan	Difference with MWTL (n days)	Difference with ship-based surveys Shortlist Masterplan (n days)
2010	May	25	No overlap, 28 days with last day April survey	No spatial overlap
		26	29 days	No spatial overlap
		27	30 days	Small overlap
	July	16	No overlap, 20 days with last day June survey	No overlap
		18	21 days	No overlap
		19	22 days	Small overlap
	August	27	No overlap, 2 days with last day August survey	No overlap, 6 days with last day August survey
		28	3 days	7 days
		29	4 days	8 days
		30	5 days	9 days
	September	20	No overlap, 26 days with last day August survey	No overlap, 5 days with last day August survey
		21	27 days	6 days
		24	30 days	9 days
	October	11	No overlap, 15 days with first day of October/November survey	Overlap
		12	16 days	No spatial overlap
		19	7 days	Overlap
	November	26	No overlap, 19 days with last day October/November survey	No overlap, 16 days with last day November survey
		27	20 days	17 days
		28	21 days	18 days
		29	22 days	19 days
		30	23 days	20 days
2011	January	26	Overlap	No overlap, 12 days with last day January survey
		27	1 day	13 days
		28	Overlap	14 days
	February	16	No overlap, 12 days with first day of February/March survey	Overlap
		17	11 days	No spatial overlap
		18	10 days	Overlap
	April	18	No overlap, 3 day and 6 days with April survey	8 days
		19	2 days	7 days
		20	1 day	6 days

Table 2.2.4.2 Overview of observation effort of the three different surveys (Shortlist Masterplan aerial surveys, MWTL aerial surveys and Shortlist Masterplan ship-based surveys) in the same study area. Effort is expressed as the total number of kilometres surveyed, the percentage of double sided observations is presented, resulting in the total effort again expressed in total number of kilometres.

	Aerial surveys Shortlist Masterplan			Aerial surveys MWTL			Ship-based surveys Shortlist Masterplan		
Month	total km flown	% double sided	total km effort	total km flown	% double sided	total km effort	total km flown	% double sided	total km effort
1	3045	64,0	4994	2138	36,1	2911	99	0	99
2	3045	44,1	4387	2137	58,0	3377	338	0	338
4	3045	0,0	3045	2140	4,6	2238	220	0	220
5	3019	83,8	5548	-	-	-	364	0	364
7	3045	77,8	5414	2124	2,6	2180	496	0	496
8	3045	82,7	5562	2136	34,3	2869	276	0	276
9	2823	77,7	5016	-	-	-	158	0	158
10	3045	68,6	5134	2137	40,4	3000	393	0	393
11	2980	78,7	5324	-	-	-	194	0	194
total	27092	64,1	44424	12811	29,4	16574	2539	0	2539

2.3 Observation conditions and other relevant factors during the Shortlist Masterplan aerial surveys

A total of nine surveys have been carried out in the period May 2010 – April 2011. No surveys were conducted in June 2010, December 2010 or March 2011. The conditions during the surveys are presented in figures 2.3.1 to 2.3.4 and the relevant human activities and natural features in figures 2.3.5 and 2.3.6 respectively.

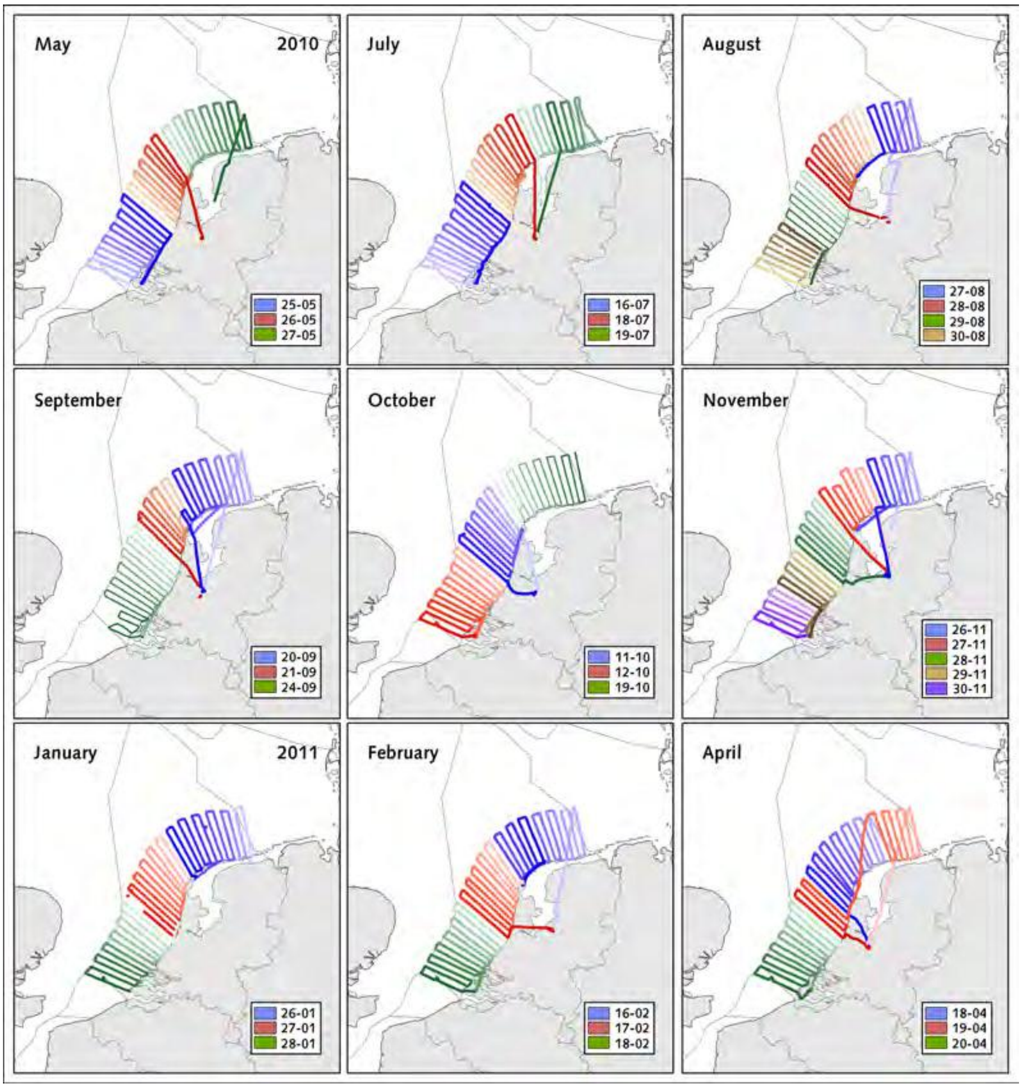


Figure 2.3.1 *Spatial survey effort and order of aerial flights per day per survey period (monthly periods). To provide an indication of the order that transects were flown, the colour of each day's transects fades throughout the day.*

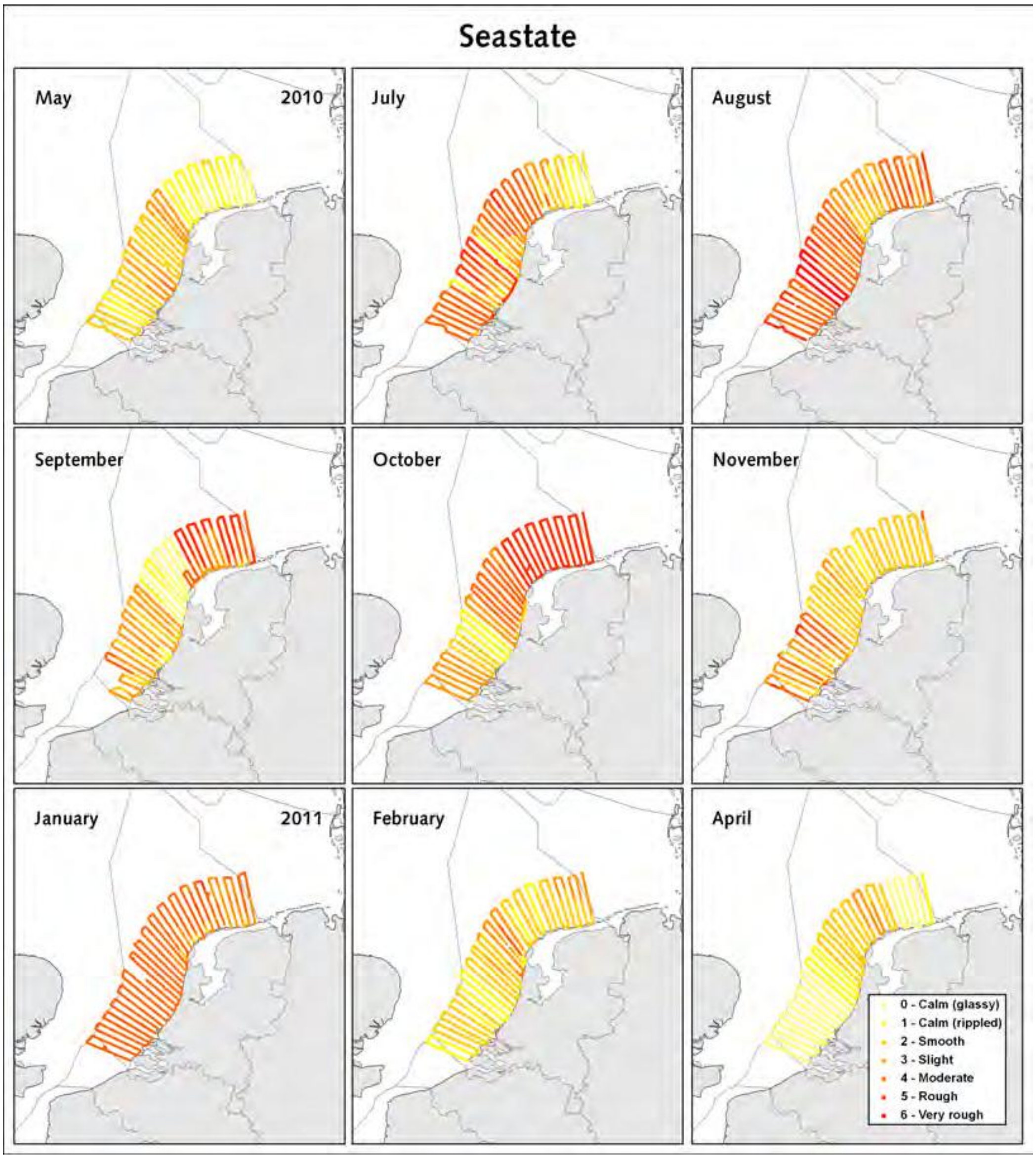


Figure 2.3.2 *Sea state conditions during the aerial flights per survey period (monthly periods). In general observations can be hindered above sea state 4.*

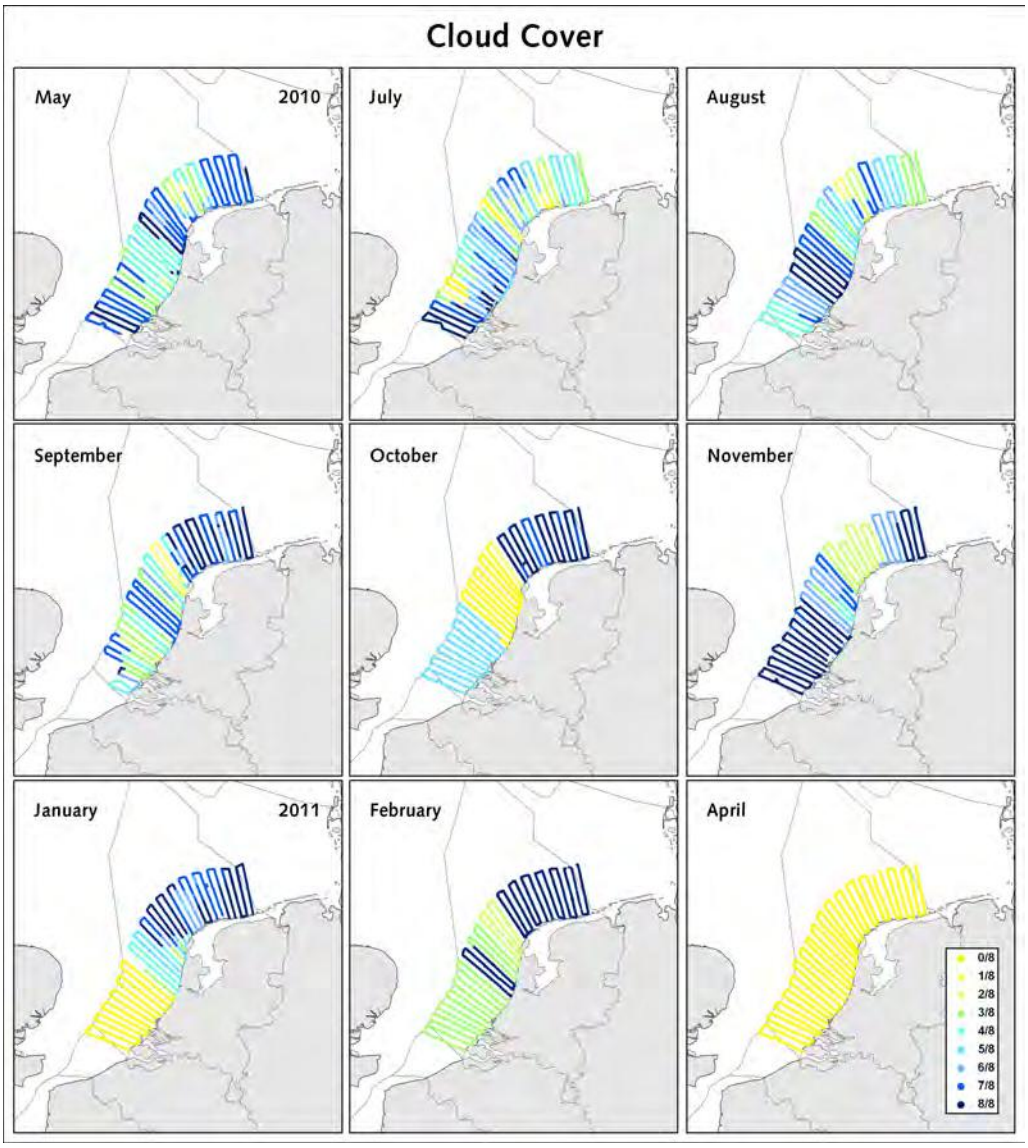


Figure 2.3.3 *Cloud cover conditions during the aerial flights per survey period (monthly periods).*

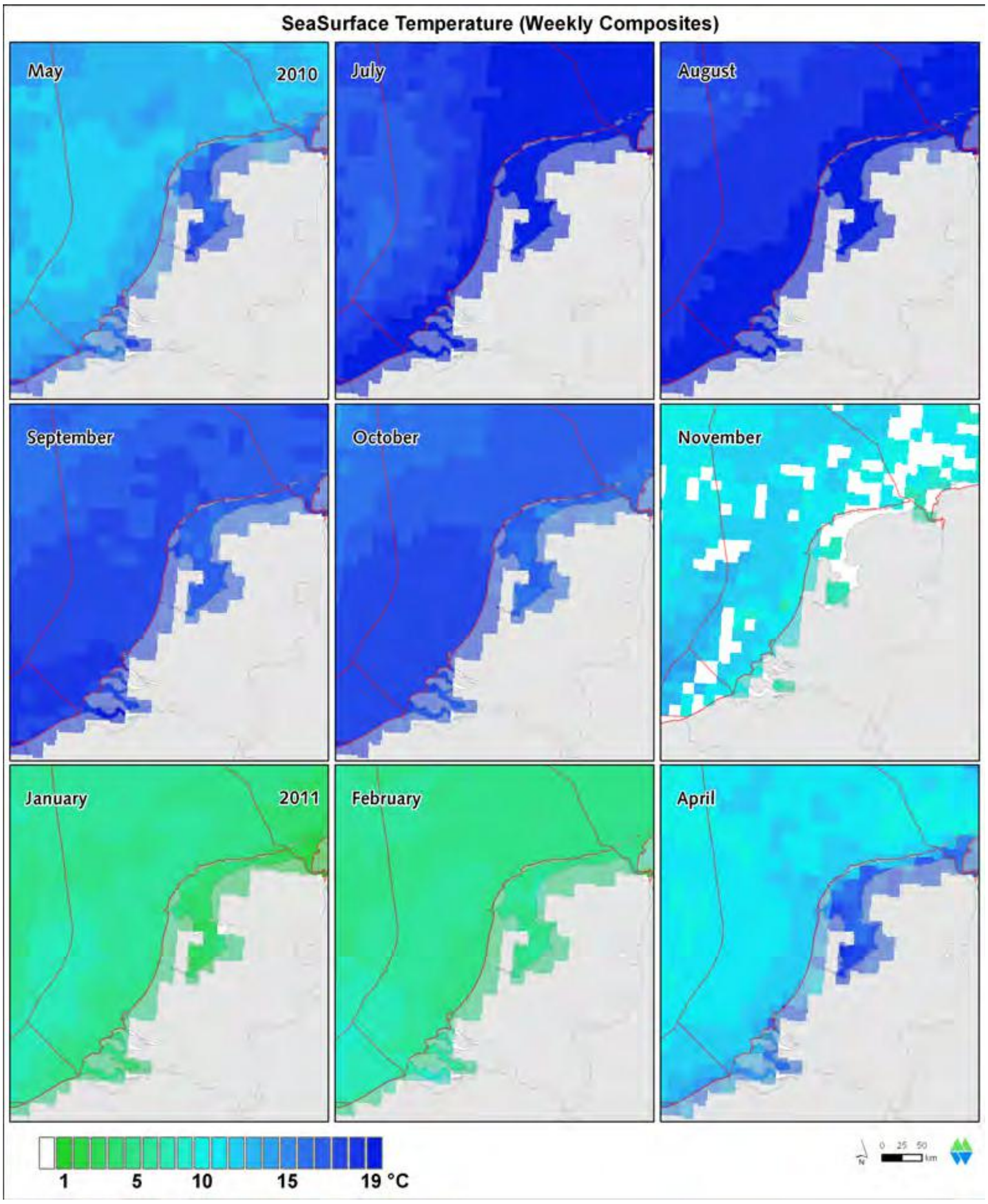


Figure 2.3.4 Water surface temperature conditions in the same week of the aerial flights per survey period (monthly periods).

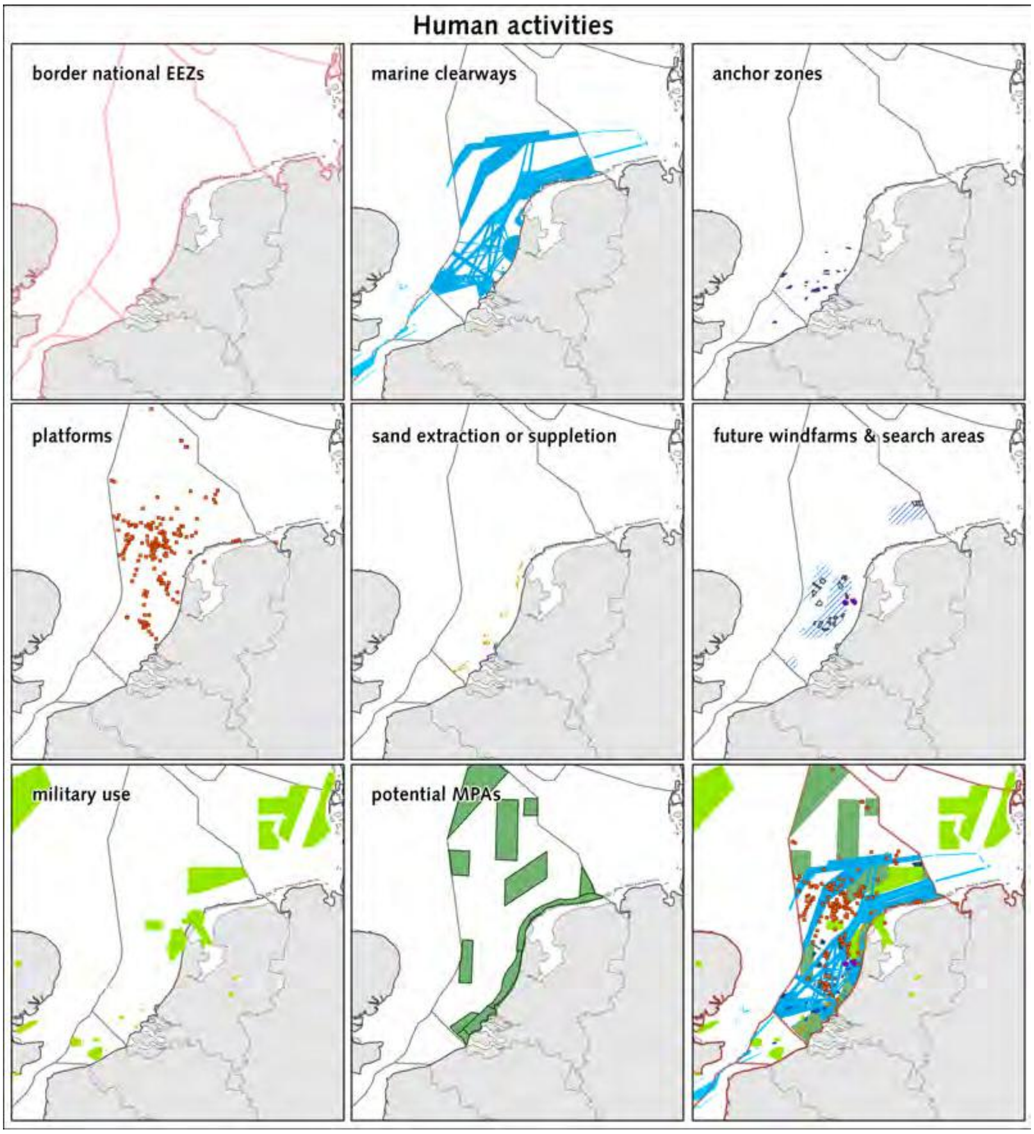


Figure 2.3.5 Human activities and specific areas in the Dutch part of the North Sea.

2.4 Analysis of data including Distance sampling analysis

During the Shortlist Masterplan aerial surveys bird and marine mammal data were collected along 35 transect lines perpendicular to the coast. Birds were recorded while flying between these transects but these data were excluded from the density analysis. With increasing distance from the transect line, the detection probability of birds and marine mammals decreases. Therefore, reliable bird densities and population sizes can be estimated with application of the Distance Sampling Technique (Buckland *et al.* 1993, 2001, 2004). With this technique a species-specific detection curve can be fitted with Distance 6.0 software (Thomas *et al.* 2010) to determine the width of the strip at which species are effectively recorded.

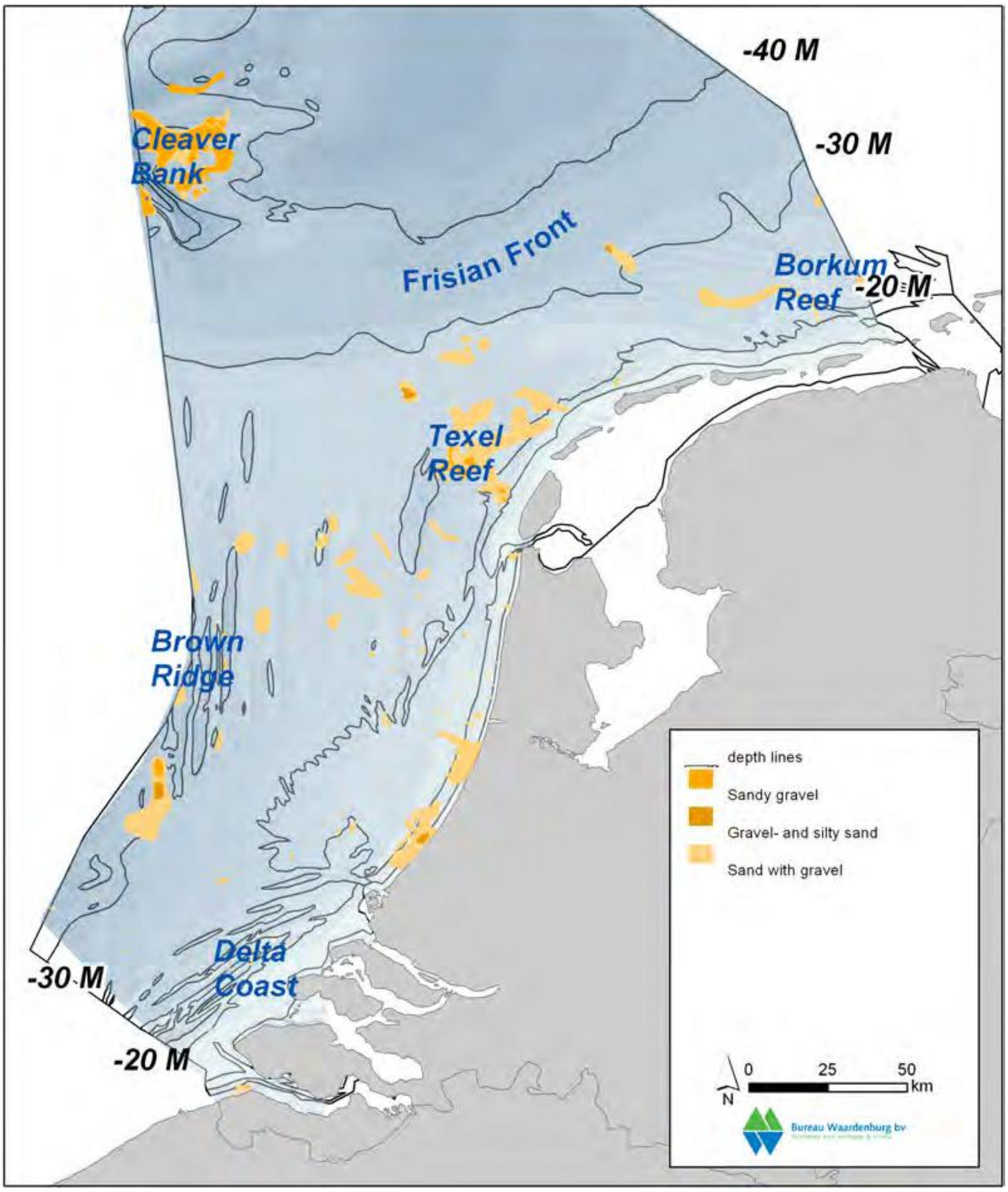


Figure 2.3.6 Indications of some topographic areas related to ecological relevant depth contours and occurrence of gravel sedimsents. The Dutch name for Delta Coast is Voordelta and used in the text.

Subsequently densities of birds and marine mammals in a study area can be calculated based on covered area (transect line multiplied with the effective strip width). A key assumption of this technique is that all birds are detected along the transect line. If that's not the case several analysis techniques can be used to try to correct for this imperfect detection.

In the present study the two first observation bands have been pooled together to overcome imperfect detection in the first observation bands resulting from the restricted view under and near the aeroplane because of the lack of bubble windows and birds responding to the aeroplane (diving or flying away). It should be emphasized that in this study the two bands A and B are actually a subdivision of the first observation band as recommended in Camphuysen *et al.* (2004). Based on our experiences we have introduced this finer subdivision to be able to investigate possible disturbance effects or missing of birds close to the transect line as described by Buckland *et al.* (1993). In the case of seabirds this can either be the result of birds diving under water or birds flying up and being detected in the second band (in the case of diving birds the time is too short that they come above water to be recorded in the second band). This results in higher numbers in Band B than Band A. When pooling these two bands a smooth distance detection curve can be constructed. As a robust, conservative approach, hazard-rate detection curves were always chosen, with truncation of data at the outer boundary of band D (see Table 2.2.1.1). In the case of flying species like Northern Gannets, gulls and terns this will yield reliable density estimates, but in the case of diving species like the auks and Harbour Porpoise the calculated densities must be regarded as a lower limit as the proportion under the water is unknown.

Table 2.4.1 Effective strip widths based on species-specific detection curves fitted with Distance 6.0 software (Thomas et al. 2010). As a robust, conservative approach, hazard-rate detection curves were always chosen, with truncation of data at the outer boundary of band D. In the case of flying birds this yielded in reliable density estimates, but in the case of diving species like the auks and Harbour Porpoise the calculated densities must be regarded as a lower limit.

Species	ESW_avg	95%_lower	95%_higher
Northern Gannet	146,1	133,2	160,2
Great Cormorant	133,0	111,1	158,6
Great Skua	117,9	79,3	175,1
Sandwich Tern	115,5	107,5	124,1
Kittiwake	112,8	106,1	119,9
Seal sp.	108,6	82,4	143,2
Large Gull sp.	105,5	97,2	114,5
Balloon	104,2	82,9	131,0
Northern Fulmar	103,8	85,9	125,4
Little Gull	101,8	92,5	112,0
Diver sp.	99,9	84,1	118,6
Great Black-backed Gull	99,0	75,5	129,8
Auk sp.	95,0	90,8	99,4
Harbour Porpoise	93,5	86,2	101,3
Lesser Black-backed Gull	92,2	83,1	102,3
Guillemot	90,7	86,3	95,4
Common Gull	85,6	78,4	93,4
European Herring Gull	85,6	78,4	93,4
Common Tern	79,8	65,3	97,6
Common or Arctic Tern	77,3	66,0	90,7
Razorbill	67,9	56,3	81,9

Determined effective strip widths are presented in Table 2.4.1 and used to calculate densities using poskeys (position keys) of one minute intervals, comparable to the poskey size used in the analysis of the MWTL aerial survey program (Berrevoets & Arts 2001). Subsequently, the same modelling technique has been used to interpolate the recorded densities for both the Shortlist Masterplan and MWTL in order to compare distribution patterns (see further below in paragraph 2.5). In this way at least for a part corrections are made for the differences in spatial effort and survey design. Because in the MWTL ship associated birds are not included in the analyses, for this exercise also for the Shortlist Masterplan the large ship associated flocks have been excluded. Ship associated birds as recorded in the Shortlist Masterplan aerial surveys were not excluded for the initial comparison of calculated densities from different types of surveys in paragraph 4.2. Differences in the temporal effort of the surveys (paragraph 2.2.4) cannot be corrected for and these differences have to take into account when comparing the results of the two surveys in chapter 4.

In contrast, the strip-transect method, as used in the MWTL program, assumes that all birds within the observed strips are recorded and birds outside of this area are ignored. This assumption prevents Distance analysis and corrections for missed birds cannot be made.

2.5 Interpolations of bird densities Shortlist Masterplan and MWTL

Shortlist Masterplan

From the aerial surveys seabird densities were determined using the effective strip width determined with the Distance software. Poskeys (position keys) were constructed of one minute intervals, comparable to the poskey size used in the analysis of the MWTL aerial survey program (Berrevoets & Arts 2001). Based on these poskeys bird densities were extrapolated into the areas where no transect lines were located. This was done by fitting regression models with measured densities of different seabird species in relation to sea depth and distance from coast. Spatial autocorrelation is a well known characteristic of ecological data (Lichtenstein *et al.* 2002) and cannot be ignored when predicting bird densities at unsampled sites (spatial interpolation, Pebesma *et al.* 2005).

Prediction was carried out with regression-kriging or Kriging with External Drift (for extensive review see Hengl (2009), a method where covariates are used to predict the overall bird densities with a regression model (GLM in this case) and the residuals of the GLM are tested for spatial correlation (Zuur *et al.* 2008), by means of a variogram analysis and subsequently used in a kriging procedure to adjust predictions locally by the residuals. With this method we combine the explanatory power of the Generalized Linear Modelling framework with spatial interpolation by means of kriging to predict densities of seabirds according analysis protocols developed by Pebesma *et al.* (2000), and further applied by Berrevoets & Arts (2001) and Poot *et al.* (2004).

Practicalities of modelling

Normalized (Pearson) model residuals are tested for spatial correlation through a variogram analysis (Pebesma *et al.* 2000). If the residuals show spatial correlation for each different season, the mean standardised variogram is used for prediction. Block mean kriging predictions are estimated for 5x5 km squares. Predictions of densities also allows for total population estimates *cf.* Pebesma *et al.* (2005) in further analyses in future.

Following Pebesma *et al.* (2000) predictions are only made for surveys with 25 or more positive observations (see appendix 1). For several species (all large gulls, Northern Gannet and Northern Fulmar), high densities that relate to ship associated birds are not used in the analysis. GLM's are built using 'pseudo-poisson' as 'link distribution family' thus allowing for some flexibility in distribution characteristics. For variogram analysis residuals over three times dispersion factor are left out (but used for predictions later on) *cf.* Pebesma *et al.* (2000). Predictions are made on a 5x5 km raster for the whole study area (Figure 2.2.1.4). Distance to coast (in km) and depth in m – NAP are taken as covariates. These are not considered as ecological explanatory covariates but serve as a proxy.

Results of modelling

Species distribution maps will be discussed in chapter 4. Here conclusions will only be drawn based on the model statistics and variogram analysis of the data. The model statistics for the GLM models are given in appendix 1. For 41% of the models a low predictive value (explained variance below 5%) is found but 26% of the models have an explained variance of greater than 5% (which is relatively high for models of ecological data!).

Variograms for all species per survey are shown in appendix 2. Semivariances are normalized which allow for comparison between surveys and species. As is clear from the graphs some species show no spatial correlation structure in any of the surveys (e.g. Little Gull), however, several species show clear spatial correlation structure on small scales (e.g. for Guillemot in all surveys with exception of survey 8). This justifies the use of regression-kriging.

MWTL

The above interpolation methodology has been carried out according calculation rules as presented in Berrevoets & Arts (2001, 2002, 2003) and Arts (2010). All data, results of analyses and figures of MWTL presented in this report (chapter 4) are delivered by Rijkswaterstaat Waterdienst/Ministry of Infrastructure and the Environment (F. Arts).

3 Observations

3.1 General summary per survey

3.1.1 May 2010

25 May 2010; transect lines in the southern part; coastal area of the provinces Zeeland and Zuid-Holland

A small part of the first transect lies in Belgian waters. In this part a wind farm is being constructed and many movements of working ships were observed. Due to time shortage no permits were arranged before hand to enter this area. Within Belgian waters a White-beaked Dolphin was observed (for a couple of years a pod of this species is present here, pers. comm. E. Stienen).

During the first part of the day it was cloudy so from both sides good observation conditions were experienced. Only in the afternoon when it became sunny no observations could be made from the southern side of the aeroplane. All main concentrations of Lesser Black-backed Gulls were related to fishery activities. A few Northern Fulmars were observed within the vicinity of fishing vessels.

26 May 2010; transect lines in the middle part; coastal area of the northern part of the province of Zuid-Holland and almost all of province Noord-Holland up to half way the island of Texel

No permissions could be arranged before hand to fly over the Prinses Amalia wind farm (PAWP) and the Egmond aan Zee wind farm (OWEZ), the transect lines were therefore adapted. In principle there are no technical limitations to survey wind farms with an aeroplane.

In front of the coast of Petten a relatively large concentration of more than 3,000 Common Scoters was found. In front of the coast of Texel a concentration of four fishing vessels was active, with large numbers of Lesser Black-backed Gulls scavenging. Flocks of Great Cormorants were also observed near the fishing vessels. Further out the number of birds was low, with hardly any fishery activity. Far out a few Guillemots were present.

Unfortunately a part of the observations of one side of the aeroplane was lost due to a malfunctioning of the dictation machine. One observation on a large flock of Common Scoters could be reconstructed.

27 May 2010; transect lines all along the Wadden Isles from Texel up to Borkum

The northern parts, especially far from the coast, were void of birds. On the Frisian Front there were hardly any birds. Only a few Guillemots, Northern Fulmars, Kittiwakes and Northern Gannets were observed. No Lesser Black-backed Gulls were found. Fishing vessels' distribution was mainly confined to the coast close to the islands. Due to extremely favourable sea state conditions large numbers of Harbour

Porpoises were observed. The last transect north of Borkum could not be surveyed completely otherwise the airport could not be reached in time for landing.

3.1.2 July 2010

16 July 2010; transect lines in the southern part; coastal area of the provinces Zeeland and Zuid-Holland
All main concentrations of Lesser Black-backed Gulls were related to fishery activities. Most interestingly, a few single Guillemots with a young bird were present far from the coast near to the Brown Ridge area. A few Northern Fulmars were observed. Due to the unfavourable sea state and light conditions only a few Harbour Porpoises were observed.

18 July 2010; transect lines in the middle part; coastal area of the northern part of the province of Zuid-Holland and almost all of province Noord-Holland up to half way the island of Texel.
In front of the coast of Petten this time no large concentration of Common Scoters was found, but this area was not available for the ducks on this day as several sailboats were active in the area. Far out at the latitude of Texel small to sometimes medium-sized flocks of up to 10 Guillemots were present, but only a few of these consisted of parent birds with young. Due to the not so favourable sea state conditions no large numbers of Harbour Porpoises were observed. As highlight a Minke Whale was observed far from the coast to the northwest of Texel. The white band on the fin lit by the sunlight and was the reason the animal was discovered by the observer, as the animal was swimming under water in northwesterly direction. In the same area also three different Manx Shearwaters were observed as bird highlights.

19 July 2010; transect lines all along the Wadden Isles from Texel up to Borkum
This time on the Frisian Front there were clearly increased concentrations of Guillemots, Northern Fulmars, Kittiwakes and Northern Gannets were present. Also regularly small flocks of Lesser Black-backed Gulls were found. Several fishing vessels were observed far from the coast. Far out at the latitude of Texel small flocks to sometimes medium sized up to 20 birds Guillemots were present, and again this only included a few parent birds with young. Due to the improved sea state conditions at some areas regularly Harbour Porpoises were observed, but especially the areas north of Ameland and Schiermonnikoog seemed to be devoid of both mammals and birds. Close to the coast of Schiermonnikoog a concentration of over 3,000 Common Scoters was present.

3.1.3 August 2010

27 August 2010; transect lines all along the Wadden Isles from Borkum to halfway Terschelling
Again the impression was that the areas north of Ameland and Schiermonnikoog held low densities of seabirds. Most remarkable was the occurrence of terns tens of kilometres out of the coastal zone. Part of these terns could not be identified and were

recorded as ‘comic terns’, but some nearby flocks could positively be identified as Arctic Terns. Furthermore, remarkably also Sandwich Terns were flying far out at sea. Here also the largest numbers of Guillemots, Northern Fulmars, Kittiwakes and Northern Gannets were present, although the latter species was most spread. Lesser Black-backed Gulls were found in much smaller numbers than in July. Great Black-backed Gulls were also present and hardly any Fishing vessels were observed. Due to the sea state conditions only a few Harbour Porpoises were observed. Migratory species recorded included both Parasitic and Great Skuas.

28 August 2010; transect lines from halfway Terschelling to almost all of province Noord-Holland up to Bergen
Also on this day relatively many tern flocks were observed far out at sea. Far out small flocks of Guillemots were present. Flocks larger than three birds were rare, implying that the numbers were smaller than in July. Increased numbers compared to July were found in Northern Fulmar and Kittiwake, of the latter species also juvenile birds were present. In front of the coast of Petten again no large concentration of Common Scoters was found. Due to the unfavourable sea state conditions only a few harbour porpoises were observed. A few Great Skuas were also observed.

29 August 2010; transect lines south of the middle part of the province of Noord-Holland up to the Port of Rotterdam
To the south of Bergen, decreasing numbers of Guillemots, Kittiwakes and Northern Fulmars were recorded. This appeared to be a true decrease in numbers rather than the result of adverse observations conditions (see also result below of 30 August). Due to the unfavourable sea state conditions hardly any Harbour Porpoises were observed.

30 August 2010; transect lines in the southern part; coastal area of the provinces Zeeland and Zuid-Holland
Although sea state conditions were around five, it was decided to finish the total survey. The general impression was that sea state conditions are not the most hindering factor for seabird observations. In line with the observations the day before low densities were found from the south, where the survey started to the north in the direction of the coast of Zuid-Holland. A few tens of Northern Fulmars were observed and a number of Great Skuas and Kittiwakes. Due to the not so favourable sea state conditions hardly any Harbour Porpoises were observed.

3.1.4 September 2010

20 September 2010; transect lines all along the Wadden Isles from Borkum to halfway Terschelling
In general, small numbers were observed of Guillemots, Kittiwakes and Northern Gannets. The first two species were clearly more numerous further from the coast. The general impression was that sea state conditions are not the most hindering factor for seabird observations, e.g. the lack of fishing vessels were the likely explanation why only a few gulls were observed further than five km off of the coast. Only a few

mostly individual terns were observed, mainly far out at sea. Due to the sea state conditions (up to five far from the coast) only a few Harbour Porpoises were observed. Migratory species included a Parasitic Skua that was recorded near to the coast.

21 September 2010; transect lines from halfway Terschelling to almost all of province Noord-Holland up to Bergen

On this day the observation conditions were excellent. Far from the coast, in contrast to the observations a day earlier only small flocks of Guillemots were present, with flocks larger than three birds being rare. Also the numbers of Northern Fulmar and Kittiwake were low. Only the part west and southwest of Texel a region with relatively high densities of Guillemots (with flocks of more than 20) and Kittiwakes was encountered. Due to the favourable sea state conditions tens of Harbour Porpoises were observed, including a mother with a recently born calf, which was keeping the calf near the surface with her beak. This is a remarkably late observation showing that the reproductive period for the species in this part of the North Sea is longer than was previously known. Single Great and Parasitic Skuas were observed.

24 September 2010; transect lines south of the middle part of the province of Noord-Holland up to the coastal area of the provinces Zuid-Holland and Zeeland

In the south low densities of Guillemots were found, however, the numbers of Northern Fulmars were largest during the September survey were found in the south, with remarkably also some tens of Great Skuas, which probably drifted and concentrated due to a severe bad weather front. Two Manx Shearwaters and a Long-tailed Skua amidst Sandwich Terns were observed. Due to the unfavourable sea state conditions hardly any Harbour Porpoises were observed.

3.1.5 October 2010

11 October 2010; transect lines from halfway Texel to the south, almost all of province Noord-Holland up south of IJmuiden

Highlights during this survey were the relatively high presence of Northern Gannets, with foraging flocks of several birds scattered all along the Dutch coastal waters, with flocks sometimes up to 25 birds. Far from the coast only small flocks of Guillemots were present. Also the numbers of Fulmar and Kittiwake were low. Only the part west and southwest of Texel a region with relatively high densities of Guillemots and Kittiwakes were encountered. Due to the unfavourable sea state conditions small numbers of Harbour Porpoises were observed. Due to the northeasterly wind, migration of non-seabirds was observed, with flocks of passerines regularly passing under the aeroplane in south and southeasterly directions (corrections flights to reach land), e.g. of Meadow Pipits, Chaffinches, three species of thrush, Starlings, and a Wheatear. Also a Short-eared Owl was observed flying far out at sea. Small numbers of Great Cormorants were still seen foraging at sea around the wind farms near Egmond.

12 October 2010; transect lines south of the middle part of the province of Noord-Holland up to the coastal area of the provinces Zuid-Holland and Zeeland

Large numbers of Northern Gannets were present as mentioned above. In the south, low densities of Guillemots were found, however, observations of Great Skuas were made in the southern region, which followed the same pattern as during the September survey. Due to the unfavourable sea state conditions hardly any Harbour Porpoises were observed.

19 October 2010; transect lines all along the Wadden Isles from Vlieland to Borkum
On 19 October also still relatively large numbers of Northern Gannets, with further out in this region reasonable numbers of Guillemots, Kittiwakes and Northern Fulmars being recorded. In the coastal zones of the Wadden Isles already tens of divers were recorded, mainly confirmed to be Red-throated Divers (one bird was registered as a possible Black-throated). Due to showers some concentrations were found of Kittiwakes, likely explained by birds avoiding the severe rain. Again small numbers of fishing vessels were observed in this region far from the coast. However, in the coastal zone near Ameland a fleet of twelve vessels was active with large numbers of accompanying gulls in the vicinity. Due to the sea state conditions (up to five far from the coast) only a small number of Harbour Porpoises were observed, but as marine mammal highlight two Bottlenose Dolphins were observed in the Frisian Front area. As bird highlight an adult Sabine’s Gull was recorded far out at sea.

3.1.6 November 2010

26 November 2010; transect lines north of the Wadden Isles from Borkum to Terschelling
Good numbers of auks, mainly Guillemots, but also Razorbills were observed. Associations of small flocks of auks with respectively Kittiwakes and Little Gulls were observed. Near the coast of Rottum a flock of several hundreds of Common Scoters was present. Near the coast also Red-throated Divers were present, with two individual birds exceptionally far from the coast.

27 November 2010; transect lines from Terschelling up to Texel
The same picture as the day before: good numbers of auks, mainly Guillemots, but also Razorbills with associations with Kittiwakes and Little Gulls respectively. Harbour Porpoises were recorded in their largest number.

28 November 2010; transect lines south of the middle part of the province of Noord-Holland up to the coastal area of the province Zuid-Holland
In the northern part still large numbers of auks were present. To the south the numbers slowly decreased. A huge foraging flock of gulls, Northern Fulmars and Northern Gannets was found associated with a twin-span fishing boat pair, whilst hardly any seabirds were observed in the surrounding area.

29 November 2010; transect lines south of the middle part of the province of Zuid-Holland up to the northern part of the province of Zeeland

Small numbers of Guillemots and Razorbills were observed although far from the coast some Northern Fulmars and Kittiwakes were present. A remarkable concentration of more than 1,500 Common Gulls was present near a gas platform.

30 November 2010; transect lines in front of the coast of Zeeland

Small numbers of Kittiwakes and auks.

3.1.7 January 2011

26 January 2011; transect lines all along the Wadden Isles from Borkum to the South point of Vlieland

In the coastal strip north of Schiermonnikoog large numbers of Common Scoters were present. Only a fraction of the total numbers present were recorded from the transect lines, but in the proceeding weekend total numbers were determined by the special coastal scoter survey of MWTL (between Terschelling and Rottum a total of around 30,000 birds, pers. comm. P.W. Wolf). Far out at sea, small numbers of Guillemots and Razorbills were present. With low fishery activities large numbers of large gulls were lacking. Common Gull and Kittiwake were most numerous, with smaller numbers of Little Gull. More than 20 Harbour Porpoises were counted.

27 January 2011; transect lines from the north point of Texel to the south, almost all of province Noord-Holland up south of Zandvoort.

On several transects hardly any birds were recorded. Some fishing vessels with gull concentrations were encountered, but overall relatively small numbers of large gulls at sea. Only one Northern Gannet was encountered. Compared with the day before larger numbers of auks, with Razorbills dominating. Many Guillemots were already in summer plumage. More than 30 Harbour Porpoises were recorded.

28 January 2011; transect lines south of the middle part of the province of Noord-Holland up to the coastal area of Zeeland

Comparable species composition was found in the southern region of the study area as the day before.

3.1.8 February 2011

13 February 2011; transect lines all along the Wadden Isles from Borkum to the South point of Vlieland

In the coastal strip north of Schiermonnikoog large numbers of Common Scoters were present. Far out at sea small numbers of Guillemots and Razorbills were present. With low fishery activities large numbers of large gulls were lacking. Kittiwake was most numerous, with fewer Little Gulls present. A few tens of Harbour Porpoises were noted.

14 February 2011; transect lines from the north point of Texel to the south, almost all of province Noord-Holland up south of Zandvoort.
During several transects hardly any birds were recorded. Some fishing vessels with gull concentrations were encountered, but overall relatively few large gulls were recorded at sea. A single Northern Gannet was encountered. Again, larger numbers of auks were present in the south, with a Razorbill dominating. Many Guillemots were already in summer plumage. The total of Harbour Porpoises was more than 30 individuals. The highlight was a pod of two White-beaked Dolphins.

15 February 2011; transect lines south of the middle part of the province of Noord-Holland up to the coastal area of Zeeland
Comparable species composition was found in the southern region of the study area to the day before, but with remarkably large numbers of Harbour Porpoises; more than 120.

3.1.9 April 2011

18 April 2011; transect lines all along the Wadden Isles from Terschelling to Petten
Due to fog conditions above Schiermonnikoog and Ameland this part could not be surveyed on this day and was left and could be done on the second day if conditions improved. Several small groups (up to 50 individuals) of Little Gull were seen mostly migrating north or east. Throughout the day large numbers of Guillemots were encountered although the distribution was patchy. Small numbers of Red-throated Divers were present throughout the surveyed area. One large flock of scoter was seen near Texel and Harbour Porpoises were regularly seen. Sandwich Terns were regularly encountered, also far offshore. Small numbers of ‘comic terns’ were recorded. Northern Gannets were scarce (around 10 individuals), which was similar to the numbers of Northern Fulmar.

19 April 2011; transect lines above Schiermonnikoog to Ameland and from the northern part till the middle part of the province of Noord-Holland
The first part of the day consisted of the survey above Schiermonnikoog and Ameland, while the second part covered the northern part to the middle part of the province of Noord-Holland. On several transects hardly any birds were recorded. Some fishing vessels with gull concentrations were encountered, but overall relatively small numbers of large gulls were recorded. Relatively large numbers of Little Gulls were encountered, both in migratory flight as well as foraging or resting on the water. Only a few Northern Gannets were encountered. Approximately 100 Harbour Porpoises were recorded. During the second part of the day many small groups of Guillemots were encountered.

20 April 2011; transect lines south of the middle part of the province of Noord-Holland up to the coastal area of Zeeland
A comparable species composition was found in the southern region of the study area as the day before, with considerable numbers of Little Gulls. Smaller number of

Guillemots were encountered, but with slightly larger numbers of Northern Gannets and Northern Fulmars.

3.2 Species accounts seabirds

A total of 56 bird species and six marine mammal species were recorded during the aerial surveys of the Shortlist Masterplan (Table 3.1 and 3.2). Accounts of the most commonly observed species are given below and provide a description of the observations made in this study, specific discussions on patterns in distributions, issues relating to observations such as sea state and disturbance by aeroplane, and also regarding the species' associations with other species, fronts and human activities.

In the maps for each survey type the recorded basic numbers are presented, so total numbers of observed flocks. Because of different methodologies regarding strip width or maximum observation range along the transect lines, the total numbers recorded are not comparable. Only the relative differences in overall patterns in distribution, taking into account the differences in survey design and the number of surveys, can be compared, although the differences in distribution patterns can also be the result of a lack of temporal overlap. Densities are compared in Chapter 4.

The results of the ship-based surveys (see van Bemmelen *et al.* 2011) are discussed in relation to identification issues together with additional information on recorded behaviour and flight altitude. A comparison of the results with distribution patterns found from the aerial MWTL data is discussed in relation to survey design, disturbance effects of the aeroplane, etc., as well as ship-associated behaviour.

Finally, in every species the distribution patterns determined by the three types of surveys (the present aerial-based study of the Shortlist Masterplan, ship-based and MWTL) are discussed in relation to the general occurrence of seabirds in the Dutch part of the North Sea and specifically in relation to the search areas for new offshore wind farms.

Table 3.1 Species list of the Shortlist Masterplan aerial survey program with total number of recorded individuals and the total number taken into account with the determination of bird/mammal densities. Note that these totals only refer to animals of the perpendicular transects of open water and not birds and mammals of parallel-to-coast transect lines (and also excluding birds and mammals associated with beaches and sand banks). In the distribution maps in this chapter these are presented. 'In transect' are the total number of birds observed on the sides with good observation conditions. These have been used to determine effective strip widths and ultimately densities.

BIRDS

Species	**Dutch name**	**Scientific name**	**total**	**'in transect'**
Red-throated Diver	*roodkeelduiker*	*Gavia stellata*	339	213
Black-throated Diver	*parelduiker*	*Gavia arctica*	1	1
unidentified diver	*Ongedet. duiker*	*Gavia spec.*	40	28
Great Crested Grebe	*fuut*	*Podiceps cristatus*	826	51
Red-necked Grebe	*roodhalsfuut*	*Podiceps griseigena*	1	1
Northern Fulmar	*noordse stormvogel*	*Fulmarus glacialis*	852	711
Manx Shearwater	*noordse pijlstormvogel*	*Puffinus puffinus*	6	4
Northern Gannet	*jan van gent*	*Sula bassana*	2325	1877
Great Cormorant	*aalscholver*	*Phalacrocorax carbo*	2615	1687
Pink-footed Goose	*kleine rietgans*	*Anser brachyrhynchus*	4	4
Greylag Goose	*grauwe gans*	*Anser anser*	41	41
Greater Canada Goose	*Canadese gans*	*Branta canadensis*	2	2
Brent Goose	*rotgans*	*Branta bernicla*	213	160
unidentified goose	*Ongedet. gans*	*Anser/Branta spec.*	26	26
Wigeon	*smient*	*Anas penelope*	213	17
Gadwall	*Krakeend*	*Anas strepera*	4	4
Mallard	*Wilde eend*	*Anas platyrhynchos*	3	3
Greater Scaup	*Toppereend*	*Aythya marila*	1	1
Common Eider	*Eider*	*Somateria mollissima*	8394	4965
Common Scoter	*Zwarte zee-eend*	*Melanitta nigra*	22548	8788
Velvet Scoter	*Grote zee-eend*	*Melanitta fusca*	22	4
Common Goldeneye	*Brilduiker*	*Bucephala clangula*	4	4
Red-breasted Merganser	*Middelste zaagbek*	*Mergus serrator*	187	187
unidentified duck	*Ongedet. eend*	*unidentified duck*	22	22
Common Kestrel	*Torenvalk*	*Falco tinnunculus*	2	2
unidentified falcon	*Ongedet. valk*	*Falco spec.*	1	1
Eurasian Oystercatcher	*Scholekster*	*Haematopus ostralegus*	26	6
Lapwing	*Kievit*	*Vanellus vanellus*	14	14
Sanderling	*Drieteenstrandloper*	*Calidris alba*	17	17
unidentified calidris spec.	*Strandloper ongedet.*	*Calidris spec.*	17	17
Curlew	*Wulp*	*Numenius arquata*	35	15
Redshank	*Tureluur*	*Tringa totanus*	4	4
unidentified wader	*Ongedet. steltloper*		19	19
Parasitic Skua	*Kleine jager*	*Stercorarius parasiticus*	5	4
Long-tailed Skua	*Kleinste jager*	*Stercorarius longicaudus*	1	1
Great Skua	*Grote jager*	*Stercorarius skua*	44	40

continuation of Table 3.1

Species	Dutch name	Scientific name	total	'in transect'
Mediterranean Gull	*Zwartkopmeeuw*	*Larus melanocephalus*	1	1
Little Gull	*Dwergmeeuw*	*Larus minutus*	1578	1174
Sabine's Gull	*Vorkstaartmeeuw*	*Larus sabini*	1	1
Black-headed Gull	*Kokmeeuw*	*Larus ridibundus*	1085	243
Common Gull	*Stormmeeuw*	*Larus canus*	4867	3888
Lesser Black-backed Gull	*Kleine mantelmeeuw*	*Larus fuscus*	16448	12909
Herring / Common gull	*Zilvermeeuw of stormmeeuw*	*L. argentatus / L. canis*	269	269
Herring Gull	*Zilvermeeuw*	*Larus argentatus*	10700	6750
Great Black-backed Gull	*Grote mantelmeeuw*	*Larus marinus*	3290	2604
unidentified large gull		*Larus spec.*	9590	6234
unidentified small gull		*Larus spec.*	3204	3138
black-backed gull spp.	*Mantelmeeuw ongedet.*	*L. fuscus / L. marinus*	5668	4461
Kittiwake	*Drieteenmeeuw*	*Rissa tridactyla*	7114	5966
unidentified gull	*Ongedet. meeuw*	*Larus spec.*	8945	4666
unidentified gull / tern	*Ongedet. meeuw of stern*	*Larus / Sterna spec.*	19	16
Sandwich Tern	*Grote stern*	*Sterna sandvicensis*	5367	2318
Common Tern	*Visdief*	*Sterna hirundo*	782	122
Arctic Tern	*Noordse stern*	*Sterna paradisaea*	38	31
Common / Arctic Tern	*Ongedet. 'noordse dief'*	*S. hirundo / S. paradisaea*	196	196
Little Tern	*Dwergstern*	*Sterna albifrons*	33	3
Black Tern	*Zwarte stern*	*Chlidonias niger*	18	18
unidentified tern	*Ongedet. stern*	*Sterna spec.*	42	42
Guillemot	*Zeekoet*	*Uria aalge*	4652	3456
Guillemot / Razorbill	*Ongedet. zeekoet/alk*	*Alca torda / Uria aalge*	1036	874
Razorbill	*Alk*	*Alca torda*	471	397
Little Auk	*Kleine alk*	*Alle alle*	2	2
unidentified auk	*Ongedet. alkachtige*	*unidentified alcidae*	2	2
unidentified pigeon	*Ongedet. duif*	*unidentified columbidae*	2	2
Short-eared Owl	*Velduil*	*Asio flammeus*	1	1
Sky Lark	*Veldleeuwerik*	*Alauda arvensis*	5	5
Meadow Pipit	*Graspieper*	*Anthus pratensis*	16	16
Northern Wheatear	*Tapuit*	*Oenanthe oenanthe*	1	1
Fieldfare	*Kramsvogel*	*Turdus pilaris*	1	1
unidentified thrush	*Ongedet. lijster*	*Turdus spec.*	11	11
Redwing	*Koperwiek*	*Turdus iliacus*	2	2
Carrion Crow	*Zwarte kraai*	*Corvus corone corone*	2	1
Starling	*Spreeuw*	*Sturnus vulgaris*	2	2
Chaffinch	*Vink*	*Fringilla coelebs*	1	1
unidentified medium passerine	*Middelgrote zangvogel ongedet.*		1	1
unidentified small passerine	*Kleine zangvogel ongedet.*		15	15
Individuals			**124351**	**78781**
Species			**56**	**56**

continuation of Table 3.1

MARINE MAMMALS

Species	Dutch name	Scientific name	total	'in transect'
Minke Whale	*Dwergvinvis*	*Balaenoptera acutorostrata*	1	1
unidentified dolphin	*Ongedet. dolfijn*	*Delphinus spec.*	2	2
Bottlenose Dolphin	*Tuimelaar*	*Tursiops truncatus*	2	2
White-beaked Dolphin	*Witsnuitdolfijn*	*Lagenorhynchus albirostris*	5	5
Harbour Porpoise	*Bruinvis*	*Phocoena phocoena*	885	564
unidentified seal	*Ongedet. zeehond*	*unidentified pinniped*	788	213
Grey Seal	*Grijze zeehond*	*Halichoerus grypus*	237	112
Harbour Seal	*Gewone zeehond*	*Phoca vitulina*	119	94
unidentified marine mammal	*Ongedet. zeezoogdier*	*Cetacean / Pinniped spec.*	4	4
Individuals			**2043**	**997**
Species			**6**	**6**

Table 3.2 *Species list with total number of recorded individuals per survey. Note that these totals only refer to animals in the perpendicular transects of open water and not birds and mammals in the parallel-to-coast transect lines (in this way also excluding over-representation of birds and mammals associated with coastal fronts, beaches and sand banks). In the distribution maps in this chapter all observed birds and mammals are presented.*

Species	May	Jul	Aug	Sep	Oct	Nov	Jan	Feb	Apr
BIRDS									
Red-throated Diver	0	0	1	3	28	50	95	140	22
Black-throated Diver	0	0	0	0	0	1	0	0	0
unidentified diver	0	0	1	1	4	20	7	1	6
Great Crested Grebe	0	0	0	0	2	663	29	132	0
Red-necked Grebe	0	0	0	0	1	0	0	0	0
Northern Fulmar	15	16	187	48	42	467	46	8	23
Manx Shearwater	0	3	0	2	0	1	0	0	0
Northern Gannet	20	152	238	165	527	1044	24	118	27
Great Cormorant	346	1113	34	66	80	66	16	10	201
Great Egret	0	0	0	0	0	0	0	4	0
Pink-footed Goose	0	0	0	0	0	0	0	0	4
Greylag Goose	0	0	0	0	0	0	2	36	3
Greater Canada Goose	0	0	0	1	0	0	0	0	1
Brent Goose	150	0	0	0	0	1	2	60	0
unidentified goose	0	0	0	0	0	1	0	25	0
Wigeon	0	0	6	5	0	0	0	196	6
Gadwall	0	0	0	0	0	0	0	4	0
Mallard	0	0	0	0	0	0	0	0	3
Greater Scaup	0	0	0	0	0	0	1	0	0
Common Eider	40	395	82	3	14	3224	1326	2689	13
Common Scoter	3010	6255	56	3	217	4096	3230	3053	2628
Velvet Scoter	0	0	0	0	0	4	14	3	1
Common Goldeneye	0	0	0	0	0	0	4	0	0
Red-breasted Merganser	0	0	0	0	50	67	41	22	7
unidentified duck	0	0	0	15	0	6	1	0	0
Common Kestrel	0	0	0	0	0	0	0	0	2
unidentified falcon	0	0	0	0	0	0	0	0	1
Eurasian Oystercatcher	2	0	0	0	0	0	4	0	0
Lapwing	0	0	0	0	0	13	0	1	0
Sanderling	0	0	0	0	0	0	9	0	8
unidentified calidris spec.	0	5	2	10	0	0	0	0	0
Curlew	0	6	0	0	0	0	0	0	9
Redshank	0	0	0	0	0	0	0	0	4
unidentified wader	1	0	2	0	0	15	0	0	1
Parasitic Skua	0	1	1	3	0	0	0	0	0
Long-tailed Skua	0	0	0	1	0	0	0	0	0
Great Skua	0	0	6	23	6	9	0	0	0
Mediterranean Gull	0	1	0	0	0	0	0	0	0
Little Gull	1	3	0	0	31	157	77	153	1156
Sabine's Gull	0	0	0	0	1	0	0	0	0
Black-headed Gull	17	74	99	7	33	547	114	63	10
Common Gull	2	10	3	3	72	2362	2137	245	32
Lesser Black-backed Gull	3509	5176	251	858	183	5	2	33	4222
Herring / Lesser Black-backed gull	0	0	1	0	0	0	0	0	0
Herring / Common gull	0	0	0	0	0	236	0	0	33
Herring Gull	922	587	1059	216	1064	1859	1632	158	309
Great Black-backed Gull	0	22	40	954	952	560	439	119	19
unidentified large gull	1335	45	120	918	2055	408	1468	648	1772
unidentified small gull	0	2	19	0	22	3045	53	31	30
black-backed gull	880	400	202	812	1709	1	0	503	1
Black-legged Kittiwake	13	18	559	739	356	3659	415	1341	14
unidentified gull	20	501	136	9	1784	1350	397	2015	1523
unidentified gull / tern	0	0	0	0	0	0	0	0	19
Sandwich Tern	413	690	615	46	0	1	0	2	1349
Common Tern	6	48	33	8	1	0	0	0	26
Arctic Tern	0	0	33	1	1	0	0	0	3
Common / Arctic Tern	54	6	118	1	0	0	0	0	17
Little Tern	0	3	0	0	0	0	0	0	0
Black Tern	0	18	0	0	0	0	0	0	0
unidentified tern	0	0	5	1	0	0	0	0	36

Continuation of Table 3.2

Species	May	Jul	Aug	Sep	Oct	Nov	Jan	Feb	Apr
Guillemot	9	520	99	569	332	1079	294	720	1030
Guillemot / Razorbill	0	1	0	2	17	676	96	155	89
Razorbill	0	1	2	3	33	112	204	113	3
Little Auk	0	0	0	1	0	0	0	1	0
unidentified auk	0	0	0	0	2	0	0	0	0
unidentified pigeon	2	0	0	0	0	0	0	0	0
Short-eared Owl	0	0	0	0	1	0	0	0	0
Skylark	0	0	0	0	3	0	0	0	2
Meadow Pipit	0	0	0	5	0	0	0	0	11
Northern Wheatear	0	0	0	0	1	0	0	0	0
Fieldfare	0	0	0	0	1	0	0	0	0
unidentified thrush	0	0	0	0	11	0	0	0	0
Redwing	0	1	0	0	1	0	0	0	0
Carrion Crow	0	0	0	0	0	0	1	0	1
Starling	0	0	0	0	1	0	0	0	1
Chaffinch	0	0	0	0	1	0	0	0	0
unidentified medium passerine	0	0	0	0	0	0	0	0	1
unidentified small passerine	0	0	0	2	5	0	0	0	8
Individuals	**10767**	**16073**	**4010**	**5504**	**9644**	**25805**	**12180**	**12802**	**14687**
Species	**16**	**23**	**20**	**25**	**30**	**24**	**25**	**26**	**33**
MARINE MAMMALS									
Minke Whale	0	1	0	0	0	0	0	0	0
unidentified dolphin	0	0	0	0	0	0	0	0	2
Bottlenose Dolphin	0	0	0	0	2	0	0	0	0
White-beaked Dolphin	1	0	0	0	0	0	0	4	0
Harbour Porpoise	132	36	14	73	24	80	92	139	295
unidentified seal	30	3	37	53	4	12	4	10	4
Grey Seal	0	2	1	0	0	1	2	1	1
Harbour Seal	0	0	2	0	0	2	5	0	1
unidentified marine mammal	0	0	0	0	1	2	0	1	0
Individuals	**163**	**42**	**54**	**126**	**31**	**97**	**103**	**155**	**303**
Species	**2**	**3**	**3**	**1**	**1**	**3**	**3**	**3**	**3**

3.2.1 Common Scoter

Observations in this study

Given the survey design (transect counts perpendicular to the coast, with only small parallel transects partly covering the coast) and the flocking behaviour of Common Scoters, it is important to realise that this species has only been partly surveyed. When comparing the two cumulative distribution patterns of the Shortlist Masterplan and MWTL (Figures 3.2.1.1. and 3.2.1.2), one should take into account that the species' near-shore distribution of concentrations are reliable, but that recorded total numbers are only indicative. In the Shortlist Masterplan surveys only short parts of the coast have been covered, while in the MWTL surveys Common Scoters are only recorded in a very narrow strip band.

During surveys, Common Scoters only occurred close to the shore (one to ten km) with the highest concentrations found off the coast of the Wadden Islands; this was also true during periods of migration. Common Scoters were present during all surveys. The largest numbers were encountered during summer (July >6,200 birds), but as indicated before, this is due to the unequal coverage of the coast and likely a coincidental result because of the flocking behaviour of this species. In January and

February large groups were present to the north of Ameland and Schiermonnikoog. In late winter the distribution of Common Scoters close to the coast appeared to be more widespread. In the Voordelta (SW part of the Netherlands) and along the coast of Noord-Holland, Common Scoters showed an infrequent distribution and were present in relatively small numbers (with a maximum of about 3,000 birds).

As Common Scoters are rather sensitive to disturbance, flocks are easily disturbed by the aeroplane and tend to fly for a short distance when the aeroplane passes. After a while (less than a minute) birds usually return to the original area. As flocks are easily disturbed by the aeroplane they are relatively easy to detect, however, flocks can be missed when observation conditions are affected by higher sea states or when they are outside the observation range of the survey transect; the latter being of particular importance during this survey as the coast was only partly covered by parallel transects.

Associations with other species, fronts or human activities
Velvet Scoters were frequently observed within flocks of Common Scoters and small groups of Common Scoters were seen in groups of Common Eiders. Also kleptoparasitising Herring Gulls and Common Gulls were often associated with actively foraging flocks. As Common Scoters are rather sensitive to disturbance, birds avoid human activities such as fishery or ship traffic lanes.

Flight altitude
Commons Scoters usually fly at low altitudes (<25 metres) above the sea (Figure 3.2.1.5). This holds true both for disturbed birds as well as for the few flocks of birds flying over longer distances (e.g. during seasonal or daily migration). During the aerial surveys of the shortlist program the number of flying birds was very limited (less then 1,000). No flying Common Scoters were observed above 25 metres above sea level.

Comparison with ship-based data
Common Scoters can be identified with high accuracy both from ships and aeroplanes; there are almost no mistakes with other species. The estimation of numbers, however, can be more accurate from aerial surveys than from ship-based surveys. This is due to influence of disturbance; Common Scoters are easily disturbed by ships and show avoidance behaviour at great distances (up to one km or even further in calm weather), whereas birds remain on the water surface longer when approached by a fast moving aeroplane. More important is that numbers are easier to estimate after disturbance from above as the observers have a better overview. As experienced pilots are capable in herding disturbed birds together this provides observers with the opportunity of performing several counts of the same flock. It should be noted that the amount of time of the disturbance by a survey aeroplane is limited to several minutes and the operations are conducted such that birds do not leave the area. Due to the effects of disturbance of the observation platform, observations of birds' behaviour are difficult to ascertain from both ship-based and aerial surveys, although from an aeroplane foraging activity can be noted indirectly by

the presence of kleptoparasitising gulls. This is potentially a recent phenomenon due to the fact that scoters have shifted their diet towards prey that are more difficult to handle (*Ensis sp.*) and therefore require more handling time compared to small bivalve prey.

Comparison with MWTL data

In comparison with the MWTL monitoring, the Shortlist Masterplan survey shows comparable distribution patterns in the northern concentration areas between Texel and Schiermonnikoog. In this area the MWTL survey follows the coast and crosses all flocks if present. Within MWTL there is also a special survey program for scoters (and seals) in the Voordelta, but these data have not been incorporated in this report. Here the design of the 'North Sea wide' MWTL survey is less appropriate for detecting flocks in the coastal areas as the distribution of the scoter flocks perpendicular to the coast is more variable (Poot *et al.* 2006). The dedicated MWTL scoter survey provides comprehensive coverage of the Voordelta area.

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea

Common Scoters are most abundant close to the coast; all concentration areas lie within ten kilometres from the shore. Birds occur year-round, although numbers peak during the winter, typically February and March (Camphuysen & Leopold 1994). In the 1980s and 1990s, Common Scoters often occurred in very large groups of up to 15,000 to 75,000 birds and exceptionally 125,000 (Camphuysen & Leopold 1994). Occasionally groups numbering several thousands of individuals can be present during the summer, which are considered to be moulting birds. Most Common Scoters in the Netherlands winter off the coasts of the Wadden Islands, but up to 25,000 were estimated off the coast of the Delta in the early 1990s (Camphuysen & Leopold 1994). Other concentration areas can be found along the coast of the province Noord-Holland, near Petten and in the Voordelta. Most movements of Common Scoter are relatively close to the shore and involve birds moving between these concentration areas. The results of this Shortlist Masterplan show that flocks passing outside of the coastal zone are relatively very rare, but it should be taken into account that movements can occur to other areas along the coast outside the National borders (e.g. Poot *et al.* 2006).

During 2010 and 2011, several additional aerial surveys of Common Scoters were conducted in the Dutch North Sea. These surveys were undertaken on behalf of the impact assessment of the Port of Rotterdam reclamation program in the Voordelta and aimed to determine the numbers of Common Scoters in the main concentration areas, e.g. the coast of the Wadden Isles (as a reference for the Voordelta). These recent surveys show that current numbers are not as large as those recorded during the 1980s and 1990s. During late winter (January-March 2011), more than 30,000 Common Scoters remained off the coasts of the Wadden Islands. Near Petten, up to 2,000 Common Scoters were present in March. In the Voordelta numbers were low (<1,500 birds) in the winter of 2010-2011.

The accuracy of the estimates depends on flock size and behaviour. When numbers rise above 10,000 birds with a widespread distribution estimates become less accurate, although calibration between different observers reveals that estimates are rather accurate. Comparison of different observers during different, close-to daily, surveys in March, with numbers above 30,000 in a widespread distribution, proved differences of less then 10%. Estimates of numbers are not significantly affected by sea state, but the detection of relatively small flocks of up to several hundreds of birds can be hampered by higher sea states.

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms

All available data show that the majority of Common Scoters stay close to the coast. Common Scoters were not observed within the search areas for offshore wind farms. Only a few observations of small flocks flying of birds crossing the North Sea were made during the migration period.

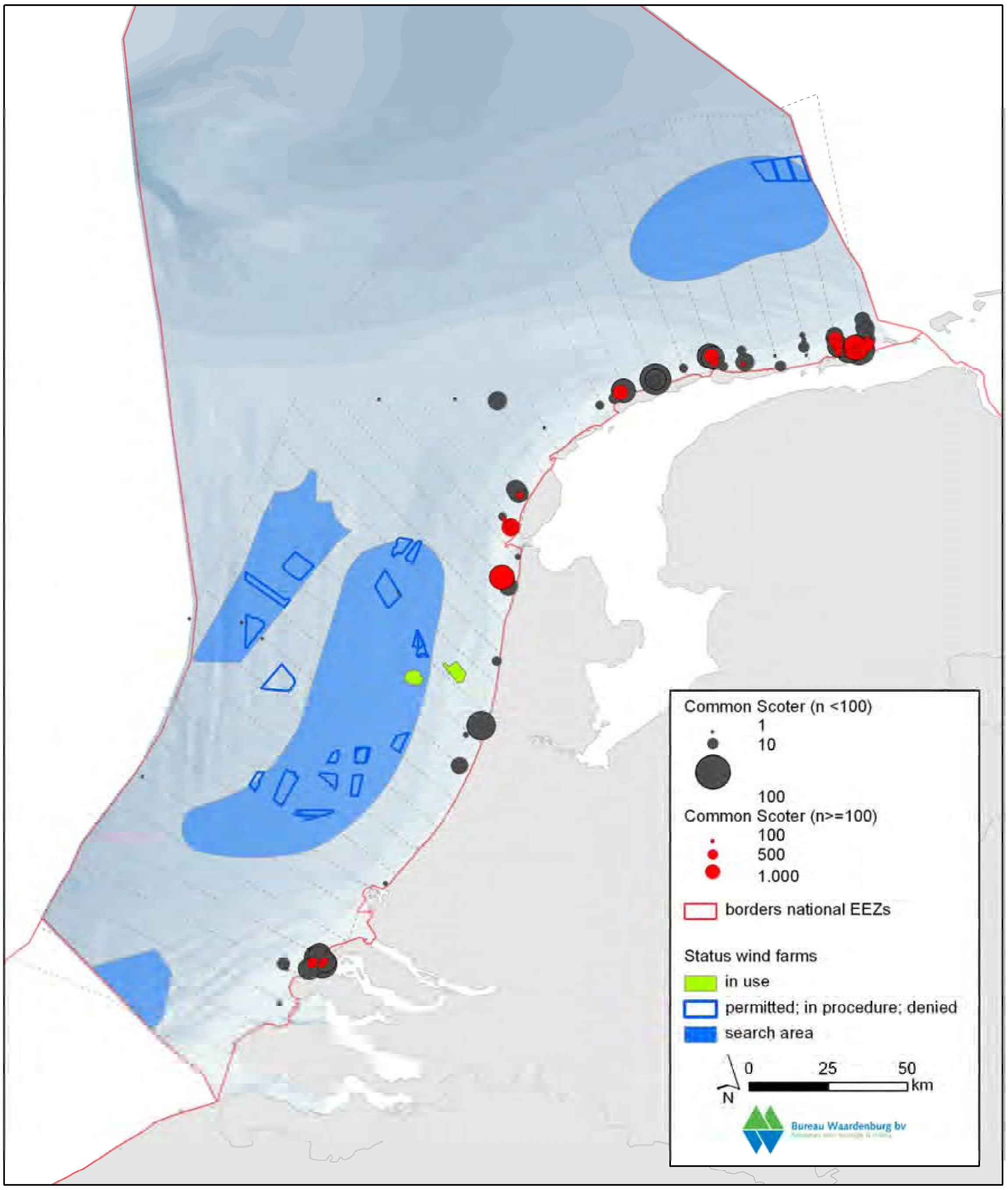


Figure 3.2.1.1 *Cumulative distribution of Common Scoters observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).*

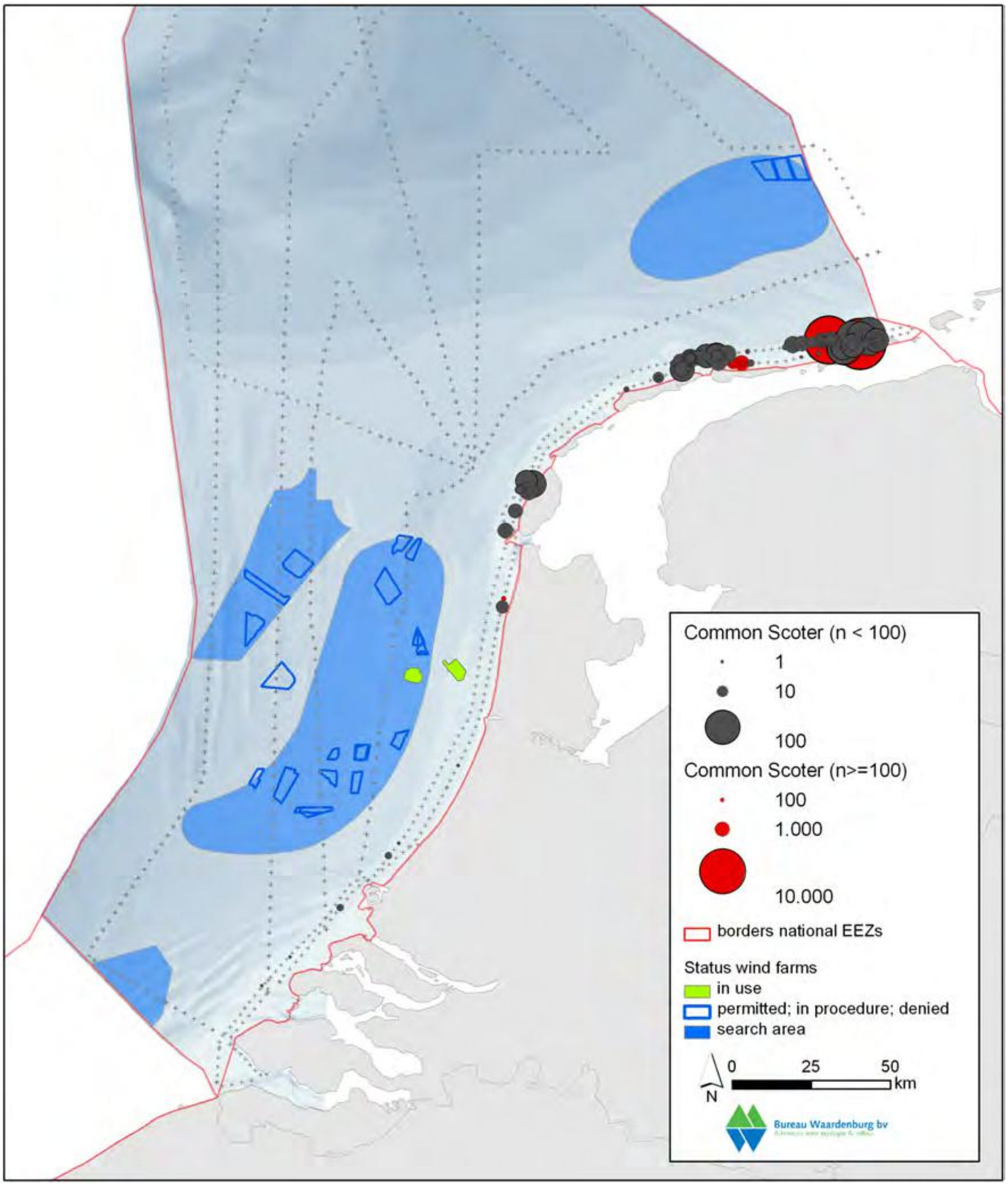


Figure 3.2.1.2 *Cumulative distribution of Common Scoters observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011). A logtransformed legend has been used as the MWTL survey is coast parallel and has a more complete coverage of the main concentration areas (with a maximum of more than 30,000 birds total during one survey).*

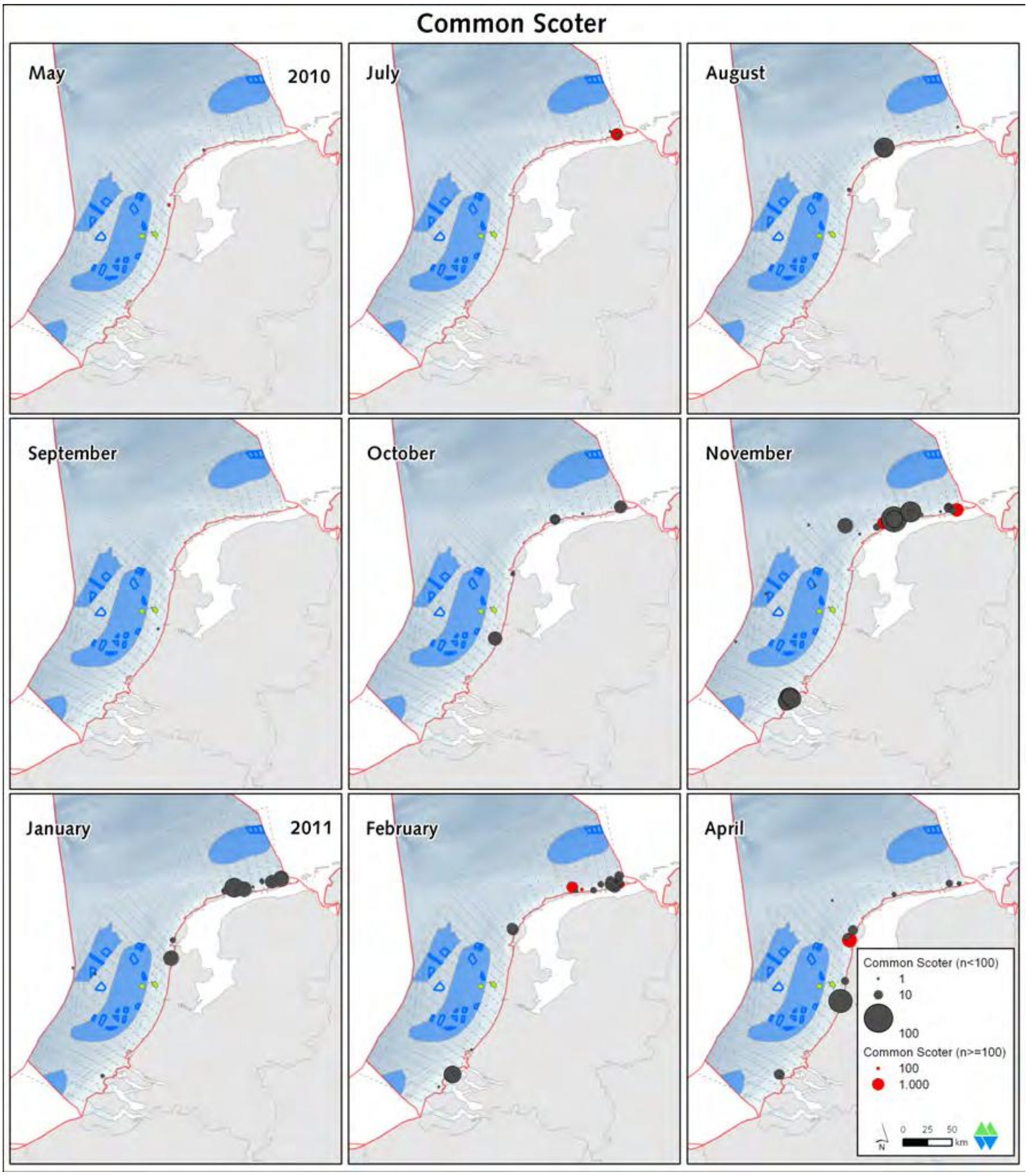


Figure 3.2.1.3 *Distribution of Common Scoters observed during the aerial-based survey monitoring Shortlist Masterplan project per month (nine surveys in the period May 2010 – April 2011).*

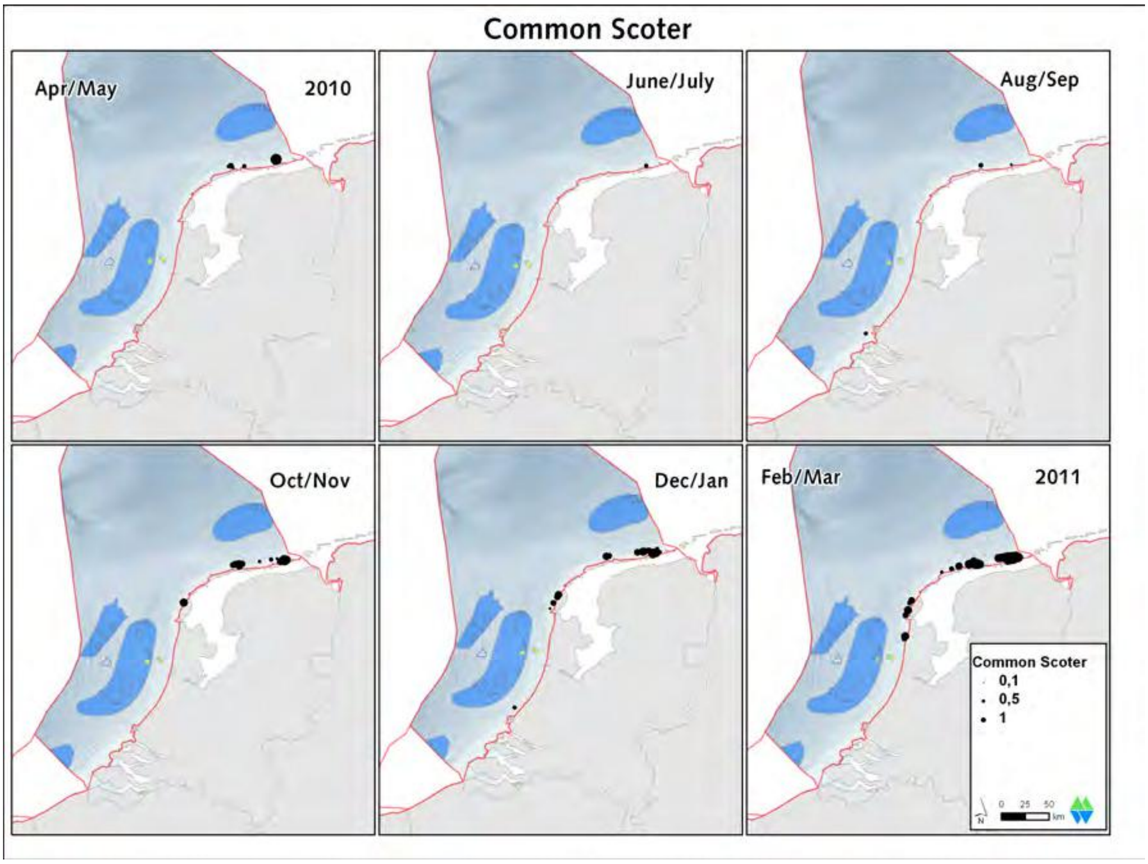


Figure 3.2.1.4 *Distribution of Common Scoters observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).*

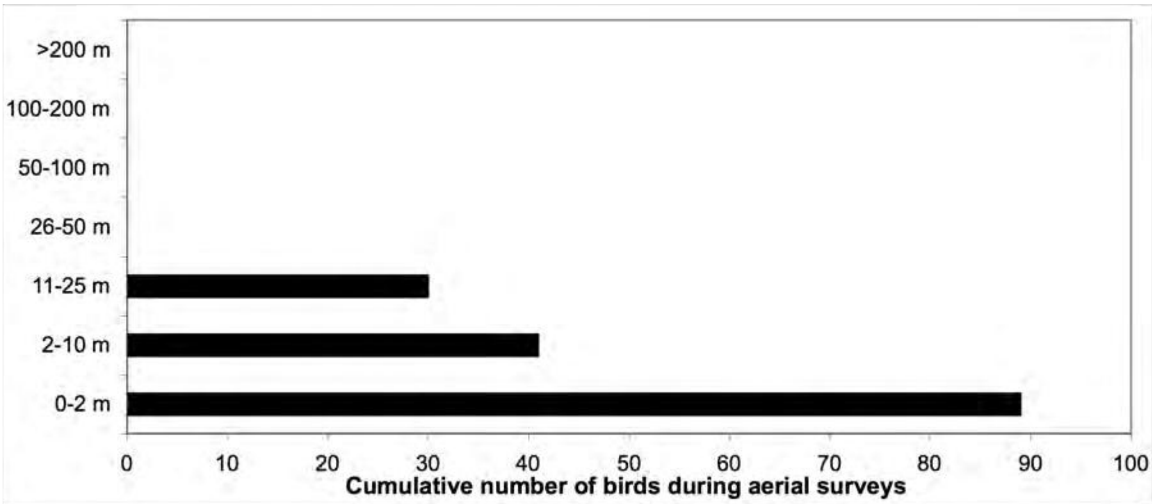


Figure 3.2.1.5 *Cumulative number of Common Scoters flying at different altitudes during the aerial-based survey monitoring Shortlist Masterplan project (nine surveys in the period May 2010 – April 2011, birds associated with ships excluded).*

3.2.2 Divers spp. (mainly Red-throated Divers)

Among the diver species present in the Dutch North Sea, Red-throated Diver is by far the most abundant. In the Shortlist Masterplan almost 90% of the observed divers could be identified as Red-throated Divers. A relatively small proportion (10.5%) could not be identified to species. One Black-throated Diver was positively identified and one unidentified diver was recorded as 'large diver sp.', potentially being a Great Northern Diver. Divers present in the Dutch North Sea are likely to show similar patterns of occurrence and responses to disturbance, associations, etc., and be subject to the same survey error and are therefore discussed here together.

Observations in this study

Red-throated Divers are present in the Dutch North Sea from early autumn (September) until early spring (April) with observations in summer being very rare. The largest numbers were recorded in January and February. During winter, divers were observed relatively close to the coast (<20 km). The highest concentrations were found in the Voordelta and in the mouths of the channels between the Wadden islands. In the Voordelta birds are recorded up to 30-40 km offshore. Elsewhere in the North Sea birds only occasionally appear at greater distances from the coast, especially during spring migration (April).

Associations with other species, fronts or human activities

Divers are very sensitive to disturbance and avoid human activities, such as fishery or ship traffic lanes. Birds occur individually or in small groups (up to 10-20 birds), although associations with other species were not recorded.

Flight altitude

Divers usually fly at low altitudes (<25 metres) above the sea (Figure 3.2.2.6). This holds true both for disturbed birds as well as for birds flying over greater distances (e.g. during seasonal or daily migration). During the aerial surveys of the shortlist program the flight altitude was recorded for 50% of all flying divers. Among those divers no birds were flying above 25 metres above sea level. This corresponds with the results of the ship-based surveys of the shortlist program. However, divers on migration can fly at much higher altitudes, at the migration watch-point at Westkapelle (SW Netherlands) it is not uncommon to see groups of divers at heights well over 70 meters (P. Wolf *pers. comm.*).

Comparison with ship-based data

Both aerial surveys and ship-based surveys have particular advantages and disadvantages with regard to diver identification and estimation. During aerial surveys divers can sometimes be difficult to detect if the contrast with the water surface is low and this is highly dependent on weather conditions (sunshine and sea state). As a consequence numbers can be underestimated and identification of concerned diver species can be hampered. During ship-based surveys identification is easier when birds are flying and observed from aside. Identification, however, can also be inaccurate during ship-based surveys, as birds tend to be disturbed at great distances

(> 1km). Given this behaviour numbers are often underestimated during ship-based surveys (see Figure 3.2.2.3). During aerial surveys divers behave differently than during ship-based surveys as the source of disturbance appears differently. If divers are confronted by an aeroplane approaching at low altitude, birds are more surprised than in the case of ships approaching at low speed. As a consequence birds have less time to respond to the aeroplane (disturbance takes only place in the very last second) and only a few birds are thought to be missed, although in case of foraging divers birds can be missed when they are under water. Therefore, especially in this species, a program of a combination of aerial and ship-based surveys most accurately records distribution and numbers.

Comparison with MWTL data

Comparison with the MWTL survey data (Figure 3.2.2.2) shows that the distribution of divers recorded was comparable as during the MWTL monitoring. The association of divers with the coastal zone appears from both the Shortlist Masterplan as well as the MWTL monitoring data, although numbers in the Voordelta are not well covered by the MWTL surveys. This is due to the survey design with none of the MWTL transects in the Voordelta being perpendicular to the coast.

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea

Observations presented here, gathered in the period 2010-2011, fit very well with the current understanding of the occurrence of divers in the Dutch part of the North Sea. Red-throated Divers are found in the coastal waters around the Netherlands, mostly within 20 km of the shore (Bijlsma *et al.* 2001), with fewer birds found further offshore (Camphuysen & Leopold 1994). The species is most abundant between October and May, when migrating birds pass the Dutch coast. Up to 10,000 individuals are estimated to winter in Dutch waters (Camphuysen & Leopold 1994). Favoured foraging areas include the channels between the Wadden Islands and off the Delta (Camphuysen & Leopold 1994; Poot *et al.* 2006). Up to 1,500 birds can occur offshore of the Delta during winter (Poot *et al.* 2006).

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms

All available data show that divers occur close to the coast. Only during migration do birds occur further offshore. The search areas for wind farms are not of particular importance for divers. During migration potential passage might occur through the search areas, mostly during spring migration.

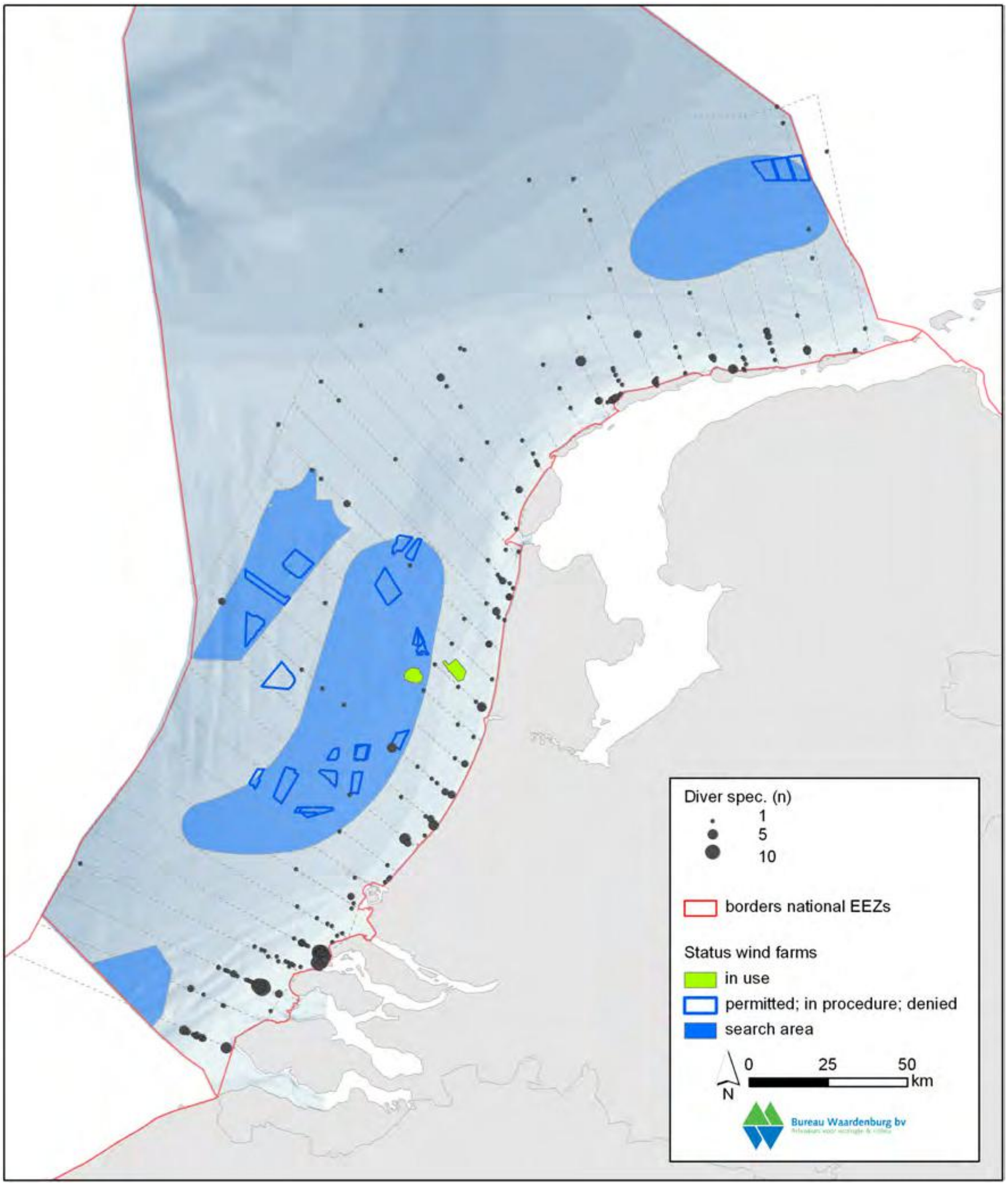


Figure 3.2.2.1 *Cumulative distribution of divers spp. (mainly Red-throated Divers) observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).*

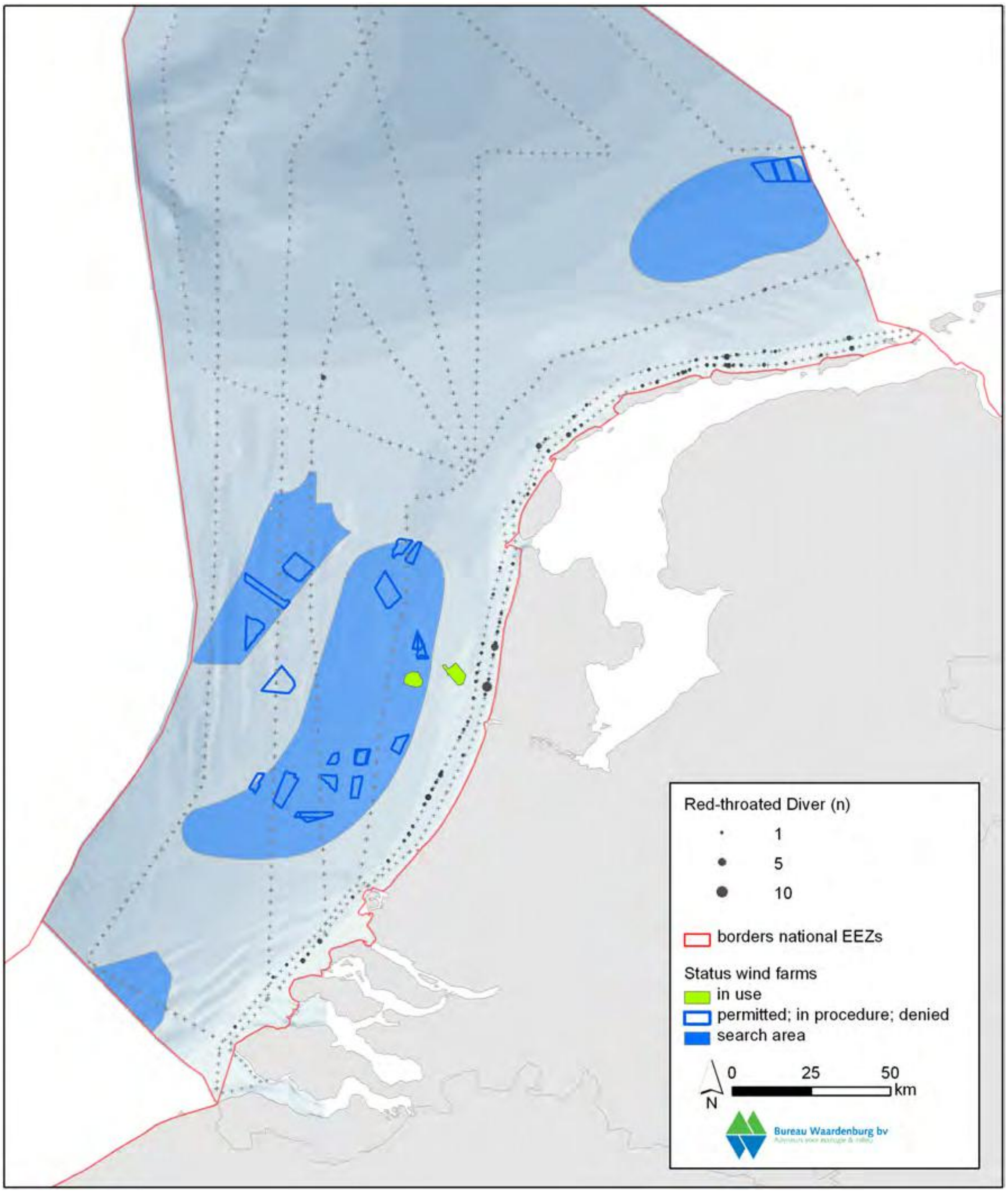


Figure 3.2.2.2 Cumulative distribution of divers spp. (mainly Red-throated Divers) observed during the aerial-based survey of the MWTL monitoring (six surveys in the period April 2010 – March 2011).

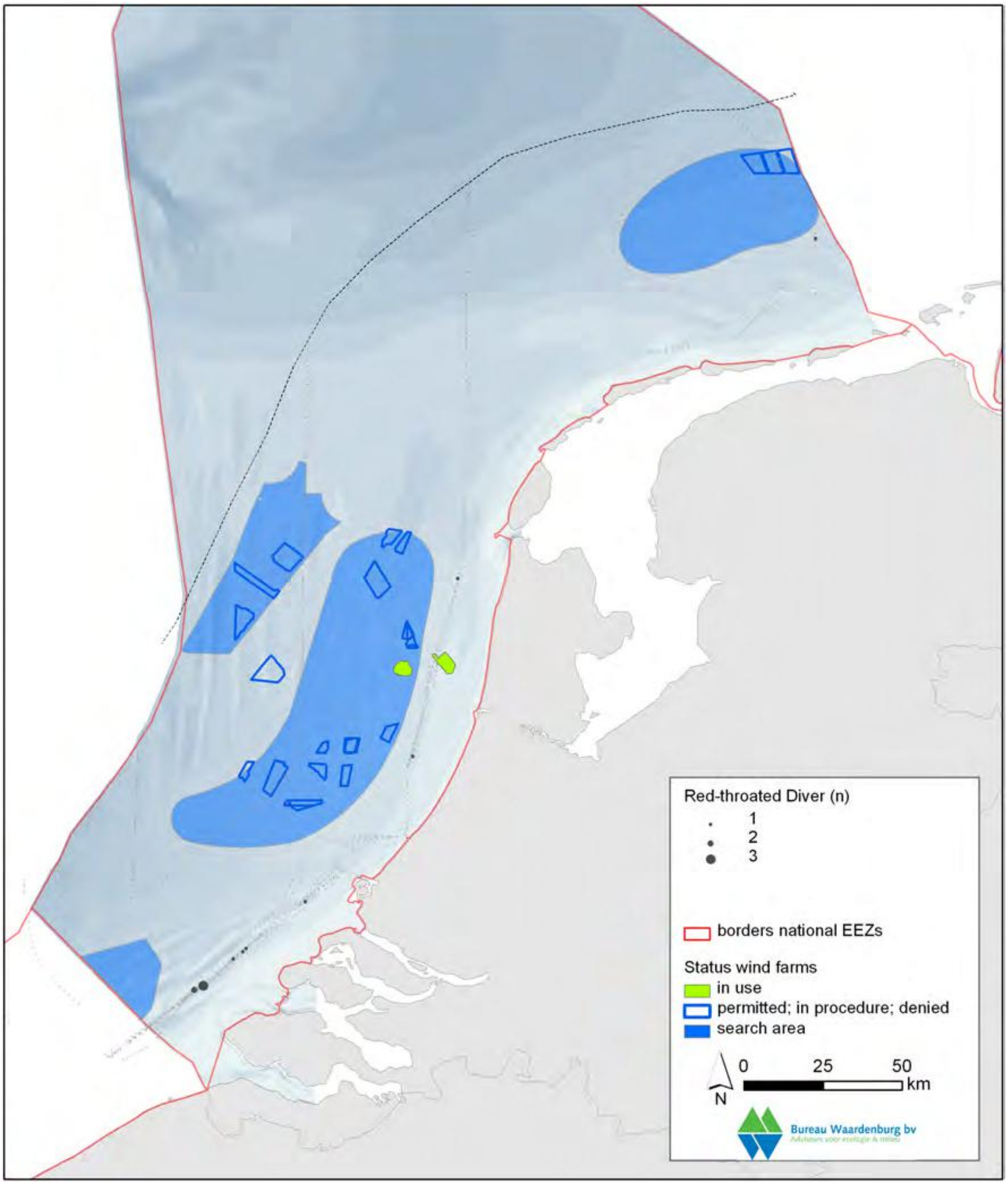


Figure 3.2.2.3 *Cumulative distribution of divers spp. (mainly Red-throated Divers) observed during the ship-based survey monitoring Shortlist Masterplan project (surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).*

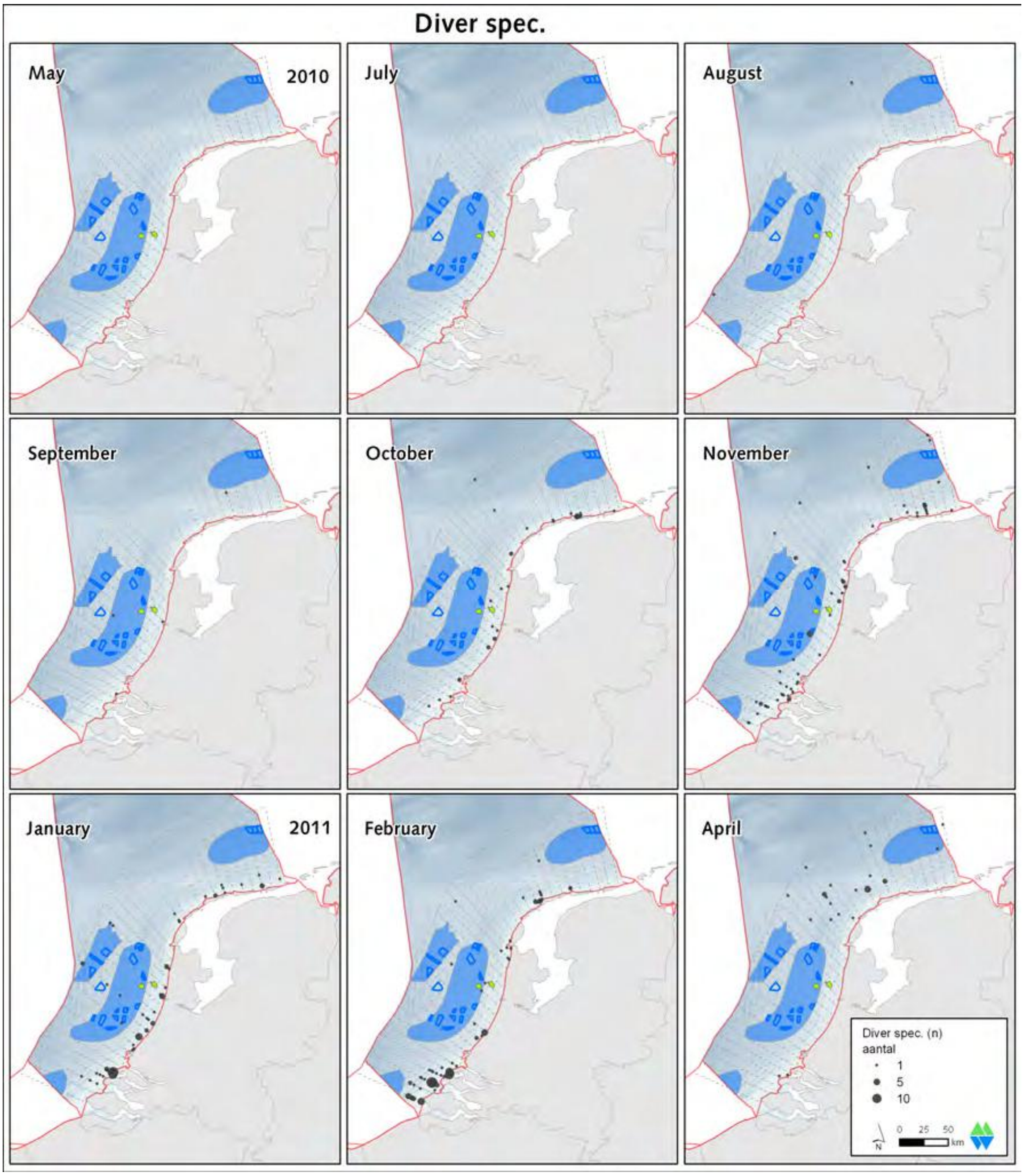


Figure 3.2.2.4 *Distribution of divers spp. (mainly Red-throated Divers) observed during the aerial-based survey monitoring Shortlist Masterplan project per month (nine surveys in the period May 2010 – April 2011).*

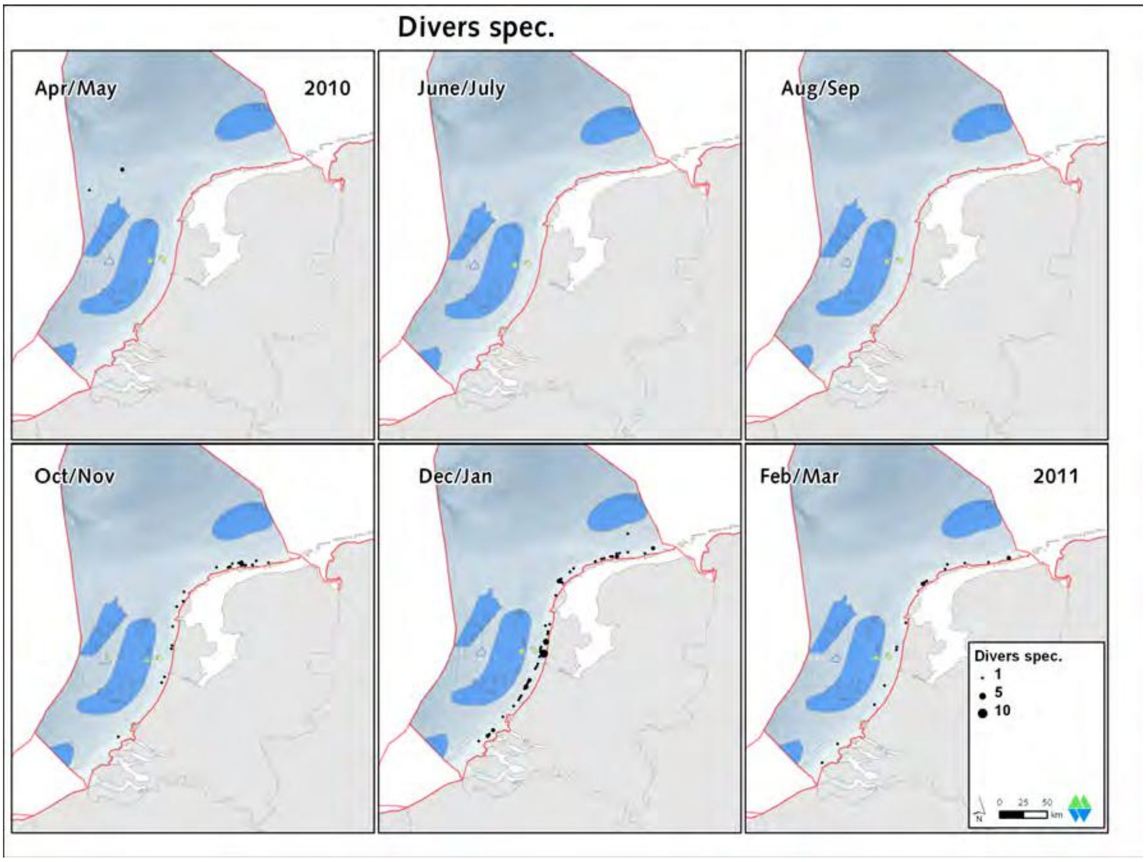


Figure 3.2.2.5 *Distribution of divers spp. (mainly Red-throated Divers) observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).*

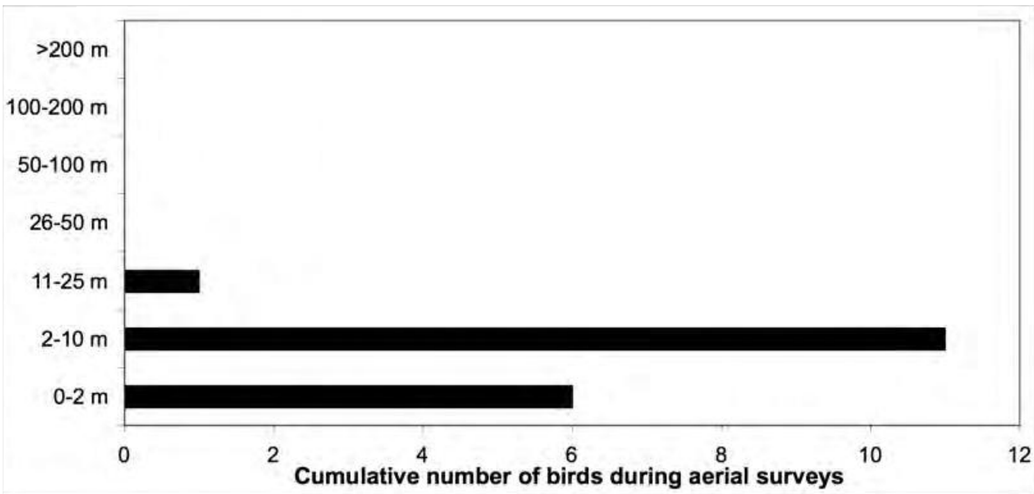


Figure 3.2.2.6 *Cumulative number of divers spp. (mainly Red-throated Divers) flying at different altitudes during the aerial-based survey monitoring Shortlist Masterplan project (nine surveys in the period May 2010 – April 2011, birds associated with ships excluded).*

3.2.3 Northern Gannet

Observations in this study

Northern Gannets were observed during all surveys and throughout the entire study area. Higher densities of birds were found in the southwest corner of the study area and west of Texel and Noord-Holland. Smallest numbers of birds were found along the coast of Zuid-Holland and Zeeland (Figure 3.2.3.1). Small numbers of Northern Gannets were also found north of Ameland and Schiermonnikoog. In late summer and autumn numbers of Northern Gannets were higher than in other seasons and the largest numbers of Northern Gannets were found in October and November (Figure 3.2.3.2). This is in line with the distribution patterns known from the literature (Camphuysen & Leopold 1994; Bijlsma *et al.* 2001) with most birds in late summer and autumn and fewer throughout the rest of the year.

In July, birds were observed closer to the shore whereas in the other months Northern Gannets were distributed more offshore. In November, two concentrations of birds were found about 70 km west of Texel and 40 km west of Westkapelle (Figure 3.2.3.4). All birds in these areas were associated with active fishing vessels. In general, Northern Gannets were widespread in low densities and concentrations occurred at fishing trawls similar as described by Camphuysen & Leopold (1994) and Bijlsma *et al.* (2001).

Northern Gannets mainly breed in colonies in the northern part of the North Sea (Helgoland is the southern-most colony). Birds in the Dutch North Sea represent individuals on migration towards or from their southern wintering grounds or birds wintering in the southern North Sea (Barret 1988; Wernham *et al.* 2002). Because of the large numbers breeding on Bass Rock, it is possible that birds from this colony constitutes a greater proportion of the birds wintering in the North Sea compared to, for example, the Norwegian colonies.

Northern Gannets are large and conspicuous birds that are mostly seen in flight. Therefore, sea state and weather conditions are less of an issue in the detection of this species. Northern Gannets did react on the aeroplane and often responded by flying away from the aeroplane, low above the sea surface. Therefore, the altitude distribution of this species may be biased by the observation method.

Associations with other species, fronts or human activities

Northern Gannets are known to associate with Harbour Porpoise, however, this was not observed in this study. This is probably due to a combination of the speed of the aeroplane and the flight response of Northern Gannets to the aeroplane, which decreases the chance of observing porpoise and Northern Gannet at the same time and location.

As stated above, (sometimes large) groups of Northern Gannets were often observed behind fishing vessels in autumn. Northwest of Texel, a ‘gap’ in numbers of Northern

Gannets can be seen. This may be due to the large number of platforms and human activity in that area.

Flight altitude
Northern Gannets usually fly at low altitudes (<25 metres) above the sea (Figure 3.2.3.6). As the birds often react on the aeroplane by flying away from the aeroplane, low above the sea surface, the altitude distribution of this species may be biased by the observation method. However, during the ship-based surveys also the majority of Northern Gannets were recorded flying at low altitudes. During the aerial surveys of the shortlist program the flight altitude was recorded for 75% of all flying Northern Gannets (81% if birds associated with ships are excluded). Among those Northern Gannets 126 birds (11%) were flying above 25 metres above sea level (15% if birds associated with ships are excluded). This corresponds with the results of the ship-based surveys of the shortlist program. Both survey programs encountered the majority of flying birds from 2-10 metres above sea level.

Comparison with ship-based data
As Northern Gannets are unmistakable, identification speed and accuracy from aeroplanes and ships is assumed to be equal. However, the most obvious dissimilarity between the two observation methods is that Northern Gannets do not flee from ships as they do from aeroplanes.

Due to the limited cover of the study area during the ship-based surveys distribution patterns are not easy to compare with the aerial surveys. Nevertheless, most birds were seen during both the ship-based and aerial surveys in the southwestern corner of the study area.

During both observation methods Northern Gannets were seen throughout the study area with some areas having higher densities. Remarkably, during the ship-based surveys Northern Gannets were observed just off the Maasvlakte, which was a relatively 'gannet-poor' area during the aerial surveys.

Comparison with MWTL data
Similar patterns were found regarding the distribution of Northern Gannet during both the aerial Shortlist Masterplan surveys and the MWTL surveys. An area with high densities of Northern Gannets in the southwestern corner of the Dutch part of the North Sea was observed in winter during both surveys. Similarly, both surveys revealed large numbers of Northern Gannets during early autumn to the northwest of Texel.

As Northern Gannets are large conspicuous birds the detection of the two aerial survey methods are expected to be similar. However, the effect of disturbance by the survey aeroplane on the numbers of recorded Northern Gannets might be different between the two types of aerial survey programs with the MWTL surveys performed at higher altitudes (with potentially a larger effect of the disturbance as birds might respond earlier to a higher flying aeroplane).

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea

The distribution patterns found in this study are in line with the patterns known from the literature (Camphuysen & Leopold 1994; Bijlsma *et al.* 2001). The largest numbers of Northern Gannets were recorded in late summer and autumn and in general, the species was widespread in low densities with concentrations occurring at fishing trawls.

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms

The aerial surveys showed that Northern Gannets were recorded in all search areas for new offshore wind farms although in some areas larger numbers were observed than in others. The smallest number of Northern Gannets was observed in the most northerly location, above Ameland. During the ship-based surveys fewer Northern Gannets were encountered within the search areas for new wind turbines but observations in this study were limited to the sailed tracks. The most northern search area yielded also the smallest numbers of Northern Gannets during the MWTL surveys; here also observations were limited to the survey track.

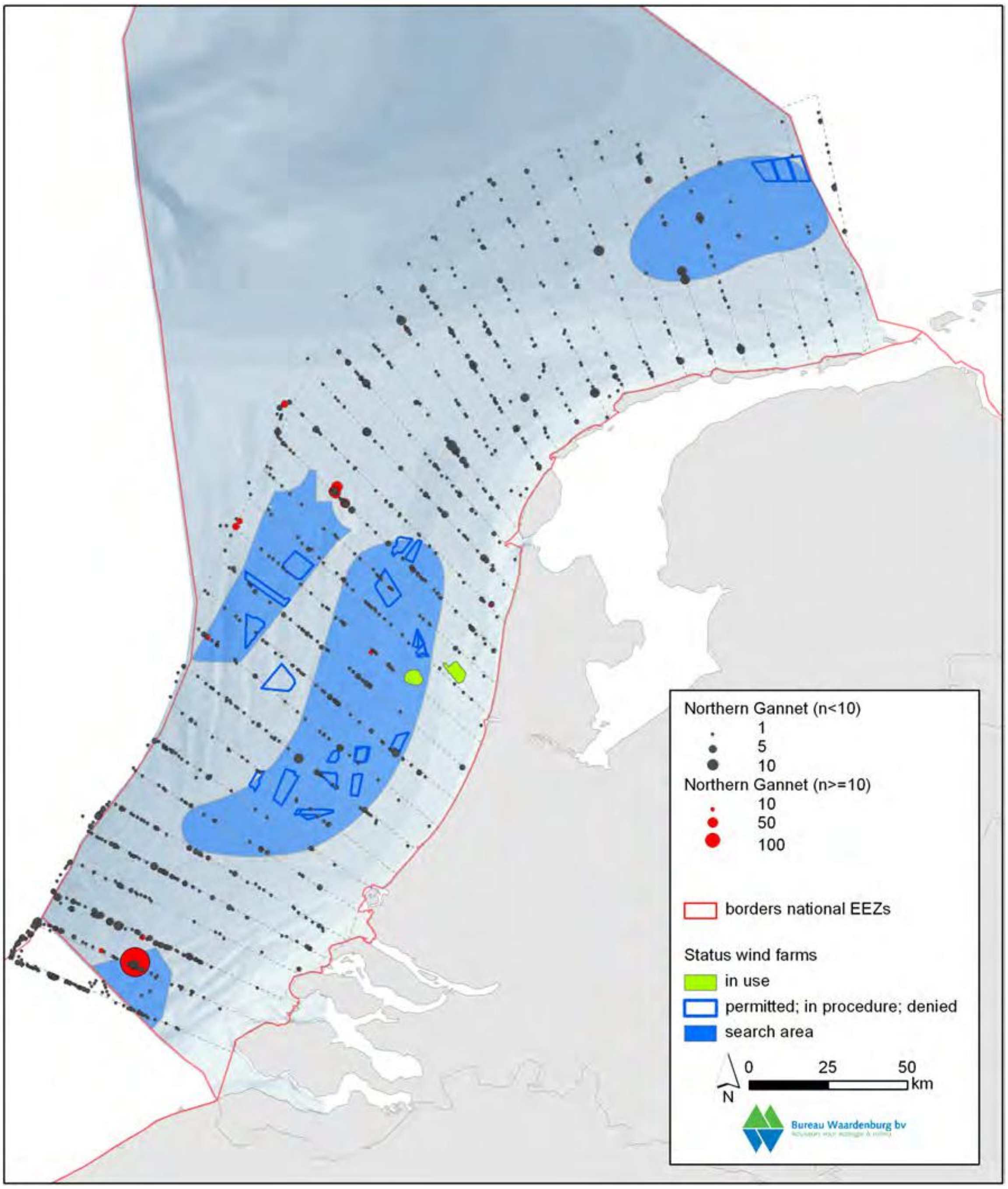


Figure 3.2.3.1 *Cumulative distribution of Northern Gannet observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).*

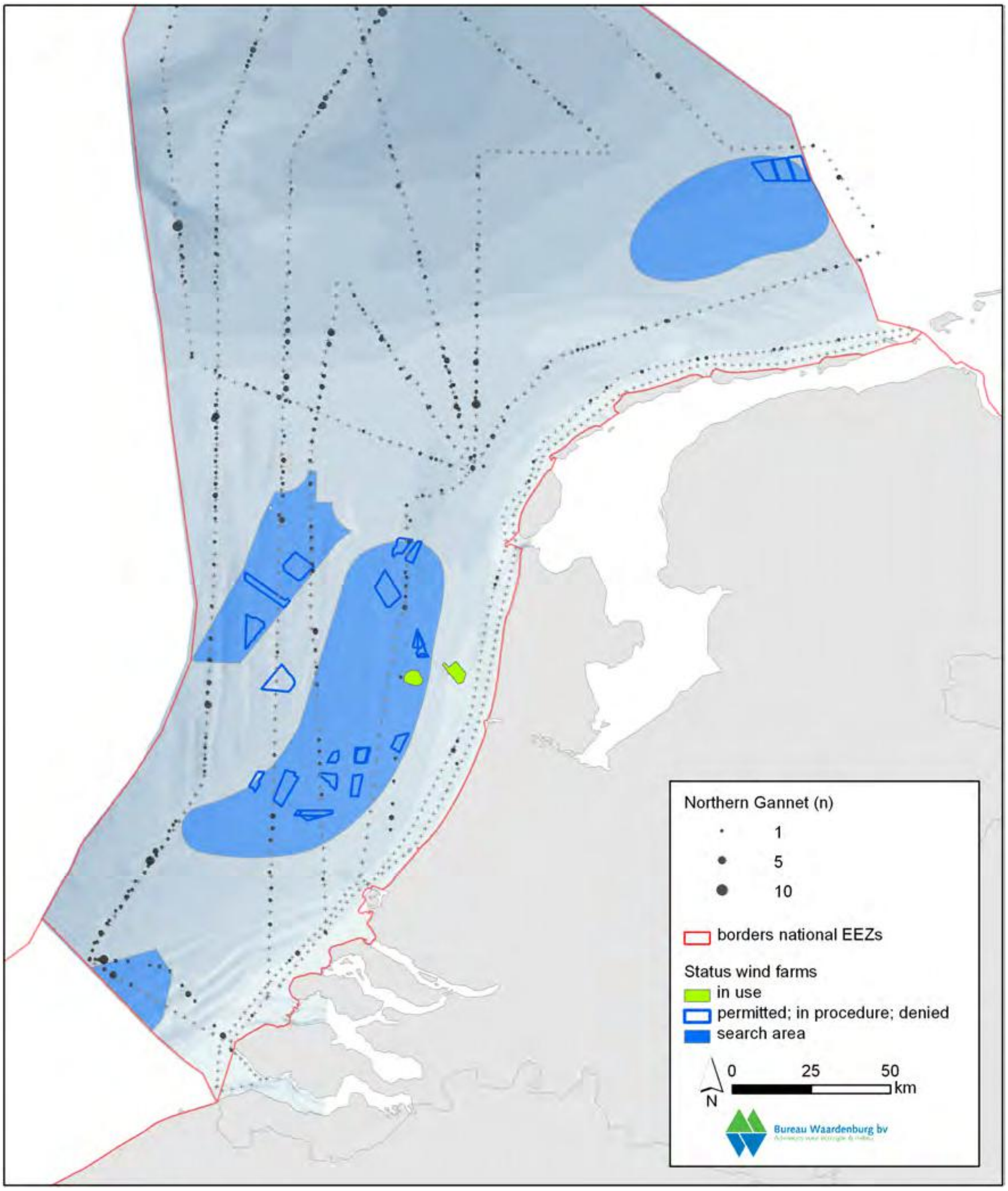


Figure 3.2.3.2 *Cumulative distribution of Northern Gannet observed during the aerial-based survey of the MWTL monitoring (six surveys in the period April 2010 – March 2011).*

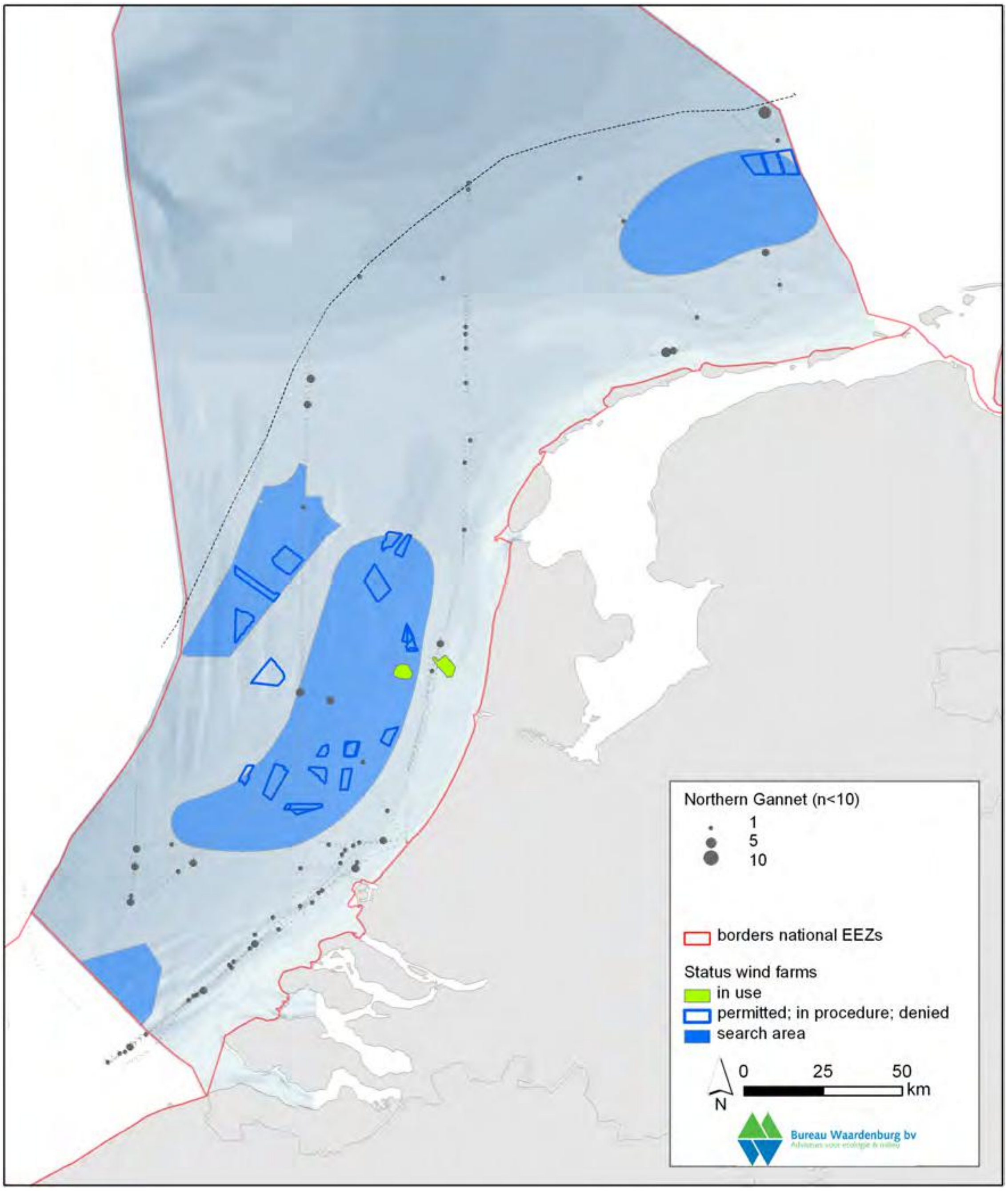


Figure 3.2.3.3 Cumulative distribution of Northern Gannet observed during the ship-based survey monitoring Shortlist Masterplan project (surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).

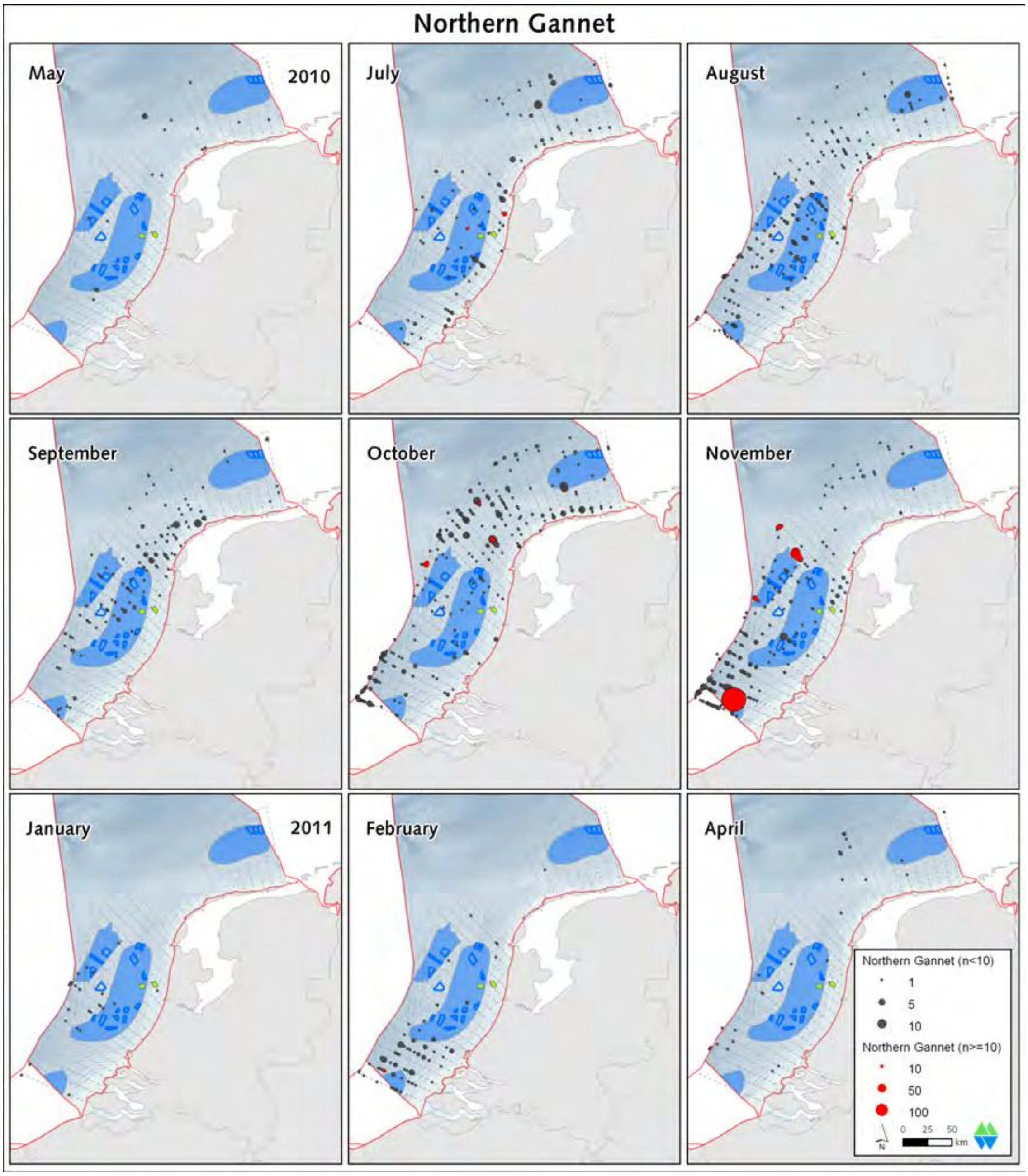


Figure 3.2.3.4 *Distribution of Northern Gannet observed during the aerial-based survey monitoring Shortlist Masterplan project per month (nine surveys in the period May 2010 – April 2011).*

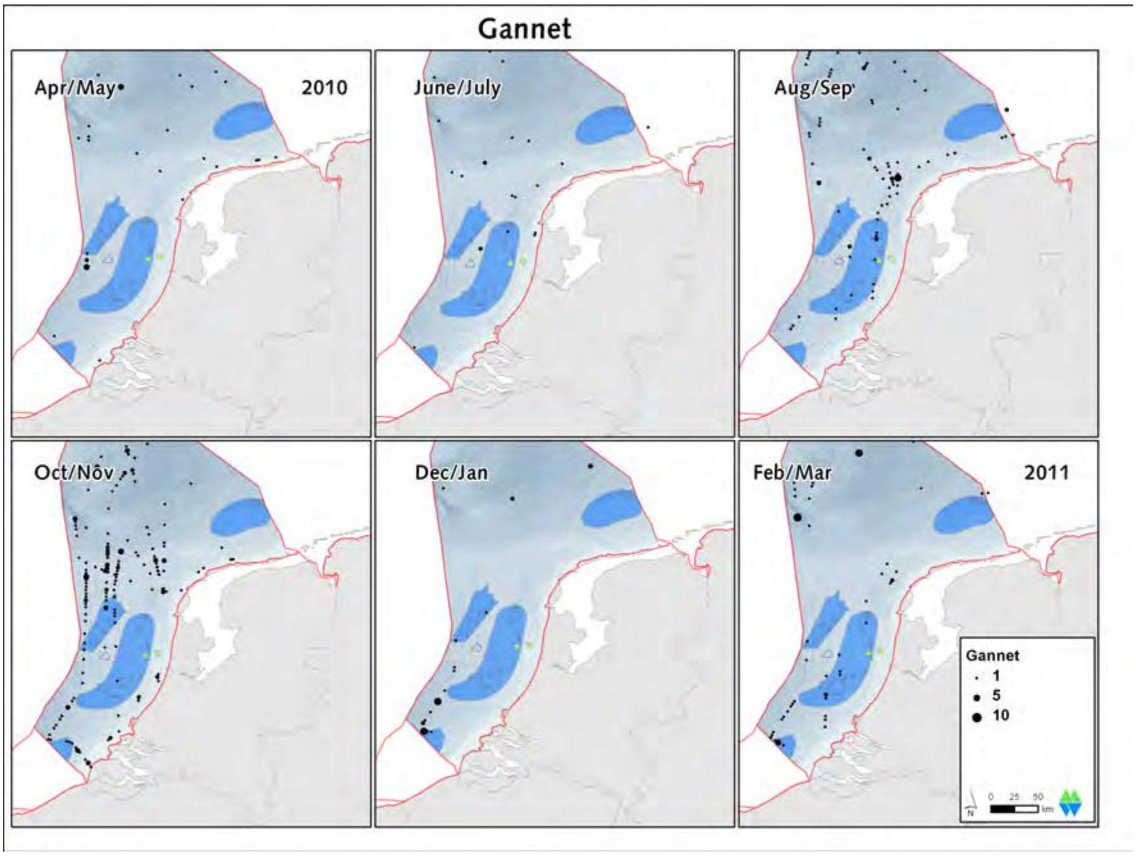


Figure 3.2.3.5 *Distribution of Northern Gannet observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).*

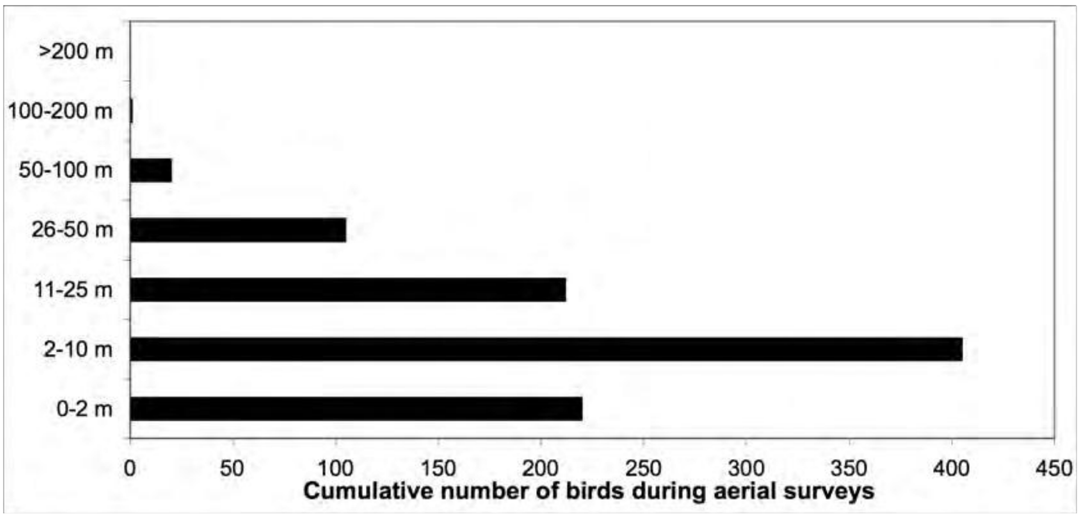


Figure 3.2.3.6 *Cumulative number of Northern Gannets flying at different altitudes during the aerial-based survey monitoring Shortlist Masterplan project (nine surveys in the period May 2010 – April 2011, birds associated with ships excluded).*

3.2.4 Great Cormorant

Observations in this study

Great Cormorants were confined to the coastal areas during the aerial surveys in this study. Only around the wind farms OWEZ and PAWP were Great Cormorants recorded further offshore and once up to 60 km from the coast. On the coast, concentrations of Great Cormorants were recorded on the western tip of Terschelling, at the Razende Bol and in the Voordelta. Here, birds were found resting on sand banks between foraging trips. At sea, concentrations of foraging Great Cormorants were often found in loose groups (Figure 3.2.4.1). The largest numbers of Great Cormorants were recorded in spring and early summer. From August onwards, Great Cormorant numbers were smaller and birds were more concentrated in fewer locations. Smaller numbers of Great Cormorants were encountered off the eastern Wadden Islands and Walcheren. In the Netherlands, the key breeding areas for this species include the IJsselmeer area, Friesland, Noord-Holland and the eastern Wadden Islands.

Associations with other species, fronts or human activities

Great Cormorants were often associated with other species. While resting, groups of Great Cormorants were often sitting together with large gull species on very small sand banks. At sea, associations with gull species were also found. These associations were mainly behind fishing vessels where both Great Cormorants and gulls (and often joined by Northern Gannets) were foraging or scavenging together. Great Cormorants also regularly exploited offshore structures like platforms, helicopter landing platforms, meteorological masts and wind turbines, on which to rest or dry their feathers between foraging trips.

Flight altitude

Great Cormorants usually fly at low altitudes (<25 metres) above the sea (Figure 3.2.4.6). This holds true both for disturbed birds as well as for birds flying over longer distances (e.g. during seasonal or daily migration). During the aerial surveys of the shortlist program the flight altitude was recorded for 32% of all flying Great Cormorants. Among those Great Cormorants only two birds (1%) were flying above 25 metres and no birds above 50 metres above sea level.

Comparison with ship-based data

The ship-based surveys clearly identified a hotspot of Great Cormorants in the northern part of the Voordelta, which was similar to the data collected during the aerial surveys. Due to the absence of survey tracks closer to the shore, other areas with larger numbers of Great Cormorants were not identified. In line with the aerial surveys, Great Cormorants were scarcely recorded far offshore. Great Cormorants take flight rather than dive in response to an approaching ship and are therefore not easily missed from the ship. It is likely that during aerial surveys diving Great Cormorants would not respond to the aeroplane and birds remaining on the water surface may be overlooked during these surveys (being dark-plumaged), particularly under difficult observation conditions. Great Cormorants are unmistakable in the field, although during aerial surveys confusion with the similar Shag might have occurred. This species is closely related to the Great Cormorant and is a rare winter visitor of the Dutch coast.

Comparison with MWTL data

During the MWTL surveys Great Cormorants were also confined to the coastal transects with hotspots similar to the findings in the aerial surveys of the Shortlist Masterplan. The largest numbers of Great Cormorants were also found in spring and early summer in the Voordelta, the area off Egmond aan Zee (near the existing offshore wind farms), the Razende Bol (near Texel) and to a smaller extent on the western tip of Terschelling.

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea

The distribution patterns of Great Cormorants found during the aerial surveys are in line with published findings on Great Cormorants in the Dutch North Sea. The Great Cormorant is a relatively recent inhabitant of the Dutch marine ecosystem. With increasing numbers of breeding Great Cormorants in the Netherlands since the 1970s (Bregnballe 1996; Bijlsma *et al.* 2001) new colonies formed in coastal regions of the Netherlands. Maximum numbers of breeding Great Cormorants were reached in the 1990s at which time the first coastal colonies occurred. This resulted after the year 2000 in a substantial increase of coastal breeding pairs and subsequently an increase of Great Cormorants foraging at sea (Leopold & van Damme 1999). During the aerial surveys foraging and resting Great Cormorants were often observed quite far offshore on platforms and wind turbines. With exploring the marine habitat Great Cormorants also learned to fish behind trawlers (Camphuysen 1999), which was also often observed during the aerial surveys.

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms

Great Cormorants were mainly absent from the defined search areas for new offshore wind farms in all research set-ups, however, offshore wind farms (as happened in OWEZ and PAWP) provide resting habitat for Great Cormorants in the marine environment. Offshore range expansion of non-breeding birds is likely to occur with newly built wind farms.

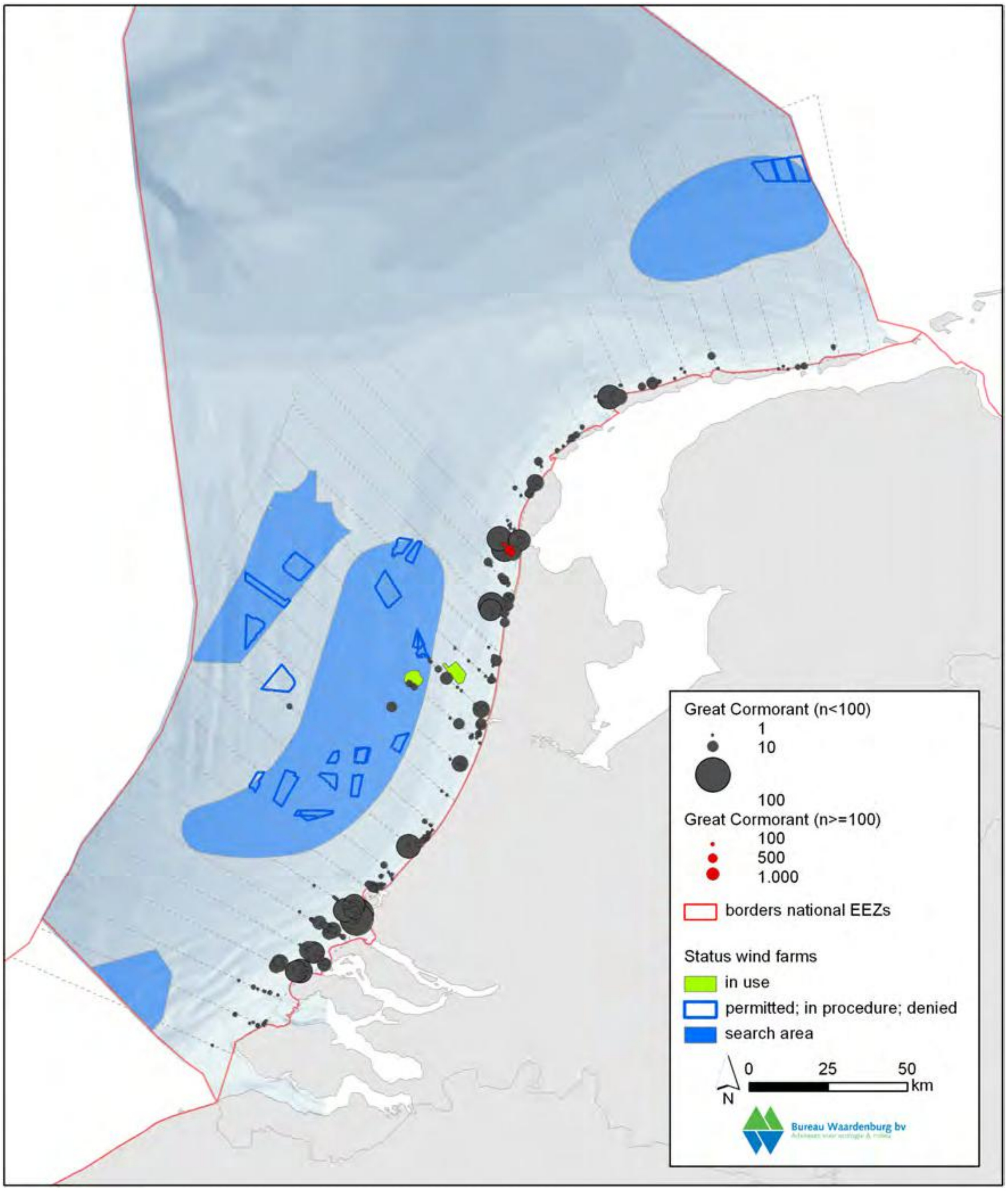


Figure 3.2.4.1 Cumulative distribution of Great Cormorant observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).

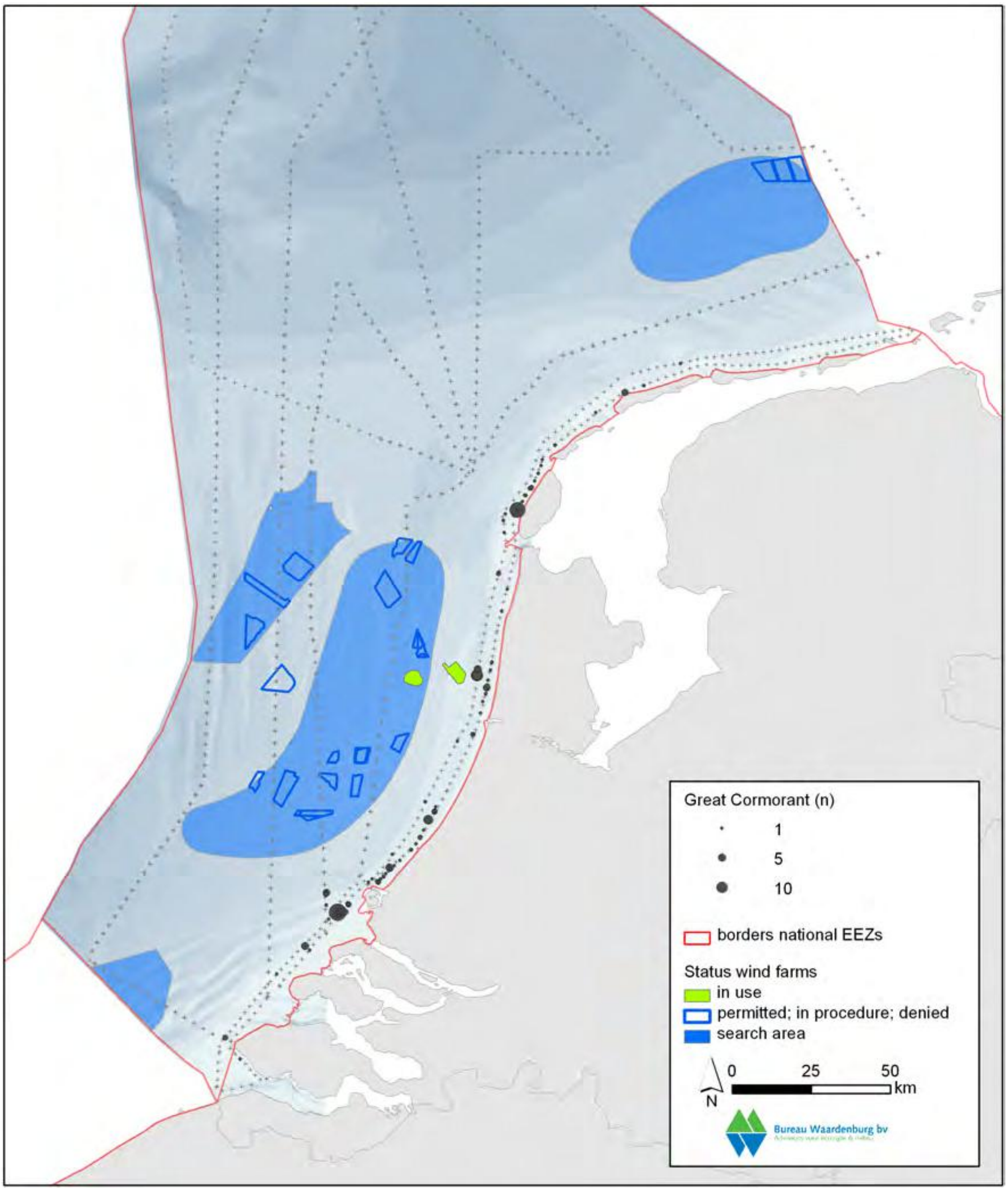


Figure 3.2.4.2 *Cumulative distribution of Great Cormorant observed during the aerial-based survey of the MWTL monitoring (six surveys in the period April 2010 – March 2011).*

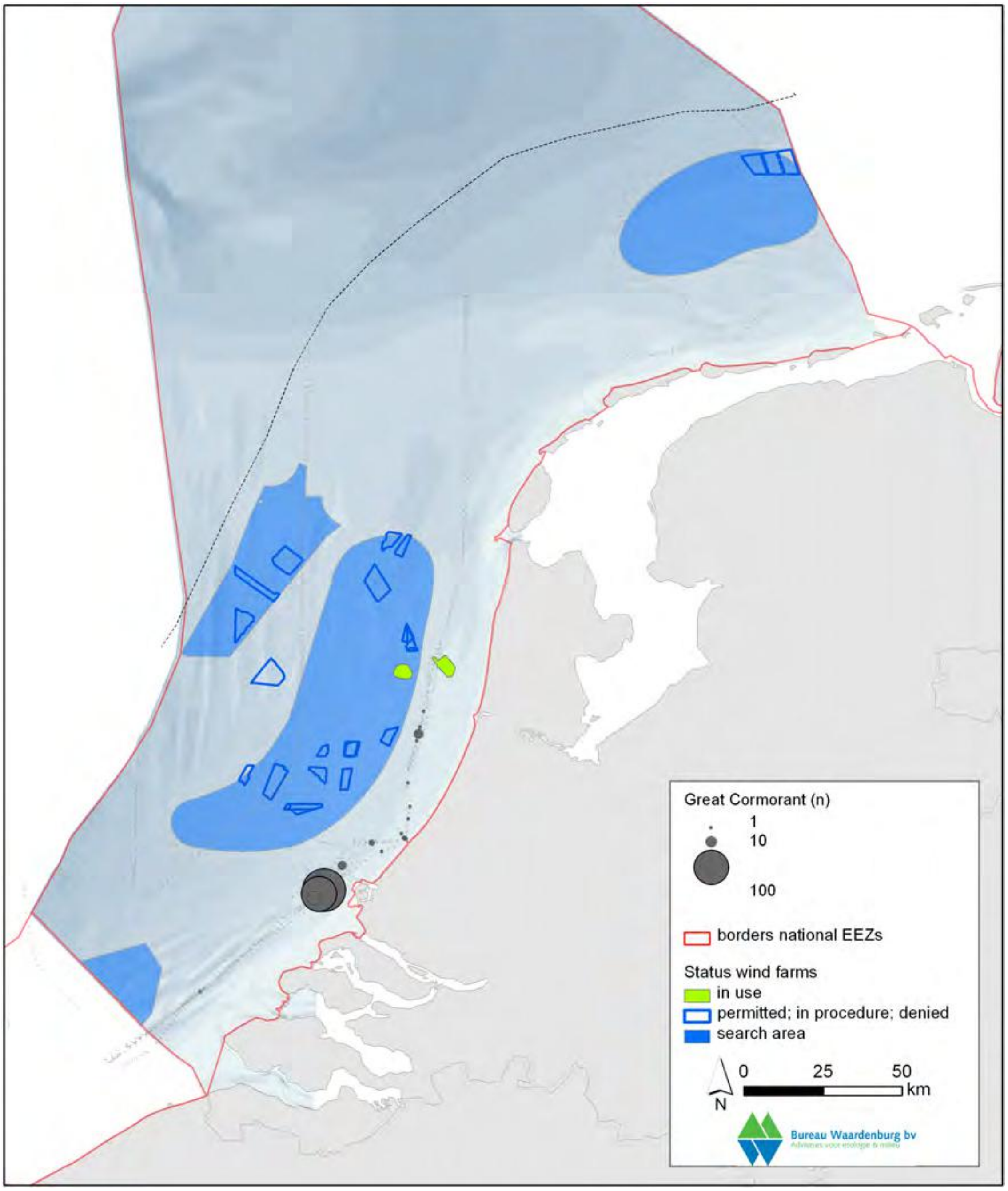


Figure 3.2.4.3 *Cumulative distribution of Great Cormorant observed during the ship-based survey monitoring Shortlist Masterplan project (surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).*

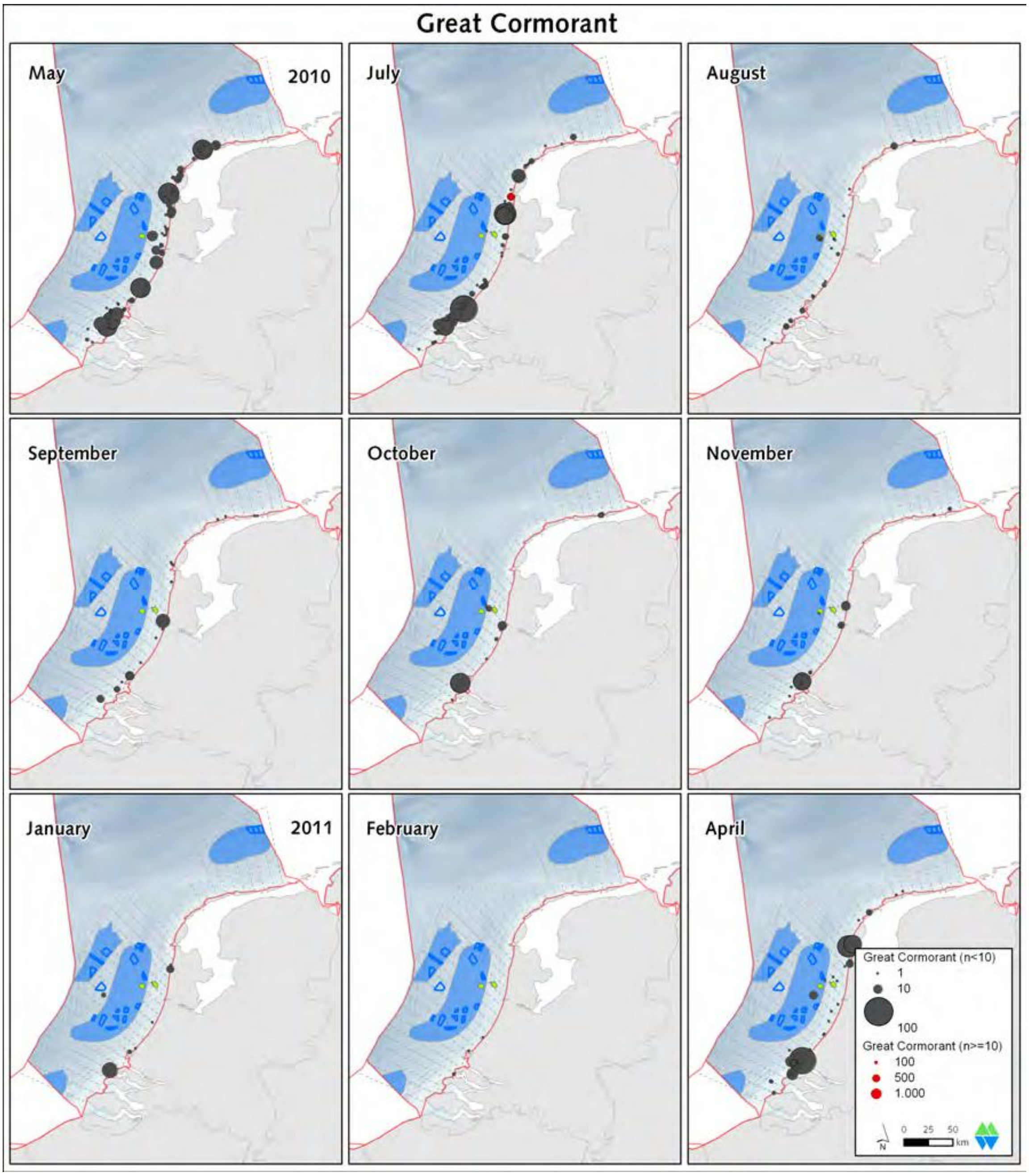


Figure 3.2.4.4 *Distribution of Great Cormorant observed during the aerial-based survey monitoring Shortlist Masterplan project per month (nine surveys in the period May 2010 – April 2011).*

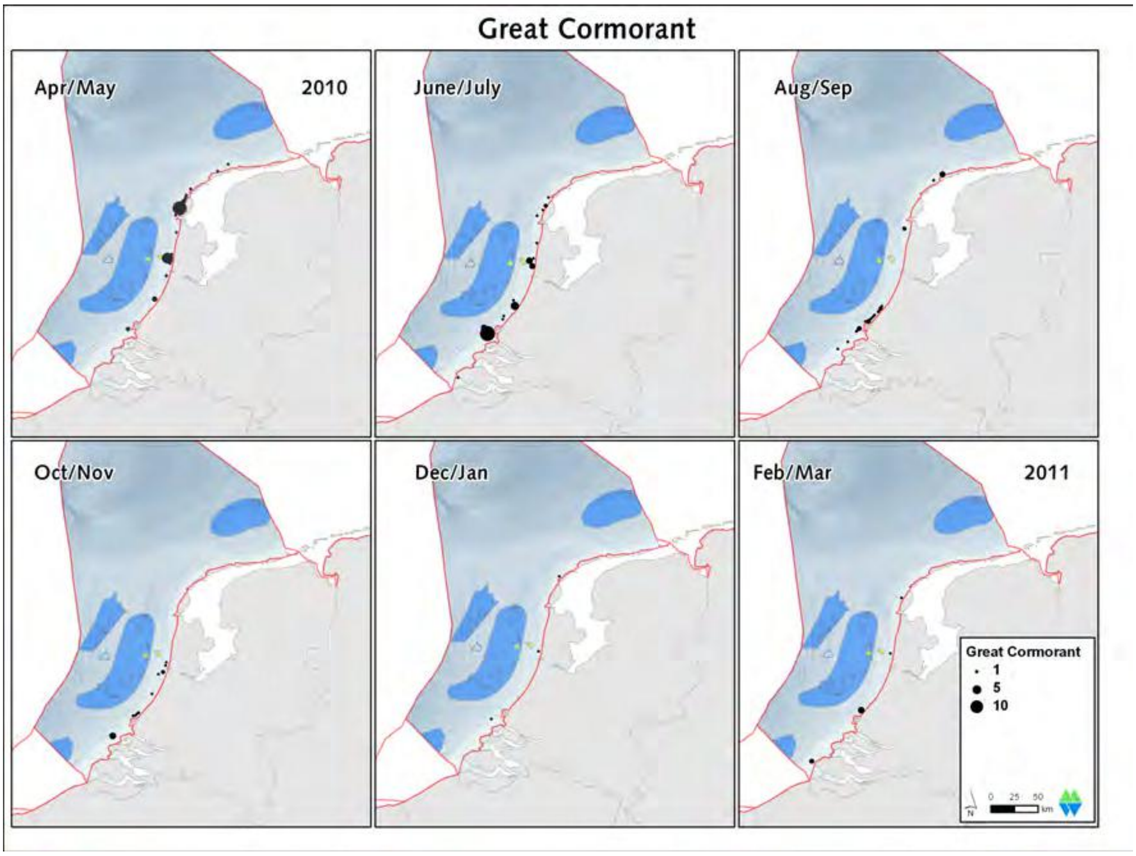


Figure 3.2.4.5 *Distribution of Great Cormorant observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).*

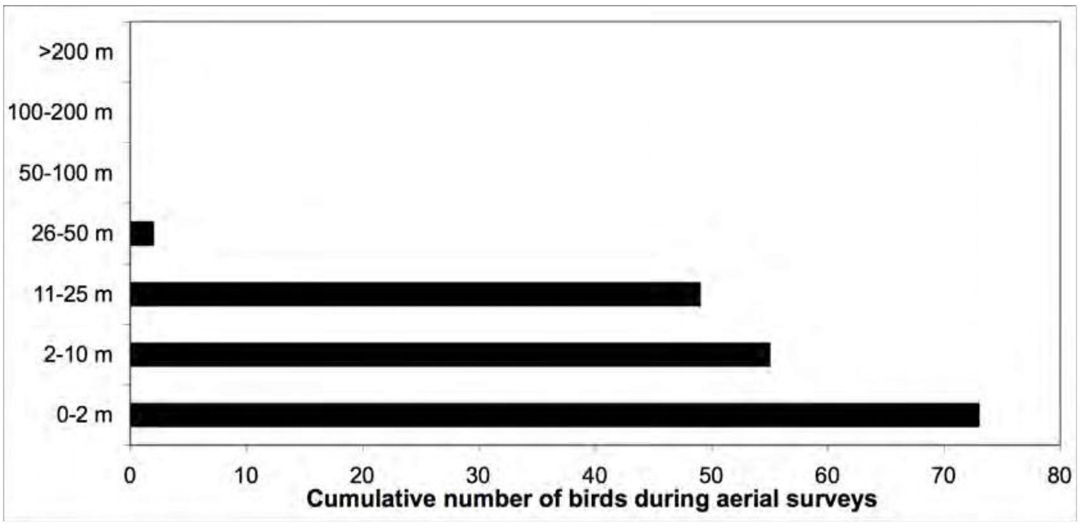


Figure 3.2.4.6 *Cumulative number of Great Cormorants flying at different altitudes during the aerial-based survey monitoring Shortlist Masterplan project (nine surveys in the period May 2010 – April 2011, birds associated with ships excluded).*

3.2.5 Northern Fulmar

Observations in this study

Northern Fulmars were found throughout the offshore regions of the study area. They were mainly recorded beyond 50 km off the coast in relatively deeper water (around the 30 metre depth line, see figure 2.3.6). Off the coast of the western Wadden Islands (Texel, Vlieland, Terschelling) the distribution of Northern Fulmars seemed to be closer to the shore, related to the deeper depths occurring closer to the coast. The largest numbers of Northern Fulmar were recorded late summer and in autumn, particularly in August. The smallest numbers were recorded in spring, although Northern Fulmars were encountered during every survey. In winter, Northern Fulmars seemed to prefer the more southern parts of the study area, whereas during spring and autumn, the species was encountered throughout the study area.

During the survey there were no indications that the aeroplane disturbed flying Northern Fulmars. In general, birds only showed aberrant behaviour when the flight path of the survey aircraft crossed theirs. Detection issues are possible; Northern Fulmars can be easily overlooked when sitting on the water surface in between large groups of gulls.

Associations with other species, fronts or human activities

Northern Fulmars were recorded as being associated with frontal zones at sea, searching these lines for food. The species also attended fishing vessels. The highest concentration of Northern Fulmars, up to 270 individuals, was recorded behind a fishing vessel in November.

Flight altitude

All birds observed flew mainly at low (0-2 and 2-5 metres) altitude levels, close above sea level (Figure 3.2.5.6). During the aerial surveys of the shortlist program the flight altitude was recorded for 73% of all flying Northern Fulmars. Among those Northern Fulmars only one bird was flying above 25 metres above sea level. The majority of flying birds were recorded at 0-2 metres above sea level. This corresponds with the results of the ship-based surveys of the shortlist program show (median flight altitude below two metres).

Comparison with ship-based data

The distribution of Northern Fulmar during the ship-based surveys is in general in line with the findings of the aerial surveys. The southwestern part of the study area yielded also the largest numbers of birds. It is expected that some detection issues might play a role when comparing the figures found during the ship-based surveys and the aerial surveys. From the aeroplane, Northern Fulmars on the water surface may be overlooked when within groups of gulls. In general, the identification of these birds could be better during the ship-based surveys as the speed of the ship allows more time for individual identification of birds in groups. The most obvious dissimilarity between the two observation platforms is that ships attract Northern Fulmars thereby potentially influencing the observed distribution and densities.

Comparison with MWTL data

The main distribution of Northern Fulmar during the MWTL surveys is in the deeper water of the northern parts of the Dutch sector of the North Sea. This area was not included in the study area of the Masterplan survey tracks. In the area that is surveyed in both methods, the highest concentration of Northern Fulmars during the MWTL surveys was also found in the southwestern part of the study area likewise to the Masterplan surveys. Similarly, this study area held the largest numbers in autumn during both surveys. However, during the MWTL surveys even larger numbers were seen in summer and winter, yet not in the study area but in the northern parts of the Dutch sector.

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea

It is known from the literature that in the Dutch North Sea area, Northern Fulmars occur in their largest numbers between August and October and February and March (Camphuysen & Leopold 1994) and more frequently relatively far offshore (Arts 2010). This was also found during the Masterplan surveys although the supposed spring peak was not so clear as the autumn peak. The pattern of distribution is in general patchy and variable. In line with our findings for Northern Gannets, Northern Fulmars also seem to be less abundant northwest of Texel in the area with large numbers of human offshore activities such as platforms.

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms

In all search areas for new wind farm initiatives Northern Fulmars were recorded during all of the different survey types. In areas closer to the coast, however, substantially smaller numbers of Northern Fulmars were encountered.

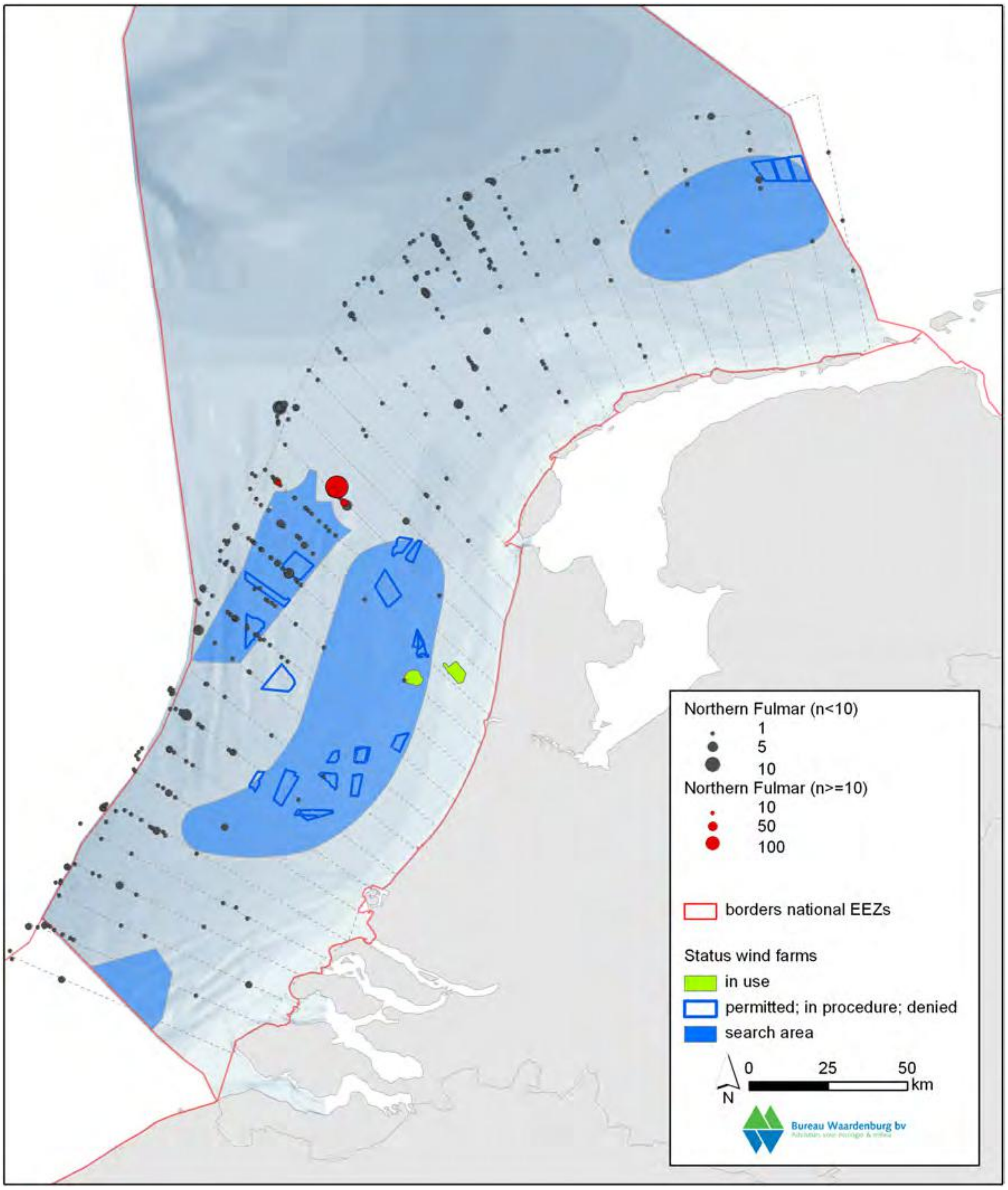


Figure 3.2.5.1 Cumulative distribution of Northern Fulmar observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).

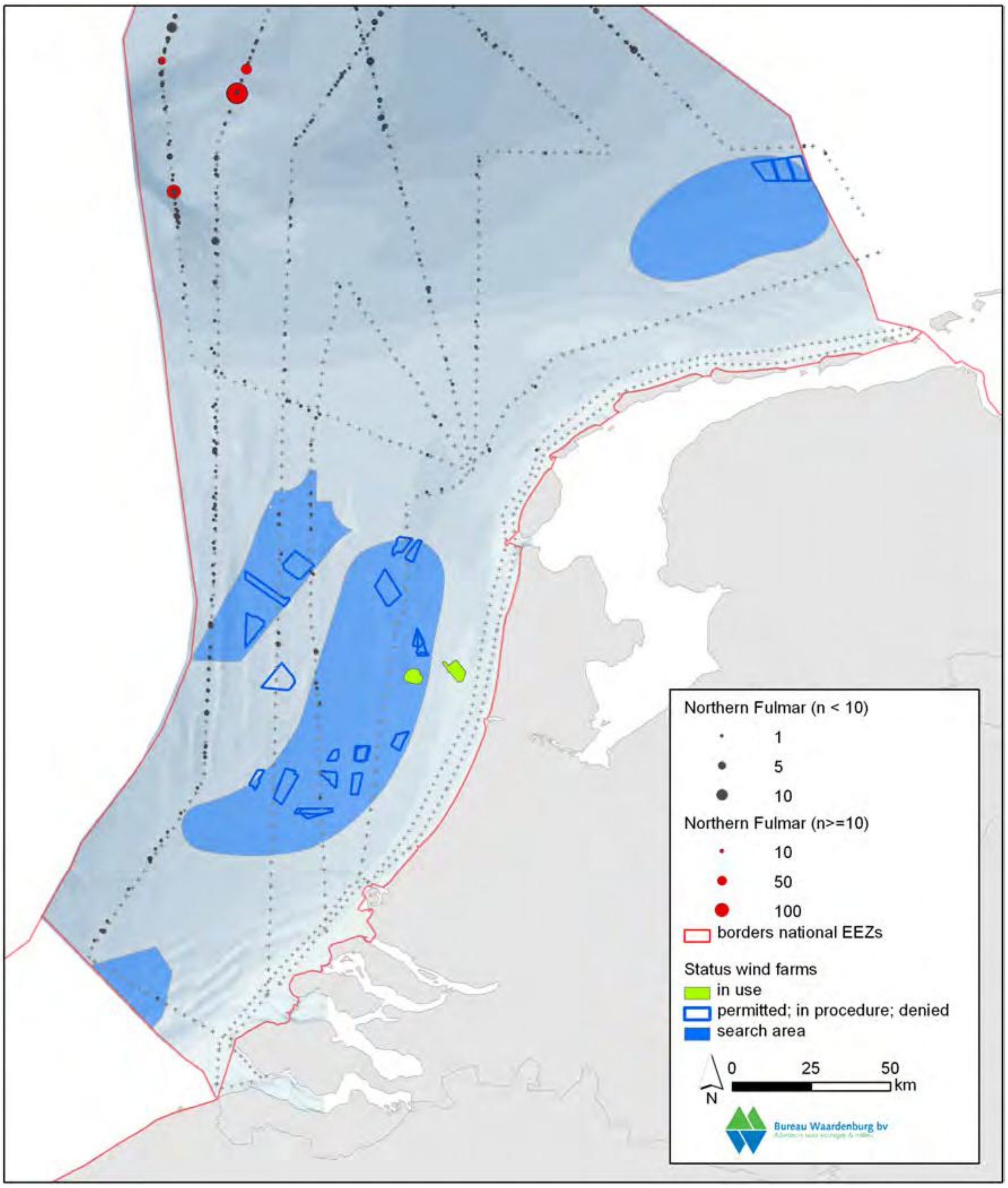


Figure 3.2.5.2 *Cumulative distribution of Northern Fulmar observed during the aerial-based survey of the MWTL monitoring (six surveys in the period April 2010 – March 2011).*

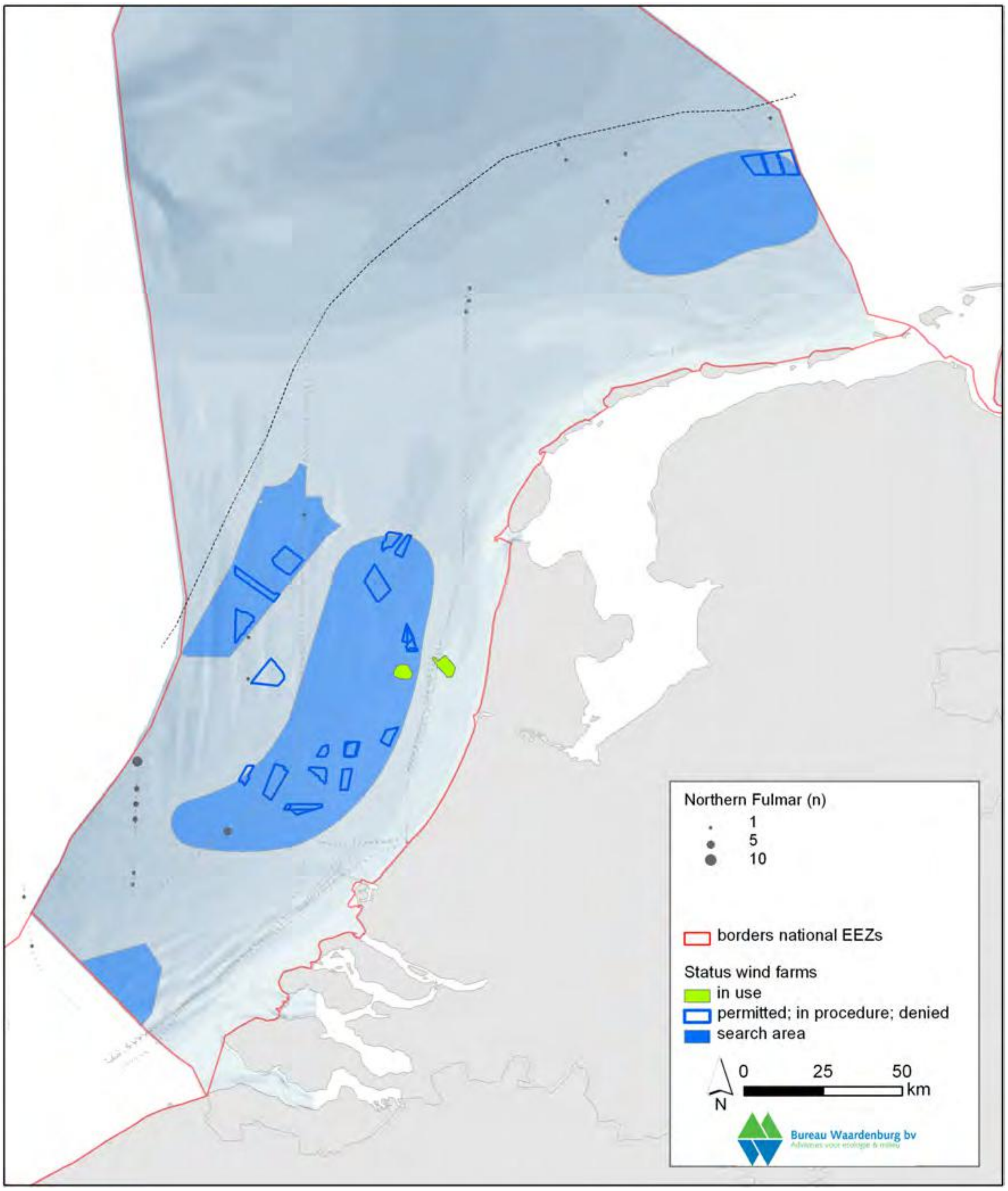


Figure 3.2.5.3 *Cumulative distribution of Northern Fulmar observed during the ship-based survey monitoring Shortlist Masterplan project (surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).*

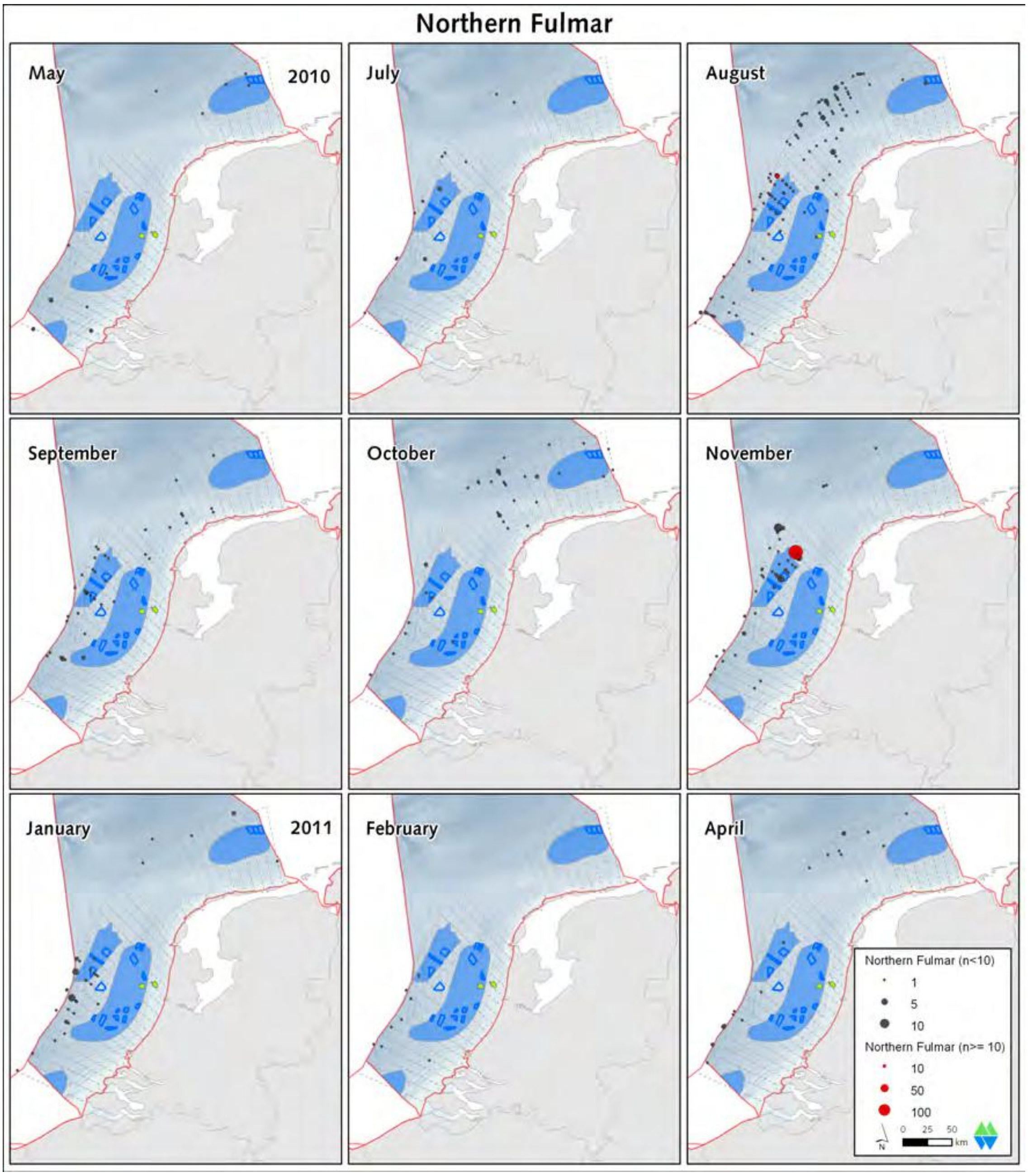


Figure 3.2.5.4 *Distribution of Northern Fulmar observed during the aerial-based survey monitoring Shortlist Masterplan project per month (nine surveys in the period May 2010 – April 2011).*

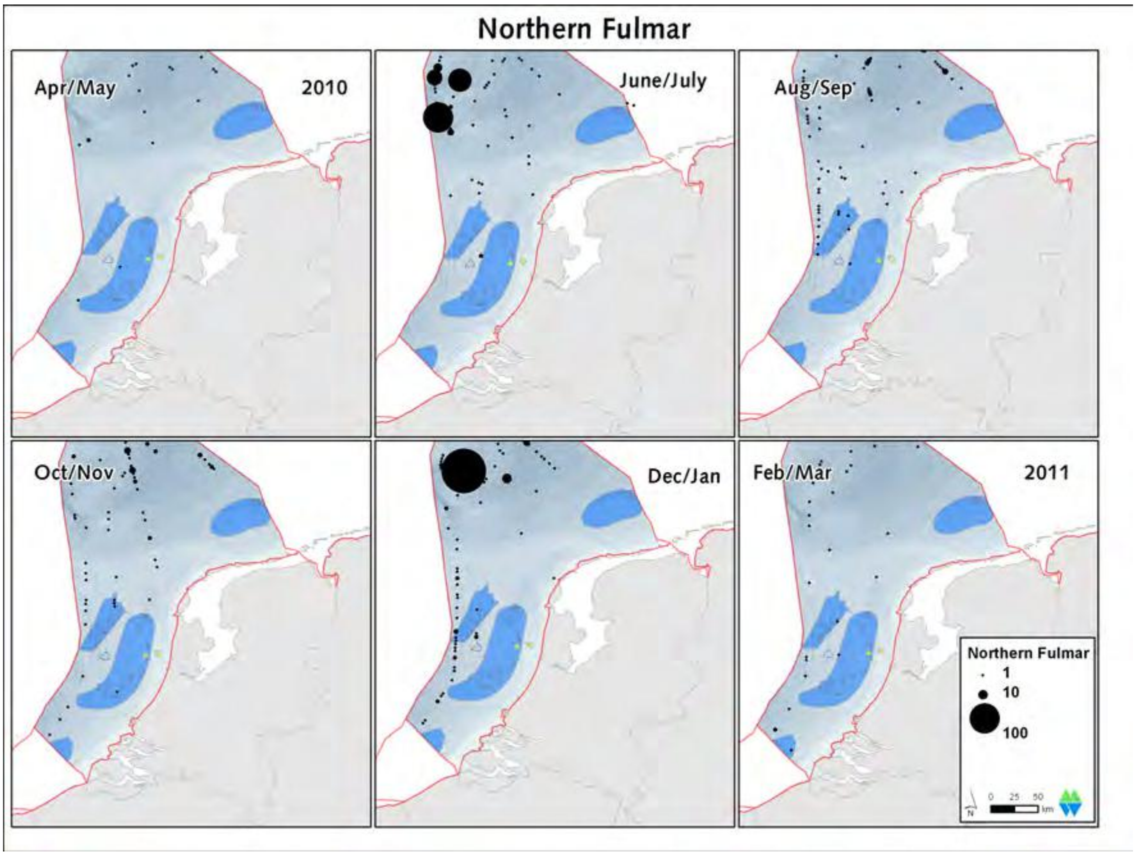


Figure 3.2.5.5 *Distribution of Northern Fulmar observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).*

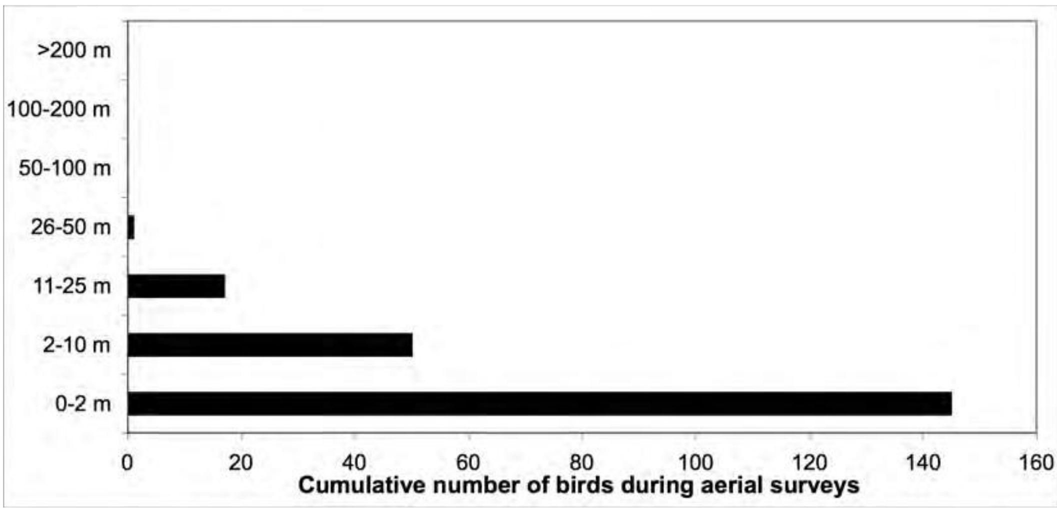


Figure 3.2.5.6 *Cumulative number of Northern Fulmar flying at different altitudes during the aerial-based survey monitoring Shortlist Masterplan project (nine surveys in the period May 2010 – April 2011, birds associated with ships excluded).*

3.2.6 Great Skua

Observations in this study

The occurrence of Great Skua in the Dutch part of the North Sea is unpredictable and highly dependent on the season and weather conditions. During the Shortlist Masterplan aerial surveys most birds were observed far offshore and only during autumn. Some exceptions did occur with a couple of observations closer to the coast especially in the northern part of the study area. The first Great Skuas arrived in August with increasing numbers in September and some smaller numbers in October and November. The highest concentrations of Great Skuas were observed around fishing vessels either scavenging at trawls or actively harassing foraging gulls. Great Skuas are large conspicuous birds and in flight unmistakable. Due to the dark colour sitting birds may be missed under difficult lighting conditions.

Associations with other species, fronts or human activities

The species was regularly associated with fishing vessels and/or congregations of gulls. Behind trawlers Great Skuas were either scavenging or actively harassing foraging gulls.

Flight altitude

Most birds seen were flying low above sea level except behind fishing vessels when foraging/chasing gulls. During the aerial surveys of the shortlist program only few flying Great Skua were recorded (total 36). The respective flight altitude was only recorded for 16 birds (44%) (57% if birds associated with ships are excluded). Among these birds 25% was flying below 25 metres above sea level (36% if birds associated with ships are excluded). This corresponds with the results of the ship-based surveys of the shortlist program.

Comparison with ship-based data

During the ship-based surveys Great Skuas were observed in August, November and the February survey. The low number of birds of this relatively scarce species is mainly a reflection of the limited effort of the ship-based surveys.

Comparison with MWTL data

In the MWTL database this species is disproportionately underrepresented. As with Northern Gannet this species is sensitive to approaching aeroplanes and birds easily respond by flying out of the observation strip (own observations). Alternatively, as the species is dark plumaged, the species might be missed from the aeroplane of MWTL due to the higher altitude, especially when birds are sitting on the water. Also, because of the strip transect methodology of the MWTL program most birds behind fishing vessels are not counted because a large proportion of the birds in those concentrations are outside the observation strip.

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea

The world population of Great Skuas was estimated at 16,000 in 1999-2000, making it one of the rarest seabirds in the Northern hemisphere. The majority of this species breeds in Scotland and Iceland (Mitchell *et al.* 2004). The numbers breeding in Scotland have increased over the past forty years and reached almost 10,000 pairs in 1999-2000. Smaller numbers breed in Norway and it is likely that most of the birds present in the North Sea originate from Scottish breeding populations.

The largest numbers of Great Skuas in the Dutch North Sea occur in autumn (Camphuysen & Leopold 1994). The species is found both offshore and along the coast and is strongly attracted to trawlers (Bijlsma *et al.* 2004). During migration birds are less frequently seen within 2-5 km of the coast except during prolonged periods of onshore winds when on some days hundreds of birds can be seen migrating along the coast. Birds in the southern North Sea are most likely from colonies in the east of Scotland (Wernham *et al.* 2002) but birds colour-ringed in Iceland have also been photographed on the Dutch coast.

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms

The largest numbers of Great Skuas have been observed in and around the Brown Ridge search area. As this species is rare at a global scale, research into the potential impacts of new offshore wind farms in this area should focus on this species.

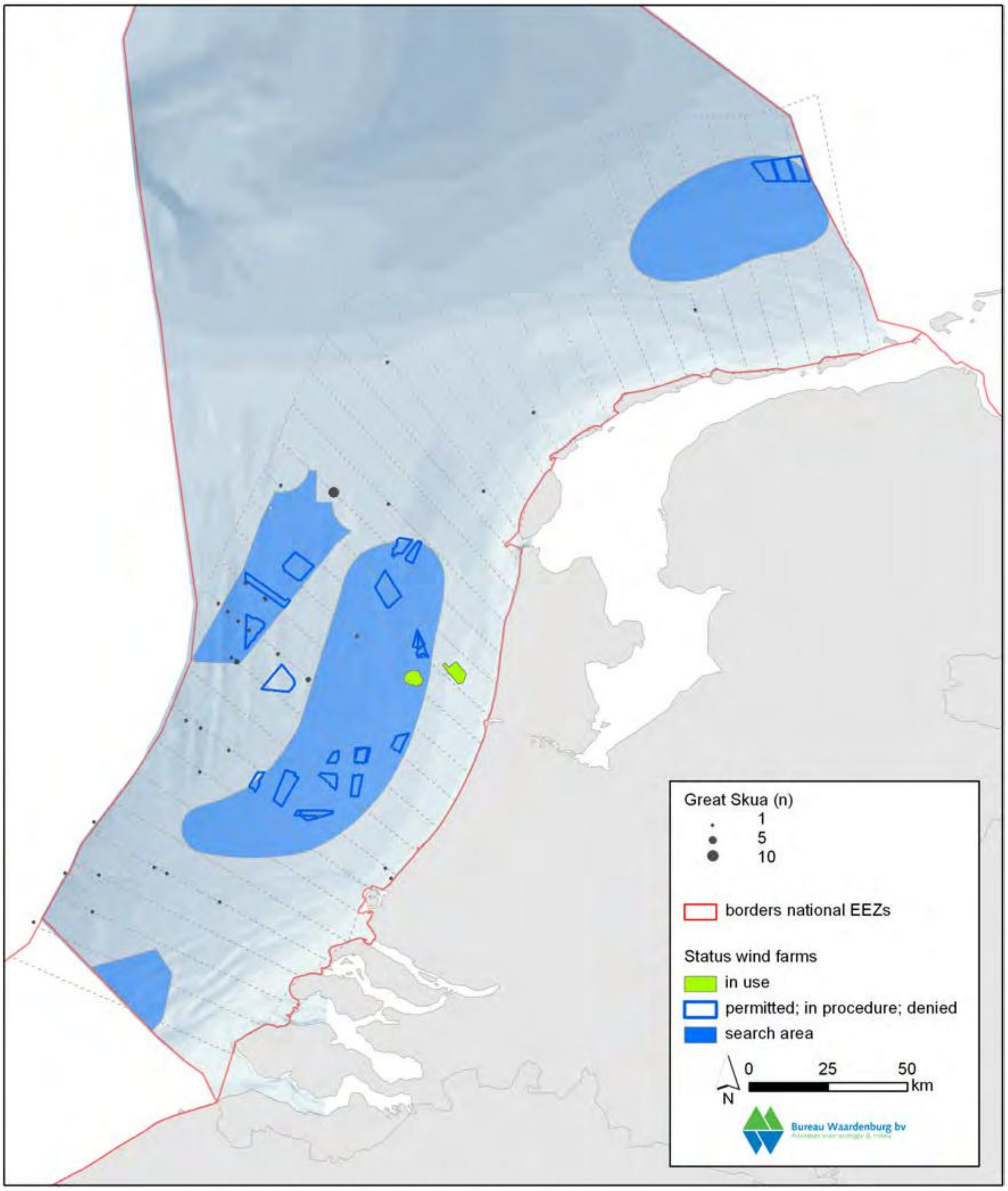


Figure 3.2.6.1 *Cumulative distribution of Great Skua observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).*

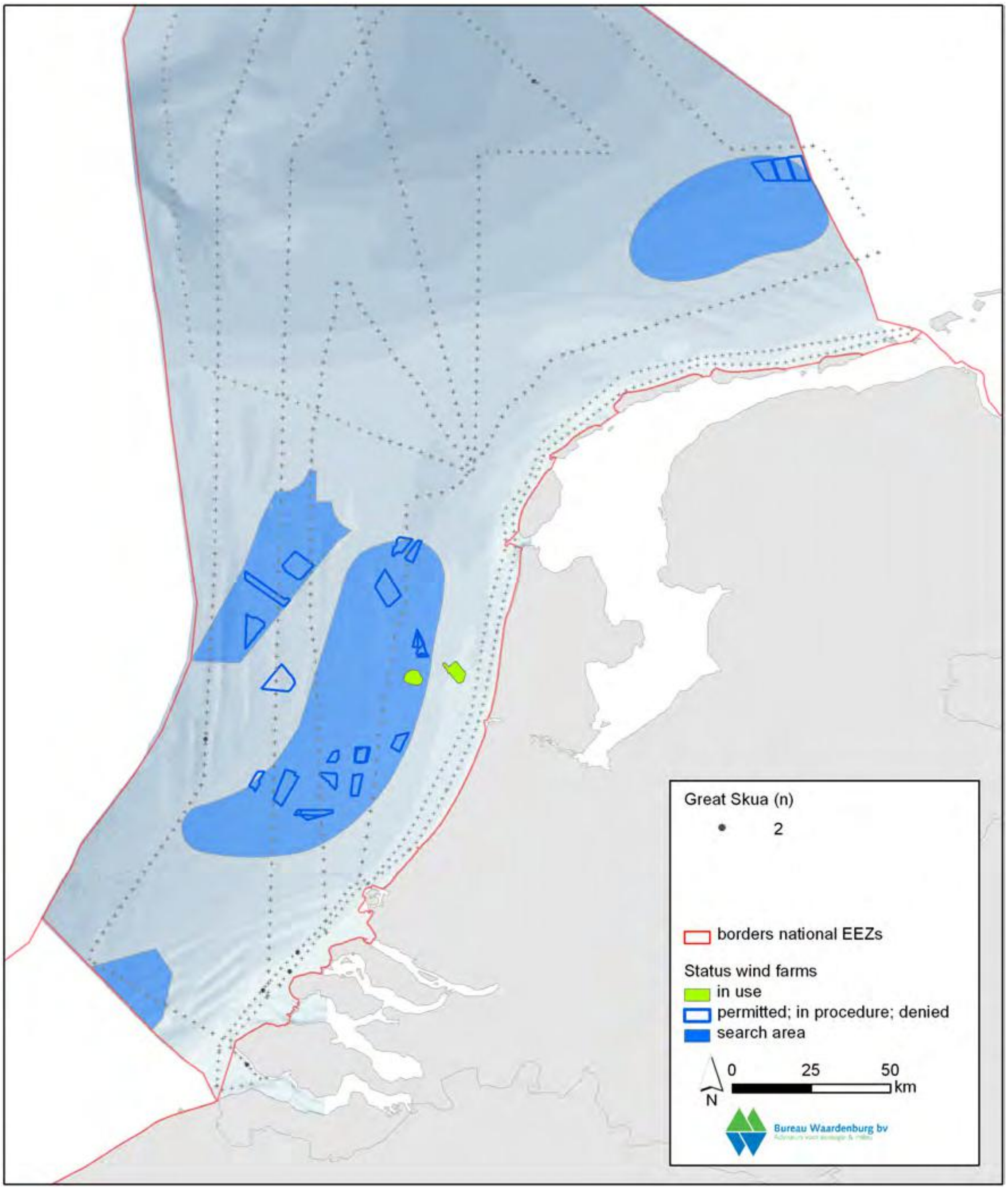


Figure 3.2.6.2 Cumulative distribution of Great Skua observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).

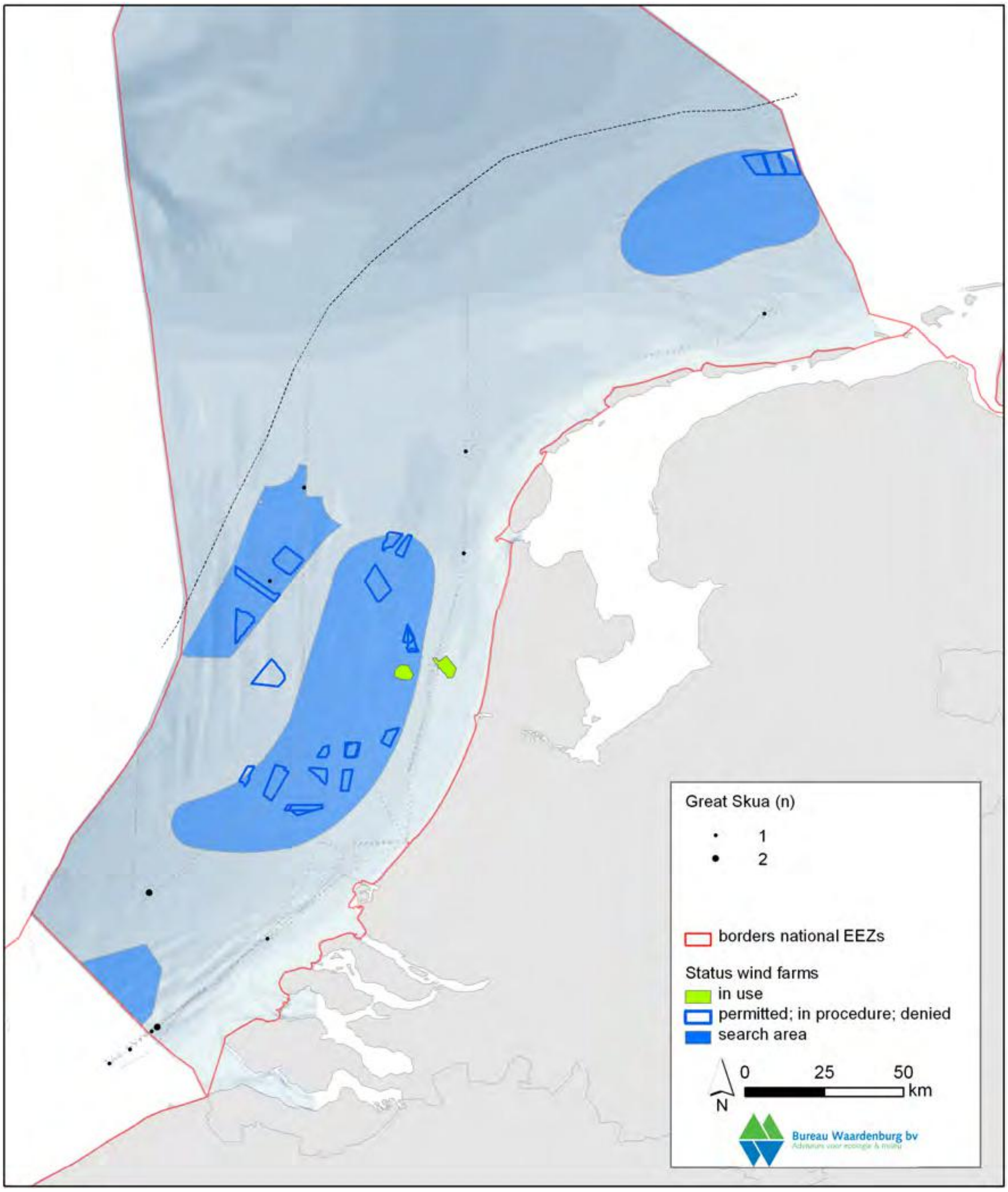


Figure 3.2.6.3 *Cumulative distribution of Great Skua observed during the ship-based survey monitoring Shortlist Masterplan project (surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).*

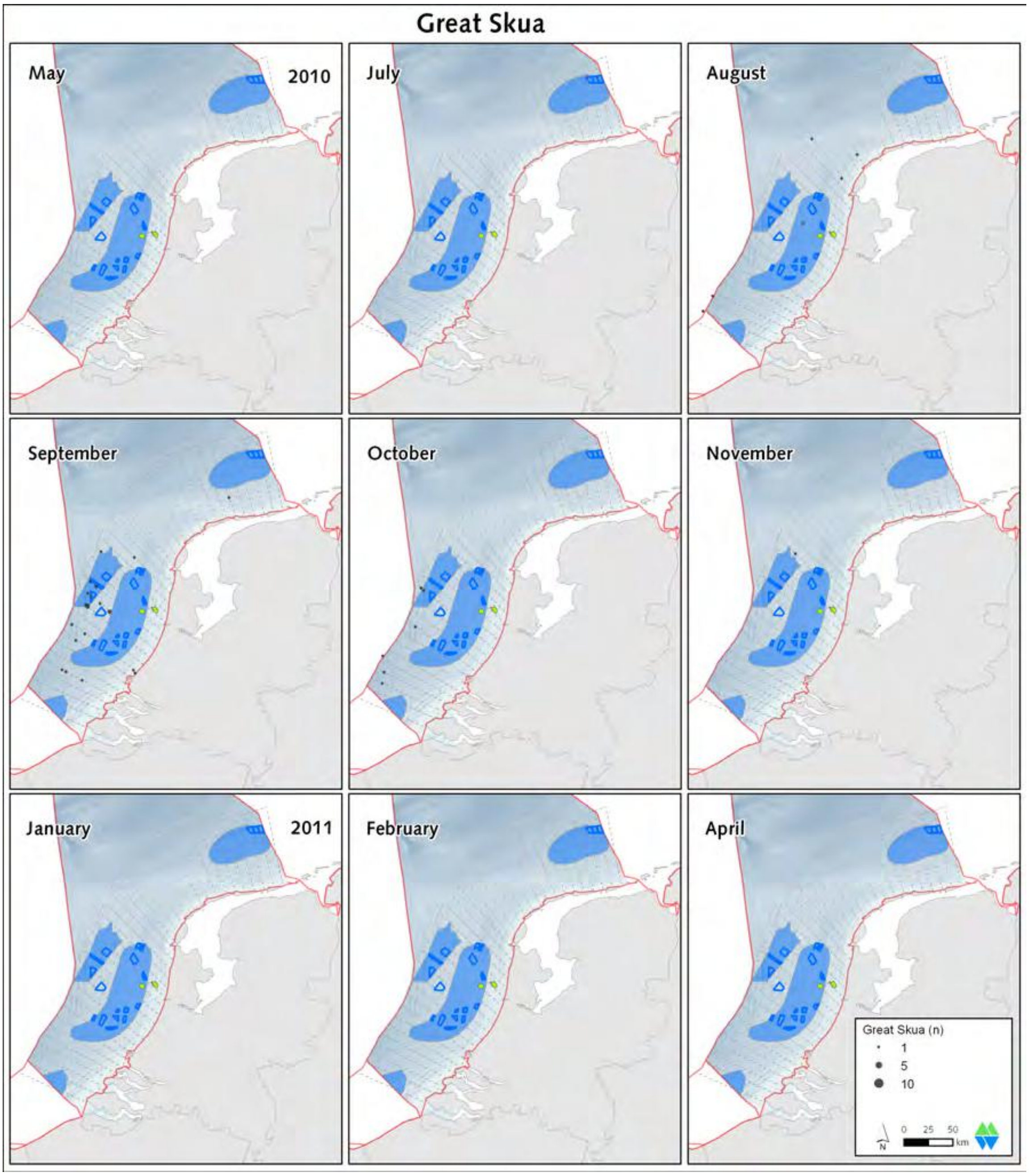


Figure 3.2.6.4 *Distribution of Great Skua observed during the aerial-based survey monitoring Shortlist Masterplan project per month (nine surveys in the period May 2010 – April 2011).*

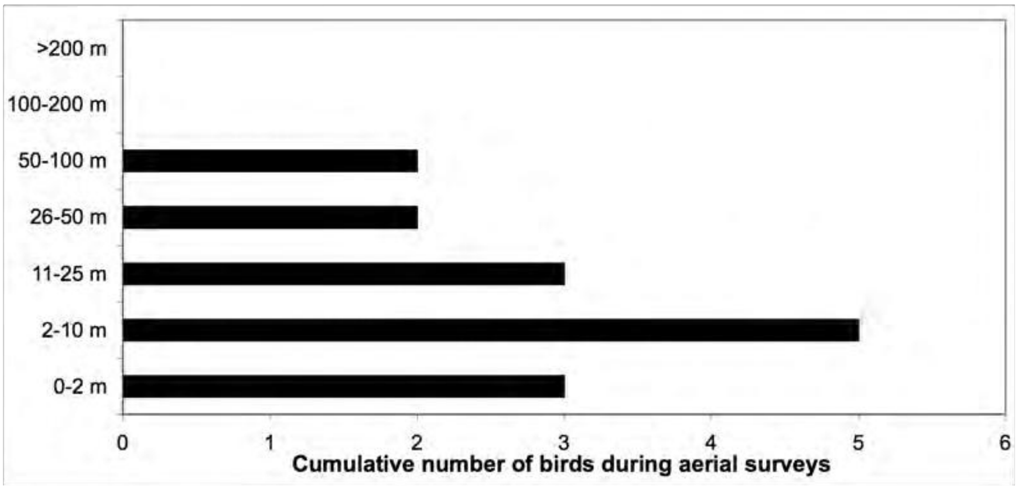


Figure 3.2.6.5 *Cumulative number of Great Skua flying at different altitudes during the aerial-based survey monitoring Shortlist Masterplan project (nine surveys in the period May 2010 – April 2011, birds associated with ships excluded).*

3.2.7 Small skua spp. (Parasitic, Pomarine and Long-tailed)

Observations in this study

In the Dutch part of the North Sea, the occurrence of skua species other than Great Skua is unpredictable and highly dependant on the season and weather conditions. Most birds were observed further offshore and only in autumn with some exceptions closer to the coast, especially in the northern part of the study area. All of the smaller skuas were observed in July - September. Identification of the smaller skuas to the species level is difficult from the aeroplane as it is usually impossible to see the finer plumage details needed to identify the very similar young birds and different colour and size morphs of these three species.

Associations with other species, fronts or human activities

Associations of smaller skua species with other birds, fronts or human activities were not observed but it is known that these kleptoparasitizing species associate with gull and especially tern aggregations.

Comparison with ship-based data

Pomarine and Parasitic Skuas were observed during the ship-based surveys. Observations of Parasitic Skua were confined to August and September whereas the Pomarine Skua was observed in October and November.

Identification to the species level is much easier from the ship as more time can be taken and birds can be viewed from the side, which is particularly important when estimating size and tail structure.

Comparison with MWTL data

In the MWTL database this species group is disproportionately underrepresented. Unclear is whether this species group is sensitive to approaching aeroplanes and might therefore respond by flying out of the observation strip. More likely, as the different species in this species group are all dark plumaged from above, the birds might be more missed from the aeroplane of MWTL due to the higher altitude. Also, because of the strip transect methodology of the MWTL program birds behind fishing vessels are not counted because the birds in those concentrations are outside the observation strip.

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea

The smaller skua species are all migratory and mainly pass along the Dutch coast in autumn. They breed from Scotland towards the high Arctic and winter in tropical and sub-tropical waters. In general, Long-tailed Skuas are the first to appear from August onwards. Later in the season, both Parasitic and Pomarine Skuas migrate along the Dutch coast and can be present through until November. The skuas mainly occur offshore but are regularly observed closer to the coast, especially during strong westerly winds.

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms

Although the smaller skuas will undoubtedly migrate in a broad front through all of the search areas for new wind farm initiatives, numbers are probably relatively small and will only occur in spring and autumn.

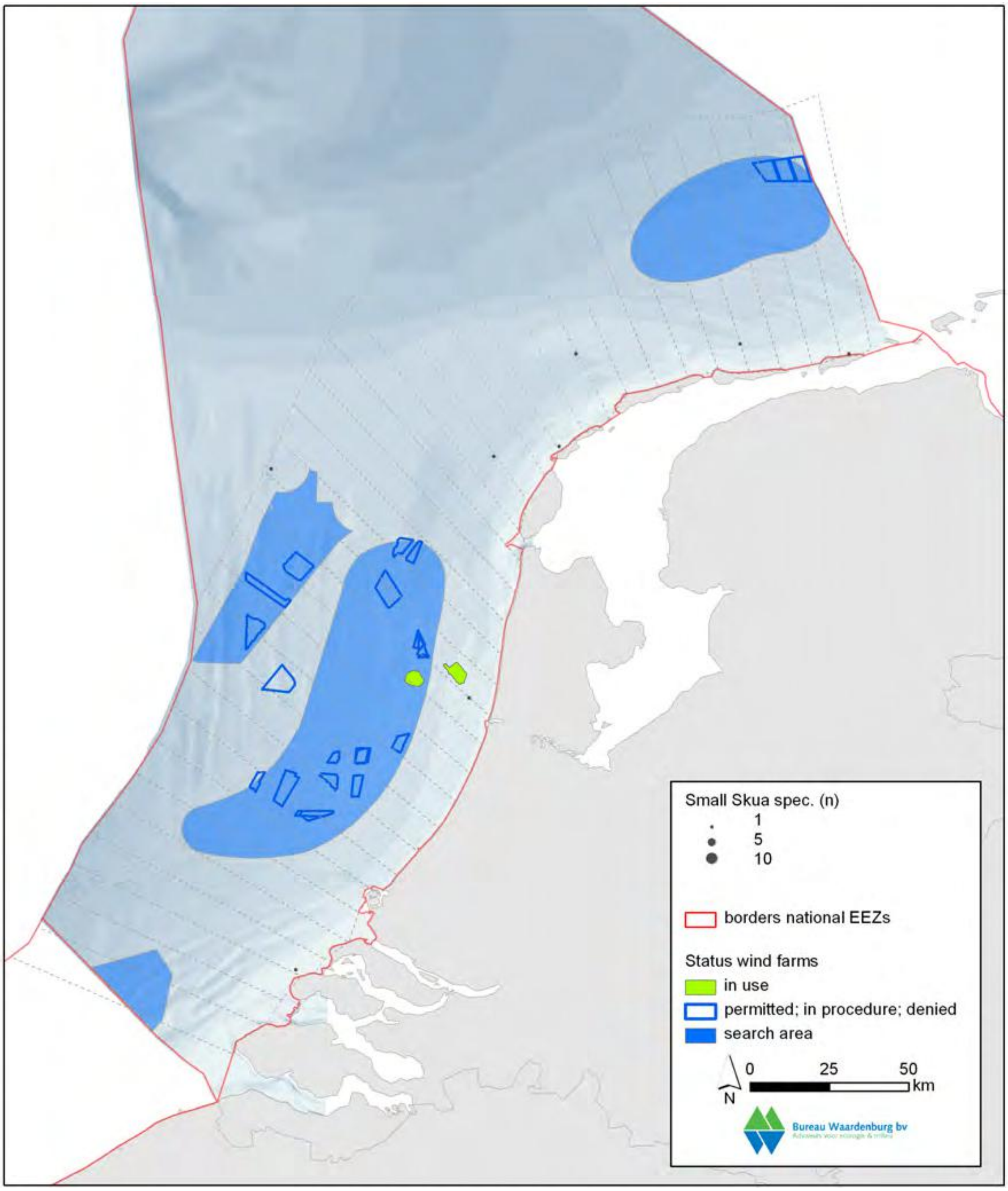


Figure 3.2.7.1 *Cumulative distribution of the species group small skua spp. (consisting mainly of Parasitic and Pomarine Skuas) observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).*

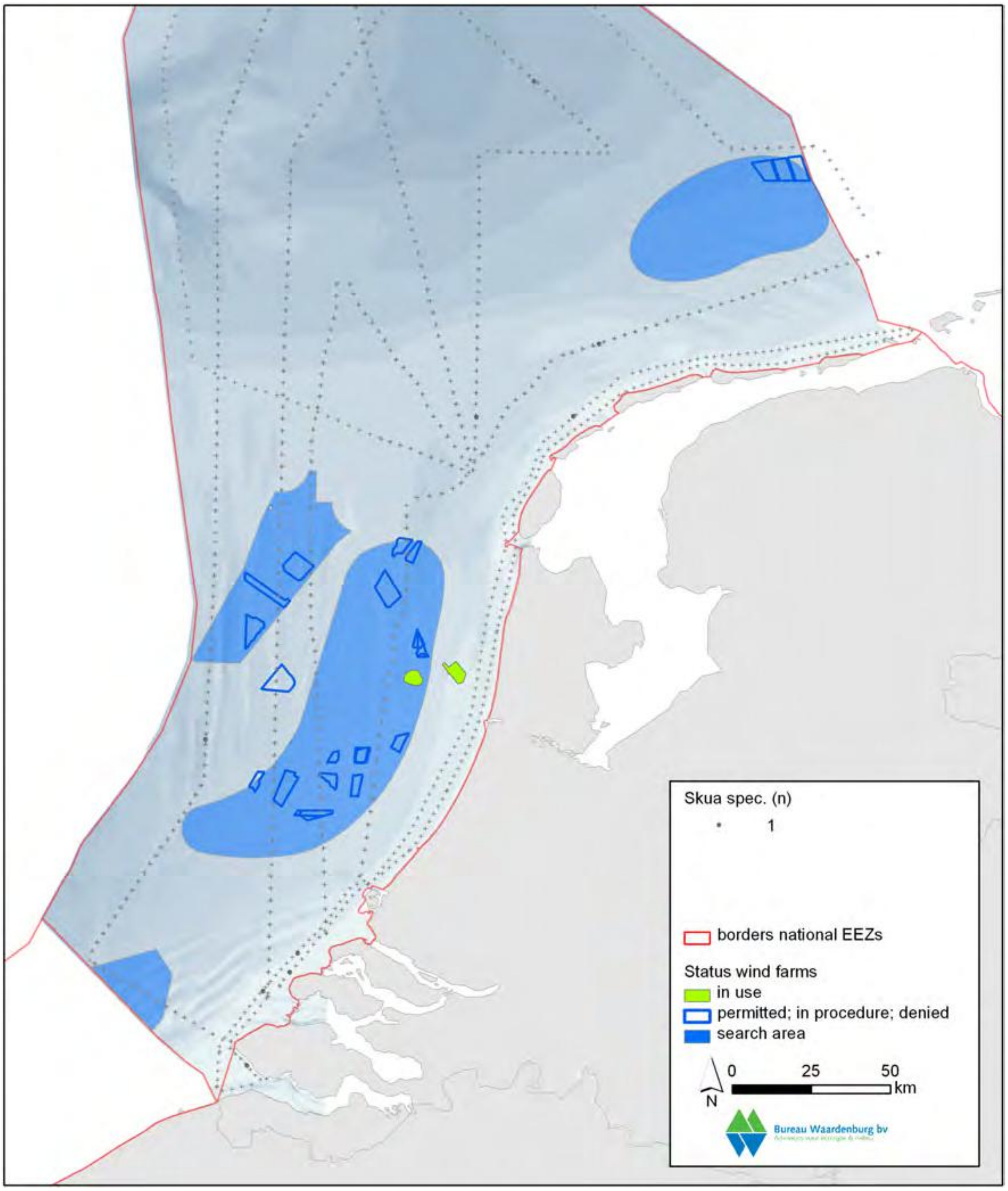


Figure 3.2.7.2 *Cumulative distribution of the species group small skua spp. (consisting mainly of Parasitic and Pomarine Skuas) observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).*

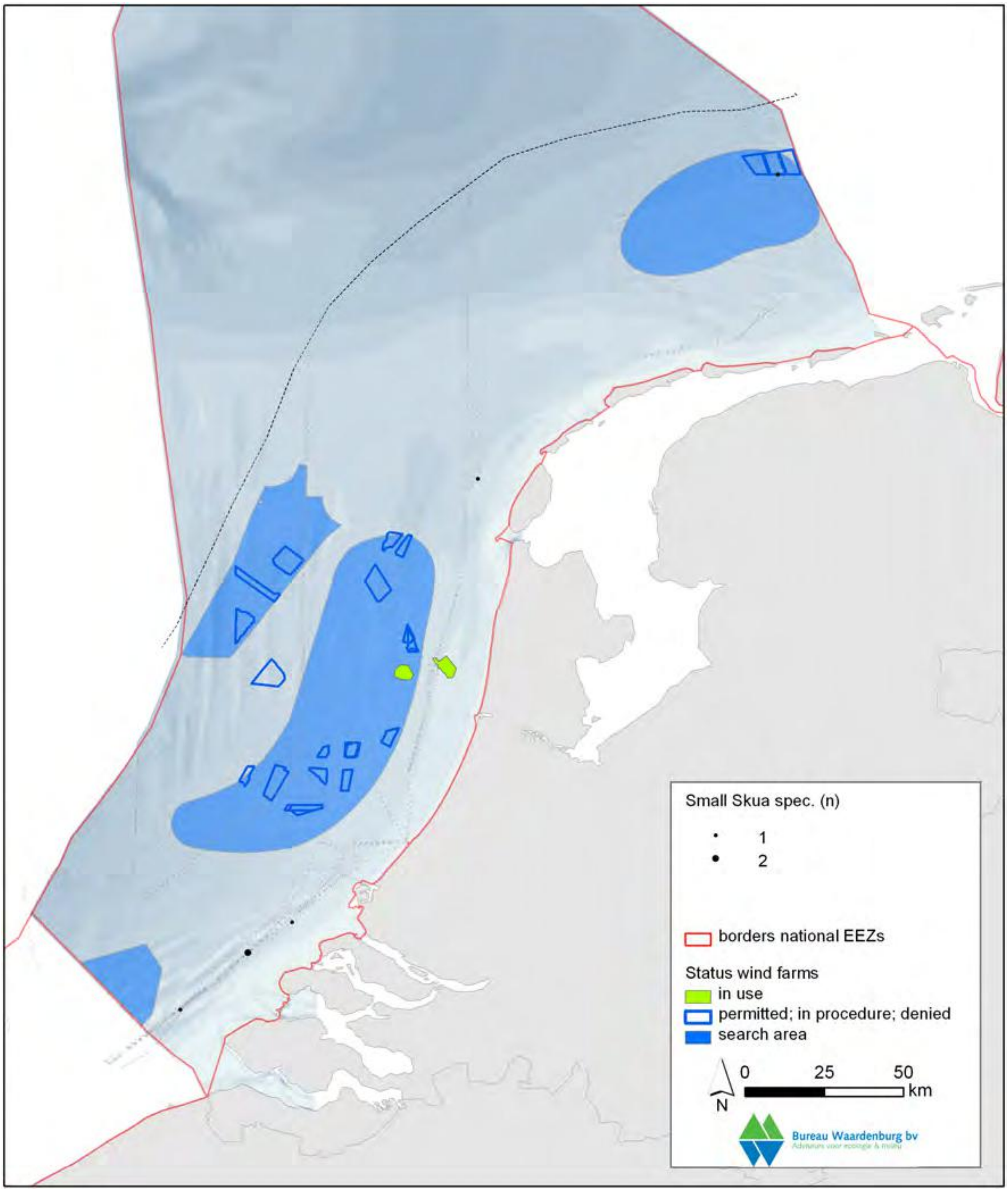


Figure 3.2.7.3 Cumulative distribution of the species group Skua spp. (consisting of Parasitic and Pomarine Skuas) observed during the ship-based survey monitoring Shortlist Masterplan project (surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).

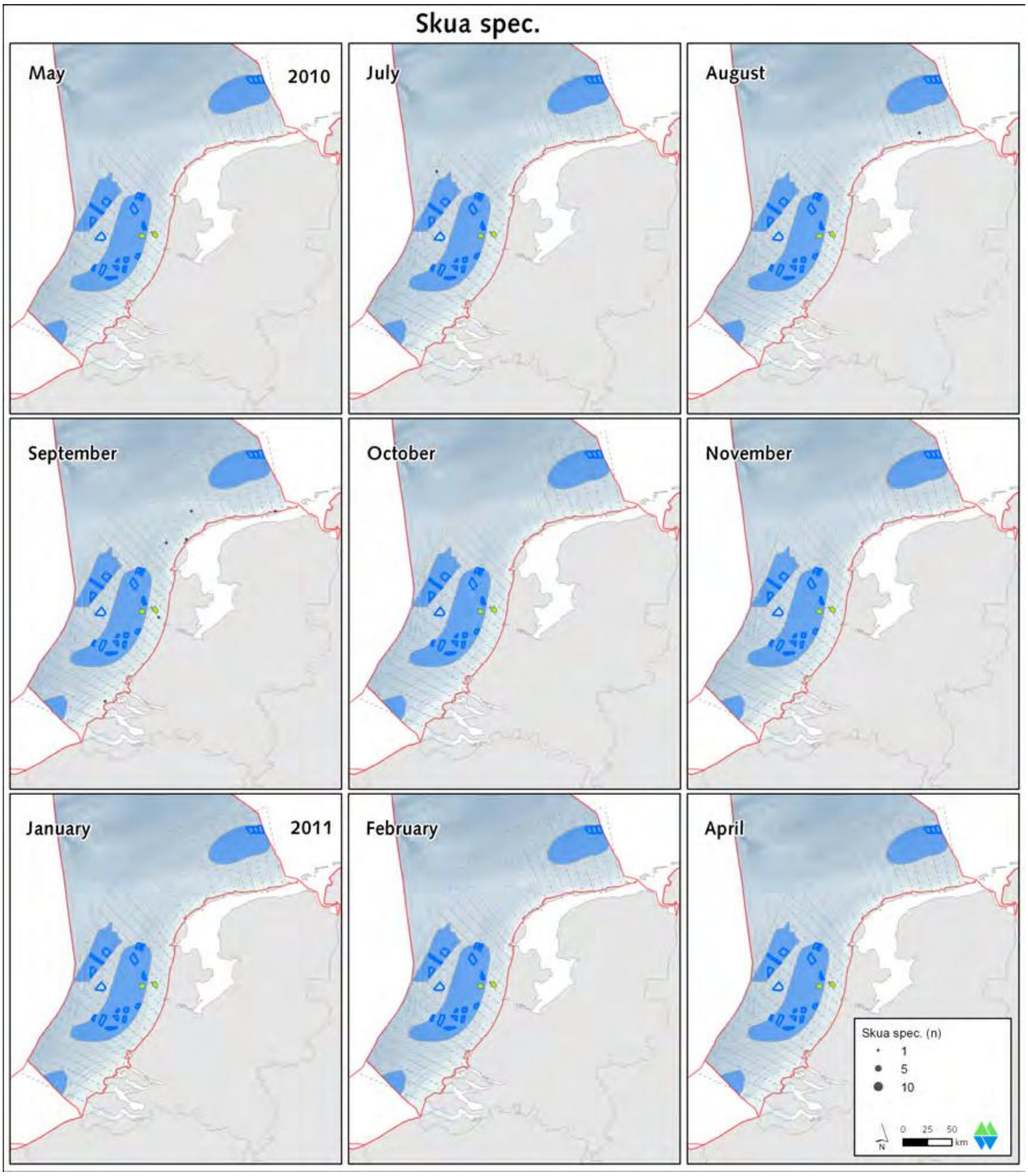


Figure 3.2.7.4 *Distribution of the species group small skua spp. (consisting mainly of Parasitic and Pomarine Skuas) per month observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).*

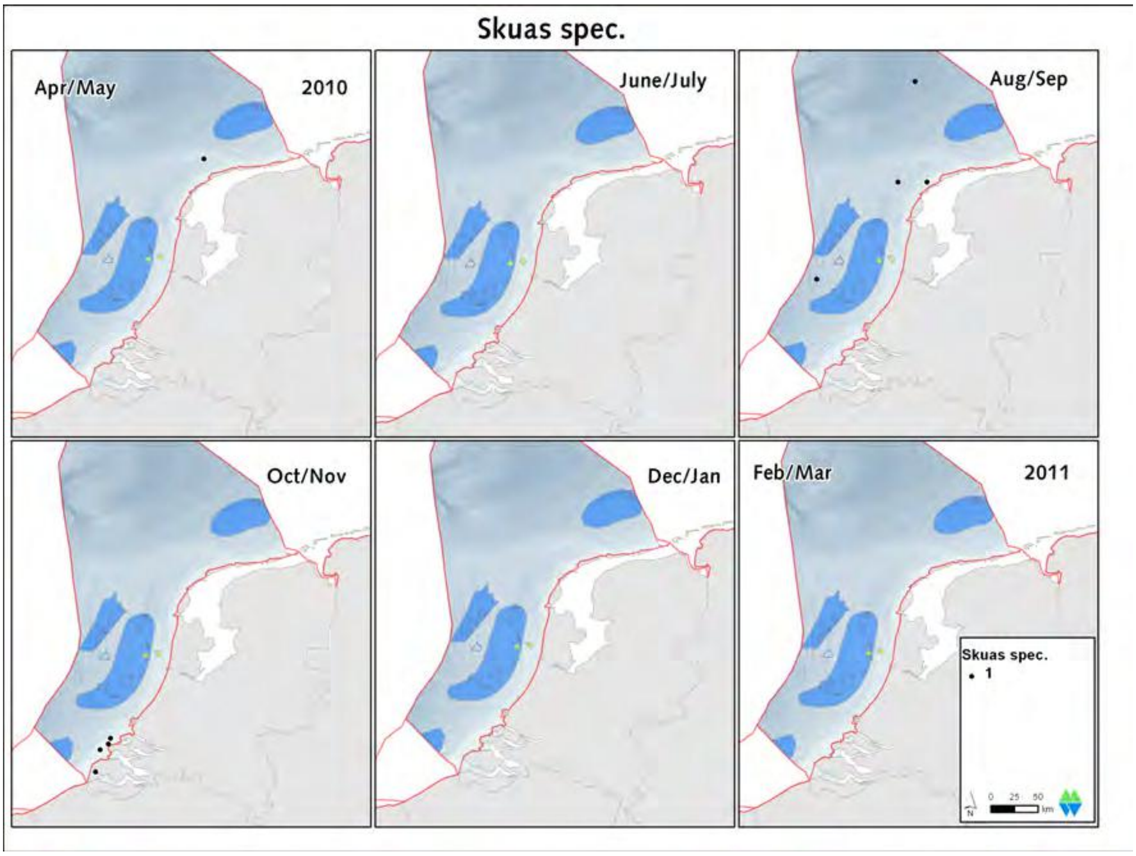


Figure 3.2.7.5 *Distribution of the species group small skua spp. (consisting mainly of Parasitic and Pomarine Skuas) observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).*

3.2.8 Kittiwake

Observations in this study

Kittiwakes were observed throughout the study area during the Shortlist Masterplan aerial surveys. The main distribution was further offshore with smaller numbers were found along the coast (Figure 3.2.8.1). Kittiwakes were most numerous in autumn and winter, between August and February. In August, most Kittwakes were observed northwest of Texel. In the course of the season the main Kittiwake distribution shifted to the south. Numbers were largest in November and February (Figure 3.2.8.2) but during the surveys of January sea-state was in general higher (Figure 2.3.2.), which may have influenced detection of Kittiwakes during the January count.

Associations with other species, fronts or human activities

Kittiwakes were often associated with auks, mainly Guillemots. Kittiwakes probably profit from the hunting activities of these Guillemots. Kittiwakes were also often attracted to platforms with large groups often being observed resting close to offshore platforms. Fishing vessels did also attract groups of Kittiwakes.

Flight altitude

The majority of Kittiwakes flew in between two and 10 metres above sea level but also between 10 and 25 metres substantial numbers of Kittiwakes were observed. During the aerial surveys of the shortlist program 16% of all flying Kittiwakes were flying above 25 metres above sea level (30% if birds associated with ships are excluded).

Comparison with ship-based data

No identification differences with flying birds comparing ship-based with aerial surveys, however, sitting birds on the water are more difficult to identify from the aeroplane.

Compared to the aerial surveys, there is a gap in the distribution off the coast of Zuid-Holland where during the ship-based surveys no Kittiwakes were observed. This area was among the areas with the highest densities of Kittiwakes during the January and February aerial surveys. Remarkably, no Kittiwakes were seen in the northeastern sector of the study area during the ship-based surveys whereas many Kittiwakes were seen here from the aeroplane during the November and January surveys.

Comparison with MWTL data

The results of the Shortlist Masterplan aerial surveys and the MWTL data are quite similar with regard to the Kittiwake distribution. Some concentrations are probably due to associations with human activities like platforms and fishery. The trend that Kittiwakes move south during the course of the summer and autumn is visible in both the Shortlist Masterplan and the MWTL data.

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea

Kittiwakes are widespread in the Dutch North Sea throughout the year, although they are present in larger numbers during autumn and winter. Numbers can peak at an estimated 53,000 during autumn (Camphuysen & Leopold 1994). Kittiwakes can be found throughout Dutch North Sea waters, but favour offshore areas and can be seen scavenging at trawls (Camphuysen & Leopold 1994). In recent years, Kittiwakes have bred in small numbers in Dutch territorial waters at platforms (Camphuysen & de Vreeze 2005). The next nearest breeding colonies are in Eastern and Northeast England and on Helgoland in Germany. The largest colonies around the North Sea are in Scotland and Norway (Mitchell *et al.* 2004).

Based on the lack of a substantial increase in wintering numbers of Kittiwakes in the Dutch part of the North Sea, at the time when breeding numbers in the UK showed a threefold increase, it has been suggested that the breeding origin of birds wintering in Dutch waters is much wider than the British Isles alone (Bijlsma *et al.* 2001). However, the increase in numbers in the Dutch part of the North Sea during 1992-2004 is strongly indicative of a relation with UK breeding bird numbers. After 2004 a decrease has set in (Arts 2010), completely in line with the dramatic decline of East Scottish colonies (JNCC 2010, Fredriksen *et al.* 2004).

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms

Kittiwakes were observed in all search areas for new offshore wind farms, although in small numbers. Peaks were likely associated with fishing activity rather than specific to other features of the location.

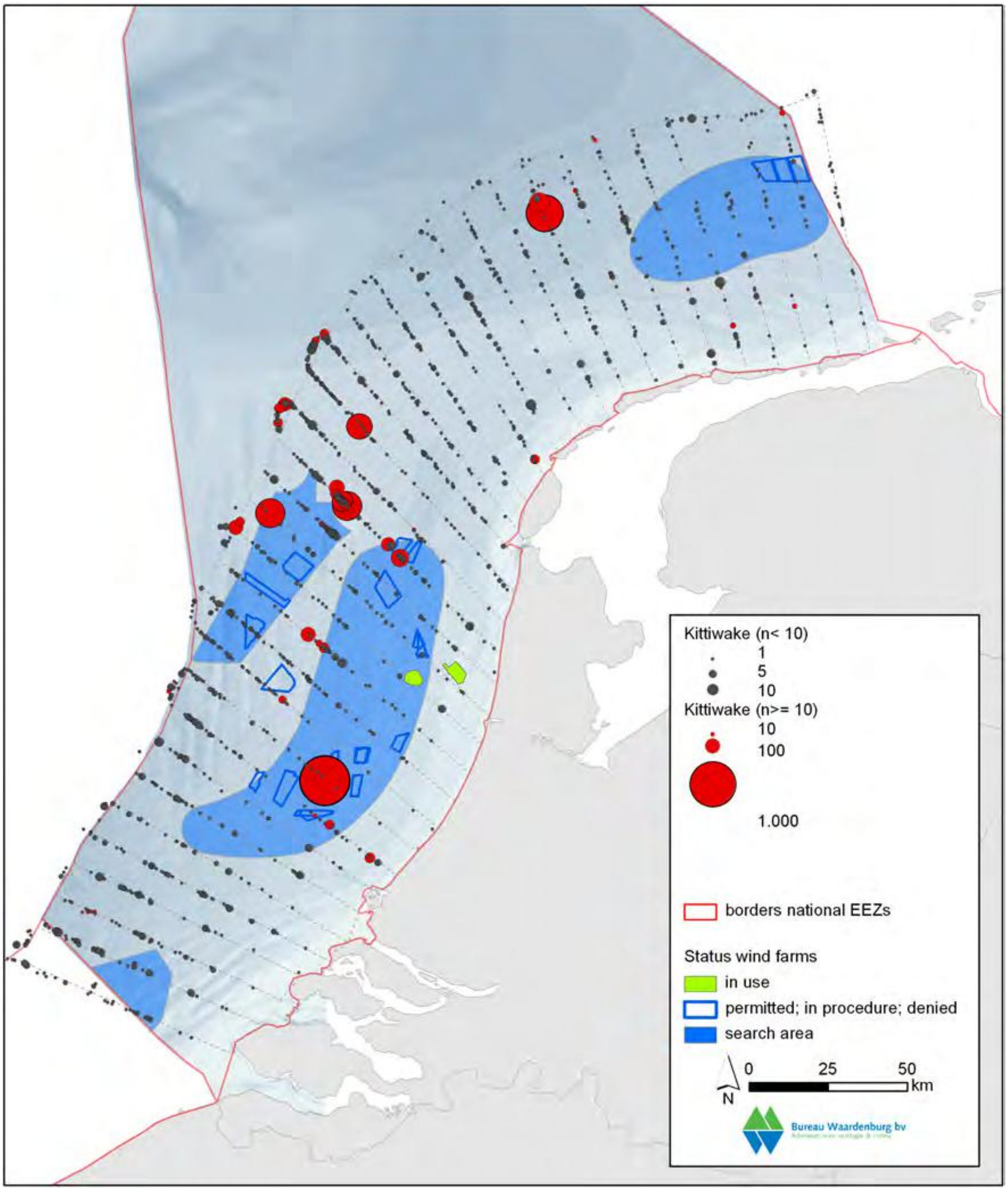


Figure 3.2.8.1 Cumulative distribution of Kittiwake observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).

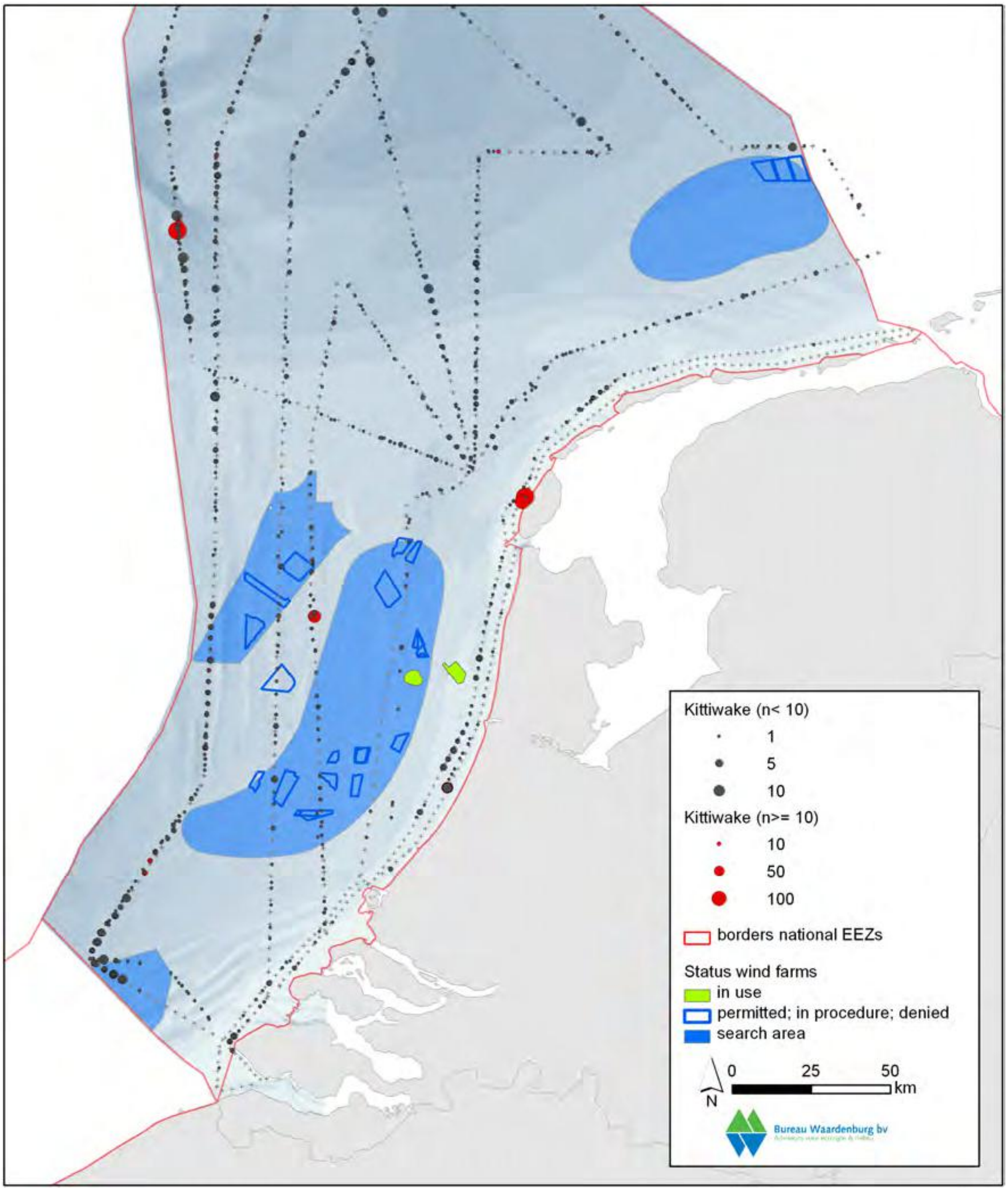


Figure 3.2.8.2 *Cumulative distribution of Kittiwake observed during the aerial-based survey of the MWTL monitoring (six surveys in the period April 2010 – March 2011).*

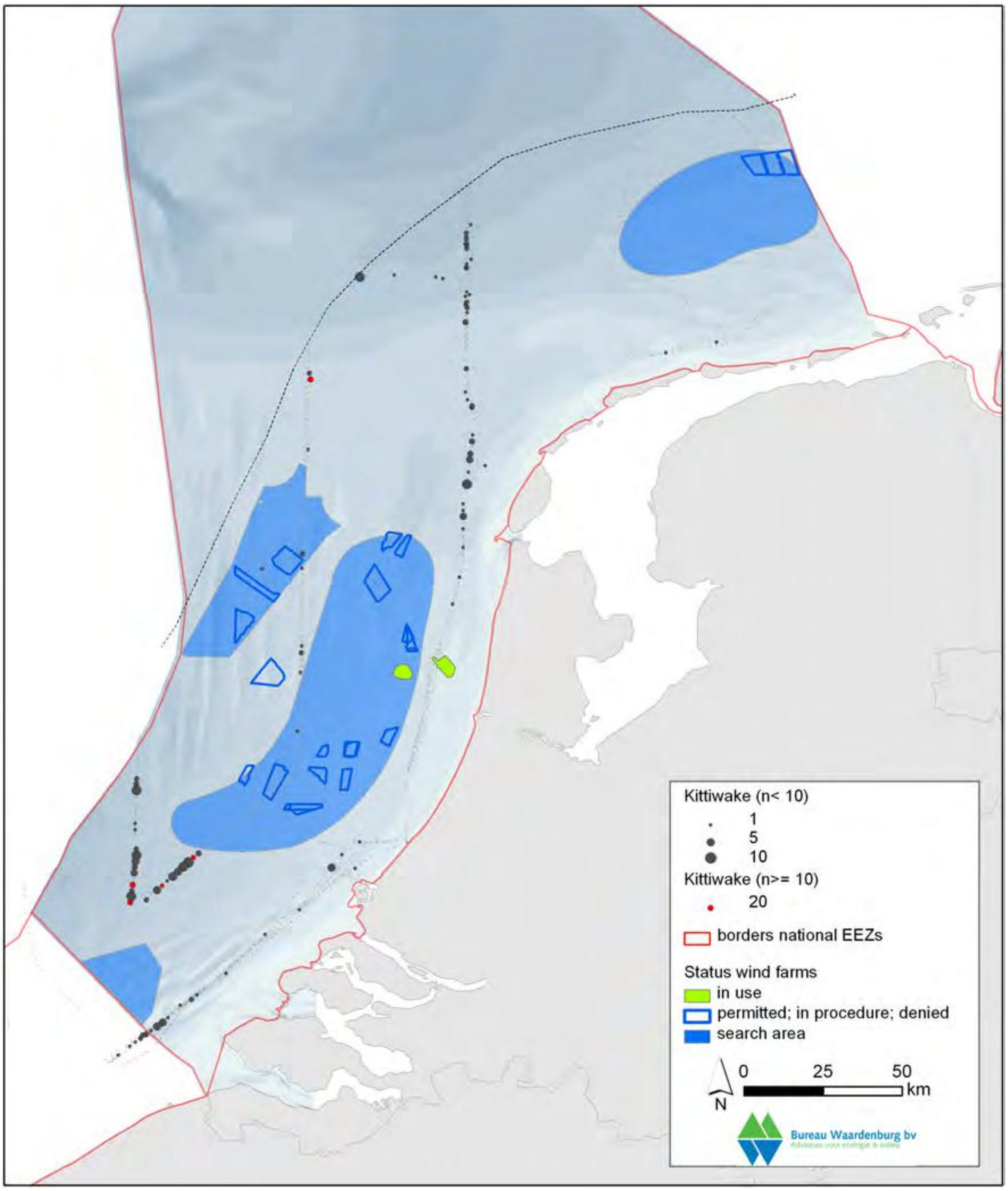


Figure 3.2.8.3 *Cumulative distribution of Kittiwake observed during the ship-based survey monitoring Shortlist Masterplan project (surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).*

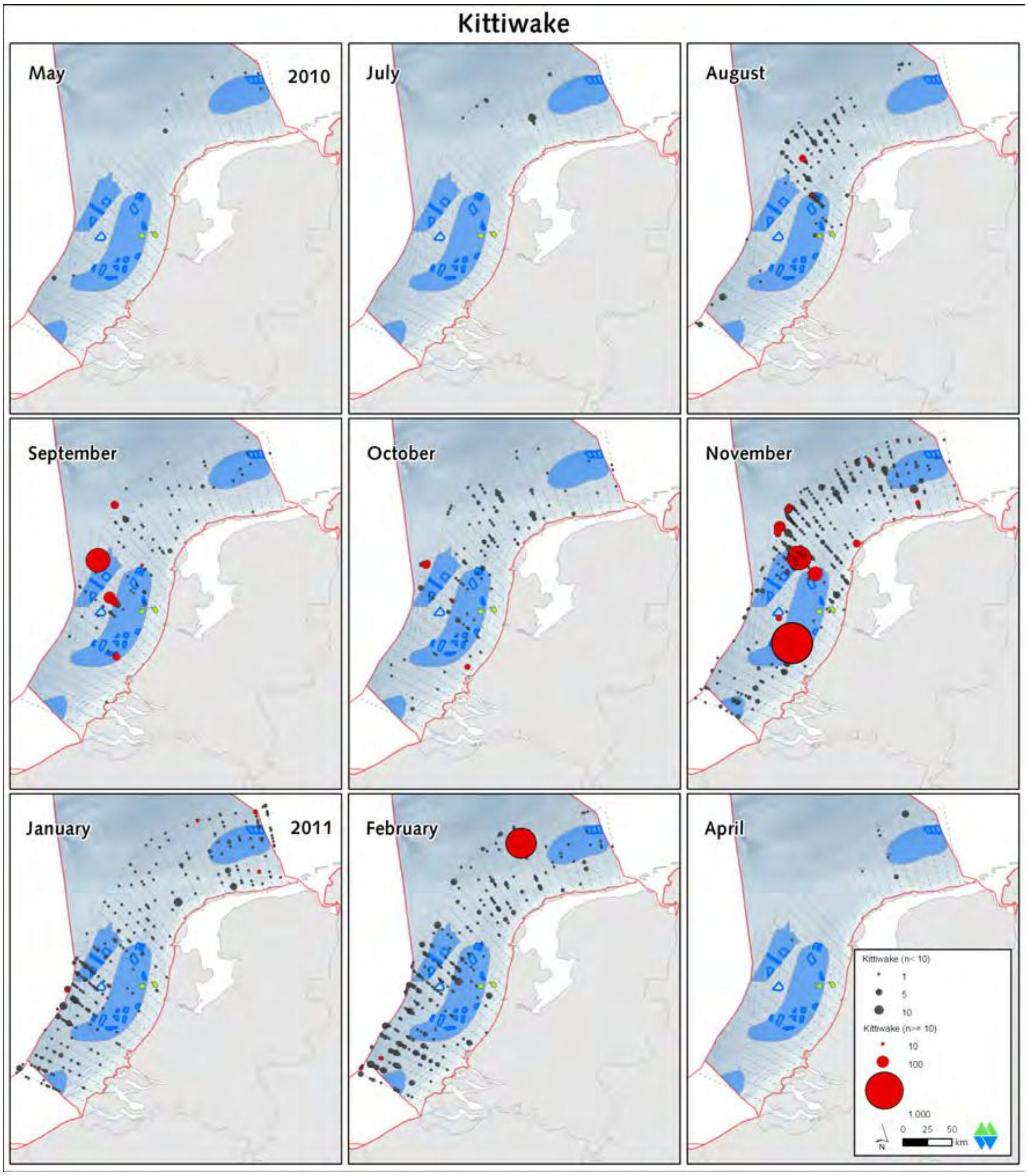


Figure 3.2.8.4 *Distribution of Kittiwake observed during the aerial-based survey monitoring Shortlist Masterplan project per month (nine surveys in the period May 2010 – April 2011).*

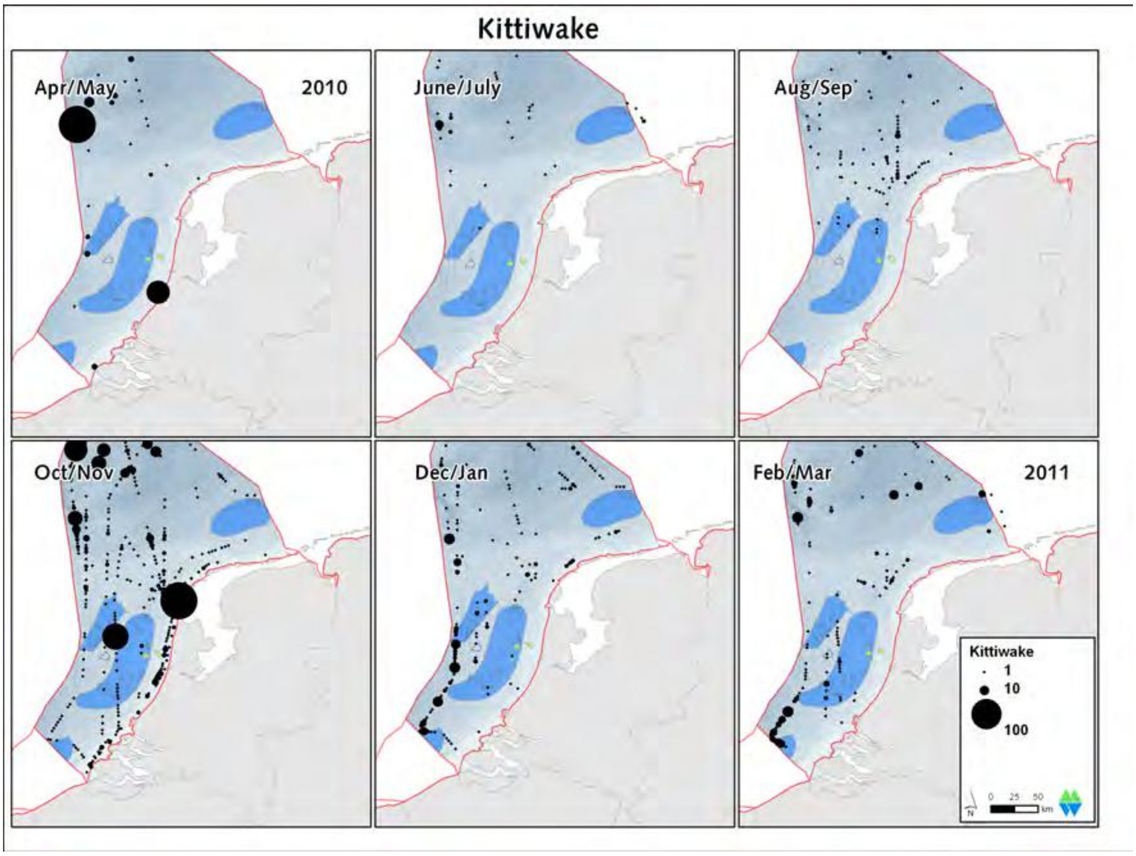


Figure 3.2.8.5 *Distribution of Kittiwake observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).*

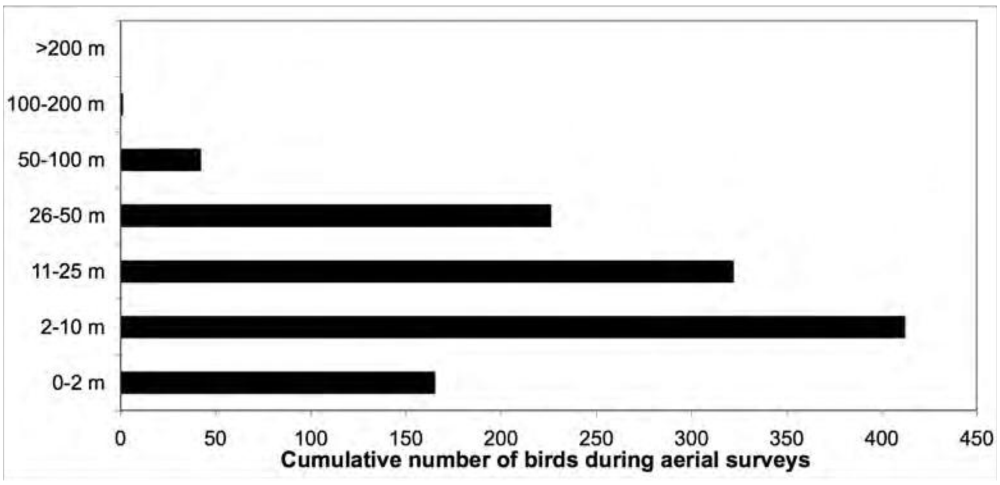


Figure 3.2.8.6 *Cumulative number of Kittiwake flying at different altitudes during the aerial-based survey monitoring Shortlist Masterplan project (nine surveys in the period May 2010 – April 2011, birds associated with ships excluded).*

3.2.9 Little Gull

Observations in this study

Little Gulls were present throughout much of the year and throughout the entire study area, although observations in summer were scarce. Relatively high densities were recorded in November and February with the largest numbers in April. Few birds were recorded in late spring and early summer and no birds were recorded in late summer and early autumn (Figure 3.2.9.2). The observed distribution was mainly scattered. Notable is the general absence of observed Little Gulls to the west of Zuid-Holland. This might be related to relative high sea states in this area throughout the year.

In November, the main concentrations of birds were observed about 70-80 km northwest of Texel, 60-80 km north of Terschelling and Ameland and 30-70 km west of Zeeland. In February, the main concentrations of birds were observed in a narrow band of 10-40 km from shore of the coast of Noord-Holland and Zeeland. Large numbers were also observed 60-80 km north of Terschelling and Ameland. In April, the concentrations of observed birds were high with the largest densities being observed near to the shore and at the Brown Ridge.

Little Gulls are relatively small birds, which, due to the paleness of their plumage, are still easily seen in flight as well as resting on water. Their distribution is often patchy, which makes counting generally problematic (Camphuysen 2009). Observation issues in relation to sea state and weather conditions may play an important role in detection. This can particularly be the case for the detection of resting birds on water under less ideal circumstances. Additionally, under less ideal circumstances identification problems can occur with small species of gull and terns. Based on comparisons between the distribution maps of the observations of these species, additional checks with observers and comparisons between observers on either side of the aeroplane, no distinct abnormalities could be detected. Therefore, no indications were found for the occurrence of large-scale mistakes in the identification of Little Gulls.

Presumable effects of sea state on detection appear to occur in the data. This is most obvious for months where differences in sea state occur, either between days or tracks and apparent changes in densities of observed Little Gull are evident. This appears most evident in the northern part of the study area during October and for the entire study area in January. During conditions with relative high sea states large numbers of Little Gull can however, still be detected. This appears to be the case in the southern part of the study area during November. This seems to suggest that other factors than sea state alone can influence the level of detection. Disturbance of gulls by aeroplane and side effects seems to be of little relevance for detection.

Associations with other species, fronts or human activities

Little Gulls are known to associate with auks (usually Razorbills) (in Camphuysen 2009). This was frequently observed during this study. Associations of Little Gulls with fronts are also mentioned in the literature (in Camphuysen 2009), however, hardly any associations with fronts were observed during this study. Furthermore, no accounts were recorded of Little Gulls being associated with human activities. Relatively few birds were recorded to the far northeast of Texel in an area with a high density of platforms. This may indicate that Little Gulls avoid areas with high densities of platforms and or related activities; however, more data would be required to confirm these observations. The species is scarcely observed as associated with ships.

Flight altitude

The observed flight altitude of Little Gulls ranged from category 0-2 to 51-100 metres. The main flight altitude that was observed was between 2-10 metres, followed by 0-2 metres and 11-25 metres. This corresponds with the results of the ship-based surveys of the shortlist program. During the aerial surveys of the shortlist program the flight altitude was recorded for 58% of all flying Little Gulls (60% if birds associated with ships are excluded). Among these birds, 39 (8%) were flying above 25 metres above sea level.

Comparison with ship-based data

As Little Gulls are relatively small, identification speed and accuracy from aeroplanes is lower in comparison to observations from ships (Camphuysen *et al.* 2004). Due to the limited coverage of the study area during the ship-based surveys, the cumulative distribution of Little Gulls appears to be restricted to a small zone of approximately 25 km offshore, but this recorded distribution patterns likely biased based on the comparison with the aerial surveys.

Comparison with MWTL data

Comparisons of the cumulative distribution patterns between both aerial-based surveys show a similar pattern. However, when comparing surveys on a monthly basis, the Shortlist Masterplan results show the presence of fairly high concentrations of Little Gulls far offshore from October until April. This is only occasionally visible in the MWTL data with the exception of April-May. The data provided by the Shortlist Masterplan aerial surveys probably give a better view of the spatial distribution of this species throughout the study area, due to the survey design with a higher density of transects which are perpendicular to the coast.

The MWTL data results in higher densities of birds flying just outside the coast. This can be attributed to the used survey routes, which run parallel to the entire coastline. This result is most clear during the main migration in spring and autumn when accumulation of numbers along shore under influence of wind direction can result in higher concentrations.

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea

Little Gulls are most common in the Dutch North Sea during the autumn migration period in October and November. Up to 4,500 are present, during winter mostly in the coastal zone (Camphuysen & Leopold 1994). Numbers increase again during spring migration although this is mainly limited from the end of April to early May.

Observations presented here gathered in the period 2010-2011 agree in general with what is known on the occurrence of Little Gulls in the Dutch part of the North Sea. In contrast to both the ship- and MWTL surveys a relative large part of the distribution of Little Gulls was found in the western part of the study area (> 50 km from shore).

The largest number of Little Gulls during The Shortlist Masterplan survey flights was seen in April. Based on almost daily accounts of migration in April (www.trektellen.nl) the survey flights were performed before the actual peak of spring migration, during the end of April. This indicates that the maximum number of Little Gulls using the study area may be even higher than seen during this survey.

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms

This study provides detailed information about the distribution patterns of Little Gull throughout the entire study area. This is only partially true for the MWLT survey data and limited in the ship-based survey data.

Based on the present study, the occurrence of Little Gulls was relatively high in the search areas for new offshore wind farms in the northern part of 'IJmuiden', the northern part of 'Hollandse kust' and eastern part of 'Borssele'. Little Gulls were relatively scarce or absent in the search areas for new offshore wind farms south of 'Hollandse kust', west of 'Borssele' and south of 'Waddensea'. In general the search areas for wind farms are not of particular importance for Little Gulls (Figure 3.2.9.1).

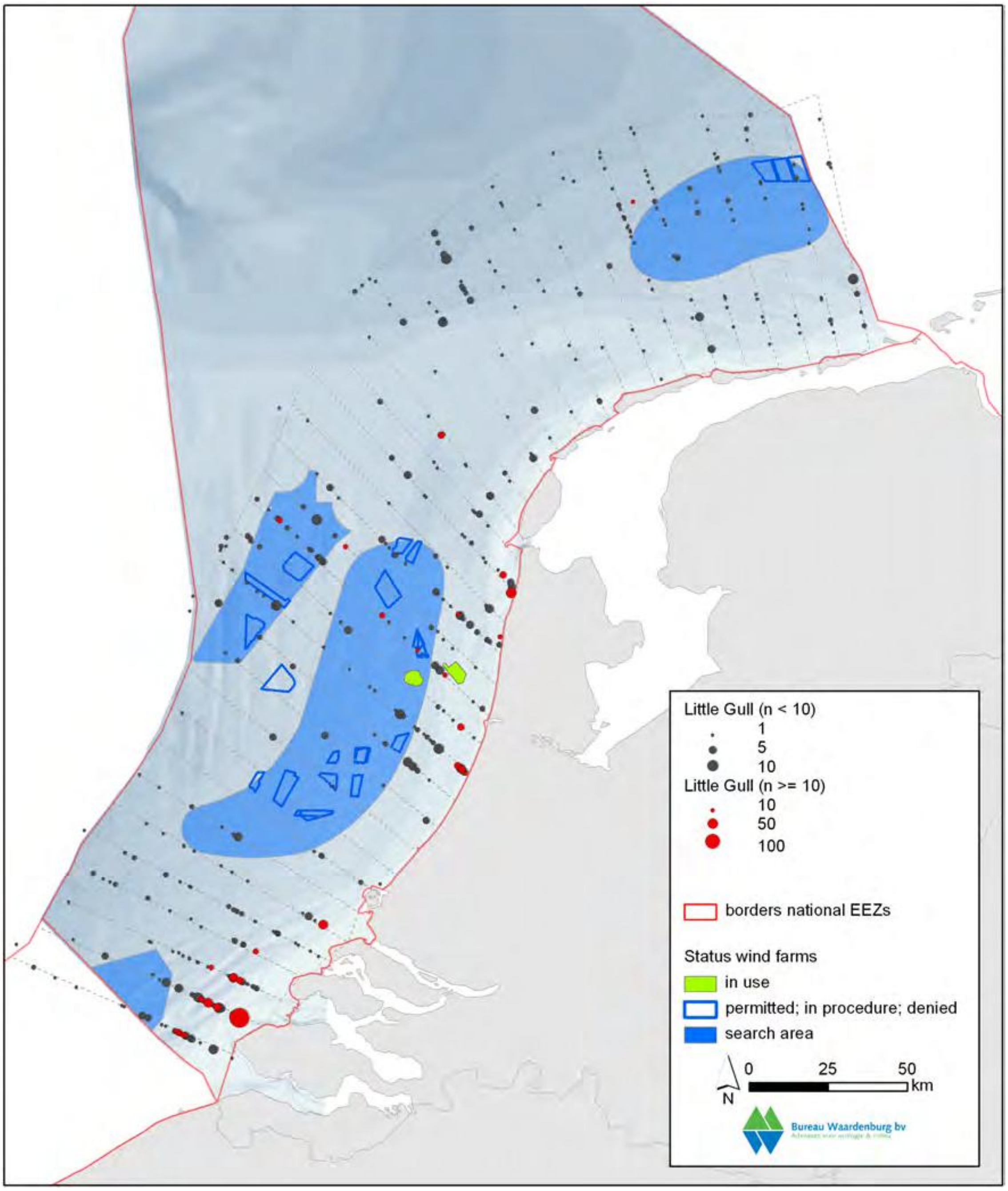


Figure 3.2.9.1 *Cumulative distribution of Little Gull observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).*

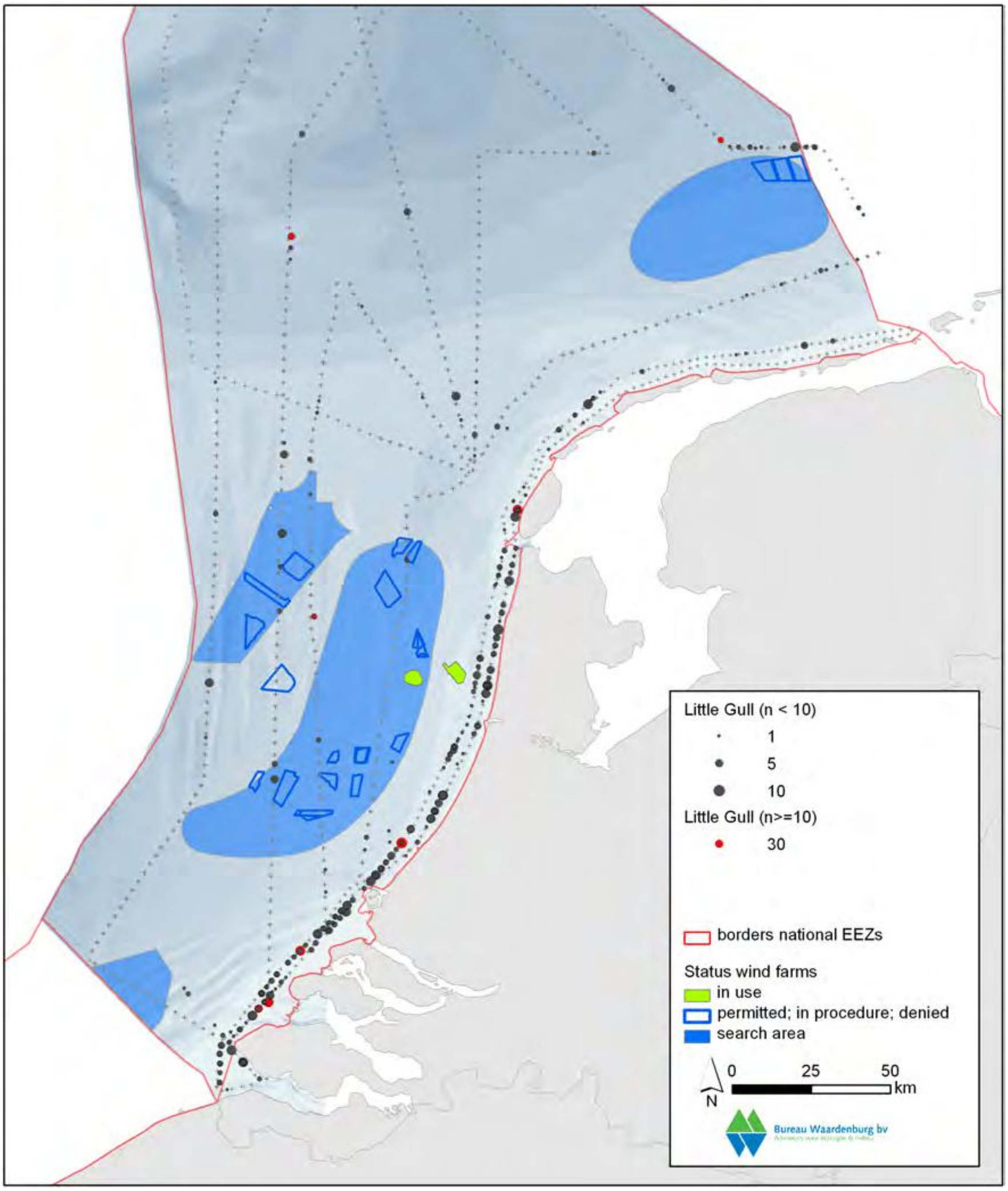


Figure 3.2.9.2 *Cumulative distribution of Little Gull observed during the aerial-based survey of the MWTL monitoring (six surveys in the period April 2010 – March 2011).*

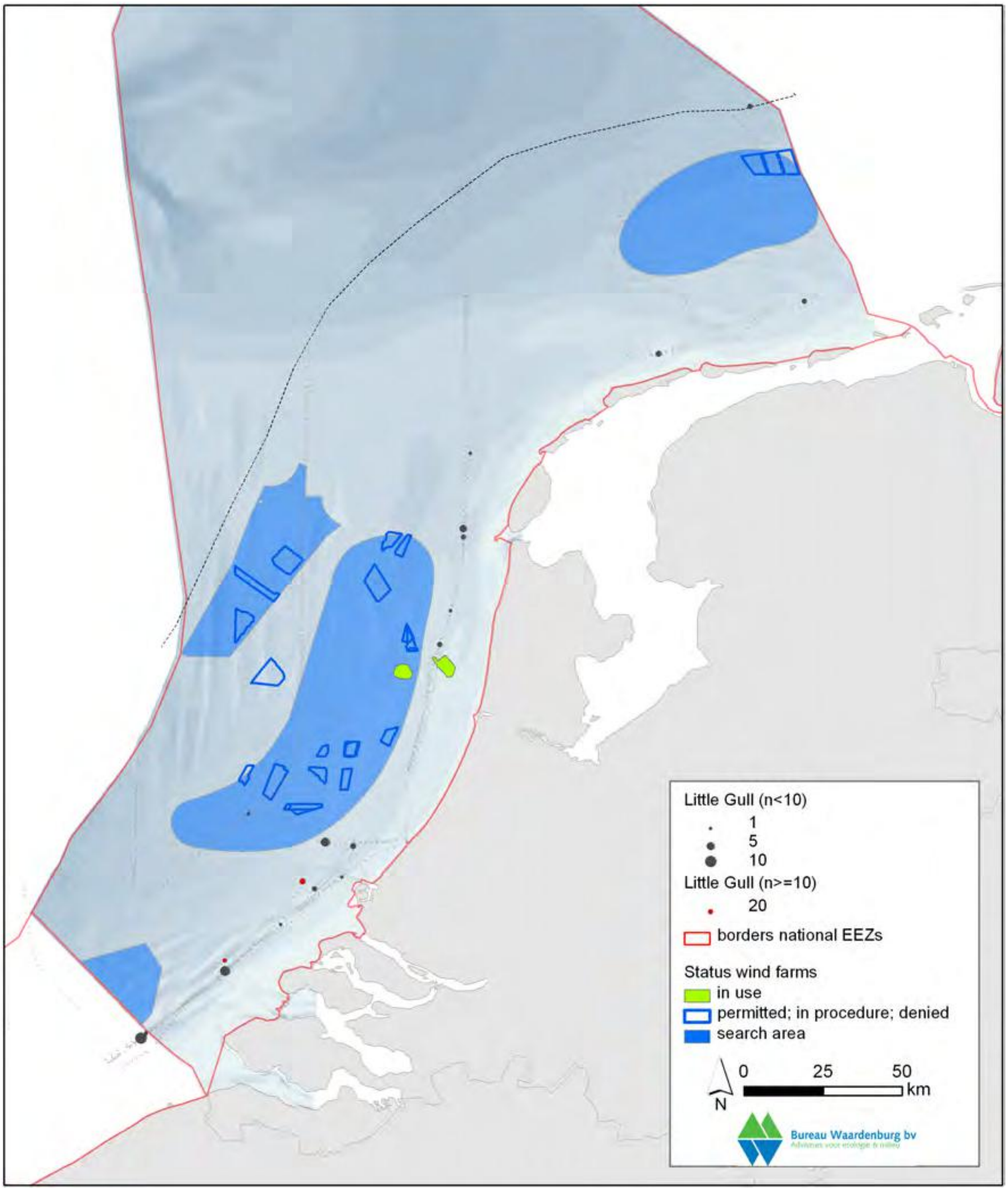


Figure 3.2.9.3 *Cumulative distribution of Little Gull observed during the ship-based survey monitoring Shortlist Masterplan project (surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).*

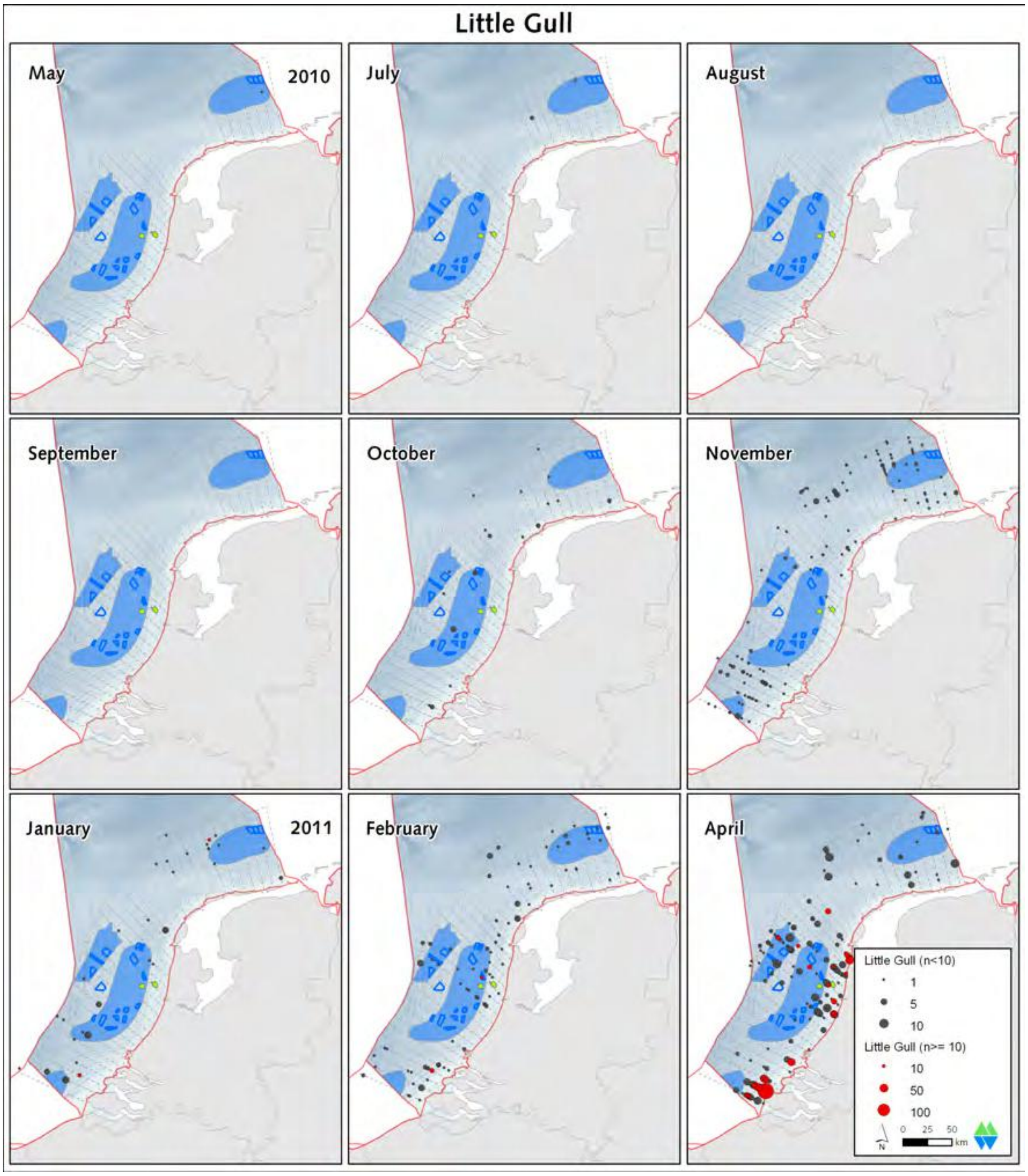


Figure 3.2.9.4 *Distribution of Little Gull observed during the aerial-based survey monitoring Shortlist Masterplan project per month (nine surveys in the period May 2010 – April 2011).*

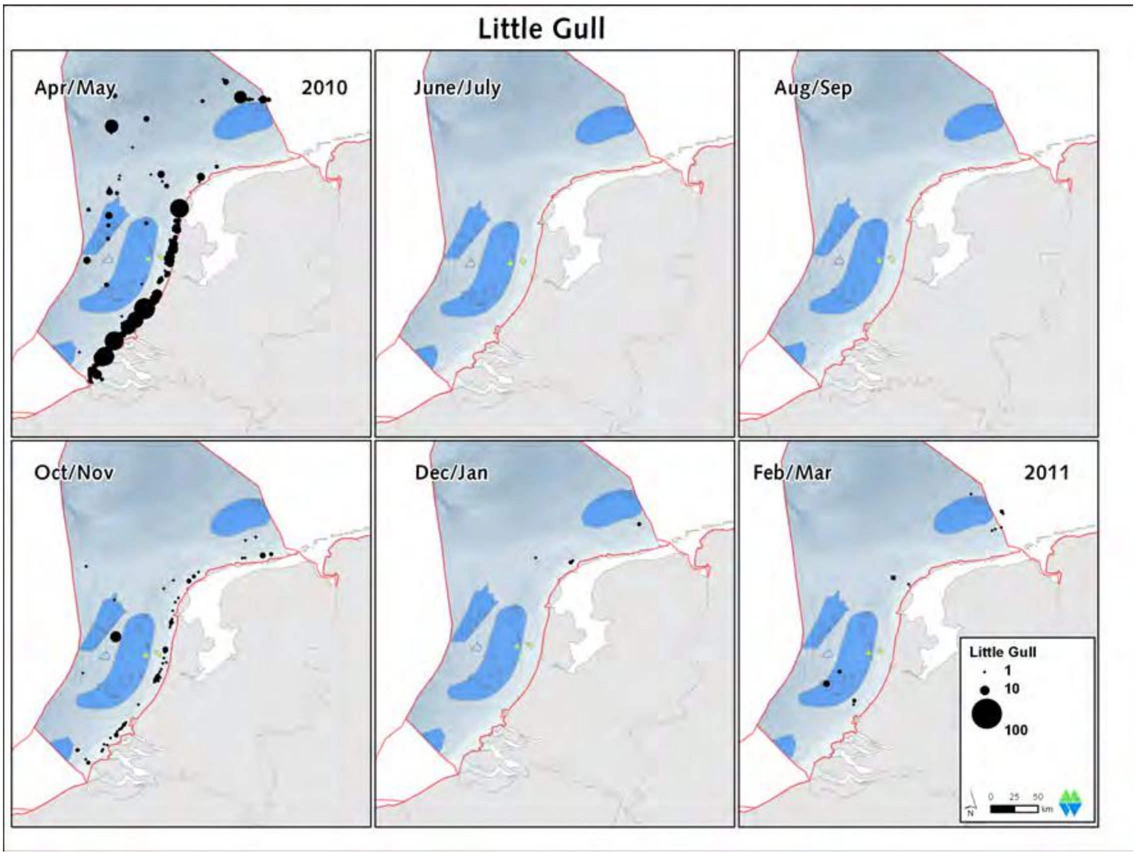


Figure 3.2.9.5 *Distribution of Little Gull observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).*

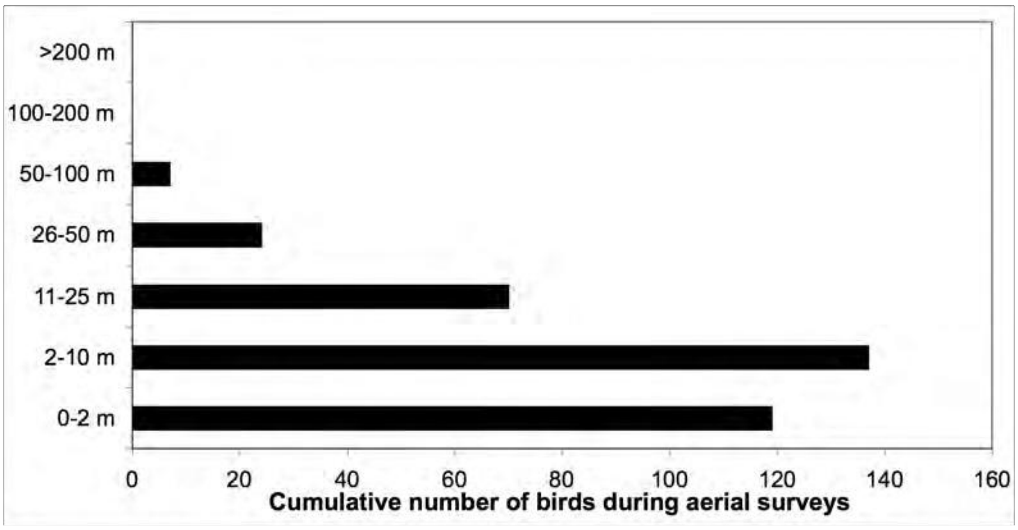


Figure 3.2.9.6 *Cumulative number of Little Gull flying at different altitudes during the aerial-based survey monitoring Shortlist Masterplan project (nine surveys in the period May 2010 – April 2011, birds associated with ships excluded).*

3.2.10 Common Gull

Observations in this study

Common Gulls were found throughout the study area although most birds were concentrated near the coast. Large congregations of Common Gull were found further offshore (Figure 3.2.10.1), mainly in winter. The majority of Common Gulls were found during late autumn and in winter, during the other seasons Common Gulls tend to remain in more terrestrial habitats. In October, the first birds start to appear on the coast and in November to February large numbers can be found at sea (Figure 3.2.10.2).

Common Gulls, sitting on the water surface, have a similar appearance to Kittiwakes. From the aeroplane this might have led to misidentification. Sea state can also be of influence in the detection of Common Gulls.

Associations with other species, fronts or human activities

Common Gulls were observed associated with fishing vessels, platforms and litter.

Flight altitude

Common Gulls were common in all altitude bands up to 100 metres. Most birds were recorded in between two and 50 metres of altitude (Figure 3.2.10.5). During the aerial surveys of the shortlist program 35% of all Common Gulls were flying above 25 metres above sea level (56% if birds associated with ships are excluded). Compared with the results of the ship-based surveys of the shortlist program this is slightly higher. This is probably due to the fact that the flight altitude was not recorded for almost 65% of all Common Gulls during the aerial surveys. Especially for those birds being associated with ship vessels flight altitude is frequently not recorded. As these birds are predominantly flying at relative low altitudes (<25 metres) the average flight altitude is overestimated.

Comparison with ship-based data

The observations based on ship-based surveys (Figure 3.2.10.3) fit in the pattern that the largest numbers of Common Gulls occur along the coast as found in both aerial programs. Truly coastal tracks were not made during the ship-based surveys and also smaller numbers of Common Gulls were encountered throughout the study area, which gives a diluted reflection of the clear pattern from the aerial surveys that the species is mostly bonded to the coast.

Common Gulls, sitting on the surface of the water, can have a similar appearance to other species like Kittiwakes. From the aeroplane this might have caused misidentification but yielded mostly in a substantial prorpotion of 'small unidentified gulls', see further paragraph 4.1. During the ship-based surveys there is more time for individual identification of Common Gulls and Kittiwakes on the water surface.

Comparison with MWTL data
The distribution patterns of Common Gulls from the MWTL surveys are remarkably similar to those found in the Shortlist Masterplan aerial surveys. Most Common Gulls were observed in late autumn and winter as well and the main distribution was on the coast (Figure 3.2.10.4).

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea
Most of the Dutch breeding population is restricted to the coast with the majority of breeding colonies being nowadays around the Wadden Sea, Noord-Holland and the Delta. These breeding birds mainly feed in coastal waters, inland waters, intertidal areas and further inland and are hardly found foraging at sea. During the winter, especially during periods with hard frost, these birds move to the marine habitat and then the species can be abundant offshore (Bijlsma *et al*. 2001). Most of these birds are found in the coastal zone (Camphuysen & Leopold 1994) as was found in this study as well. Besides our own breeding birds a major part of the Dutch wintering population at sea originates of birds coming from a very wide range of northern breeding areas, covering Scandinavia and large parts of Russia.

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms
Common Gulls were observed in all search areas for new wind farm initiatives but were less abundant in the more offshore located search areas. These birds generally fly at higher altitude above sea level, which makes them more sensitive to offshore wind turbines than some other seabird species.

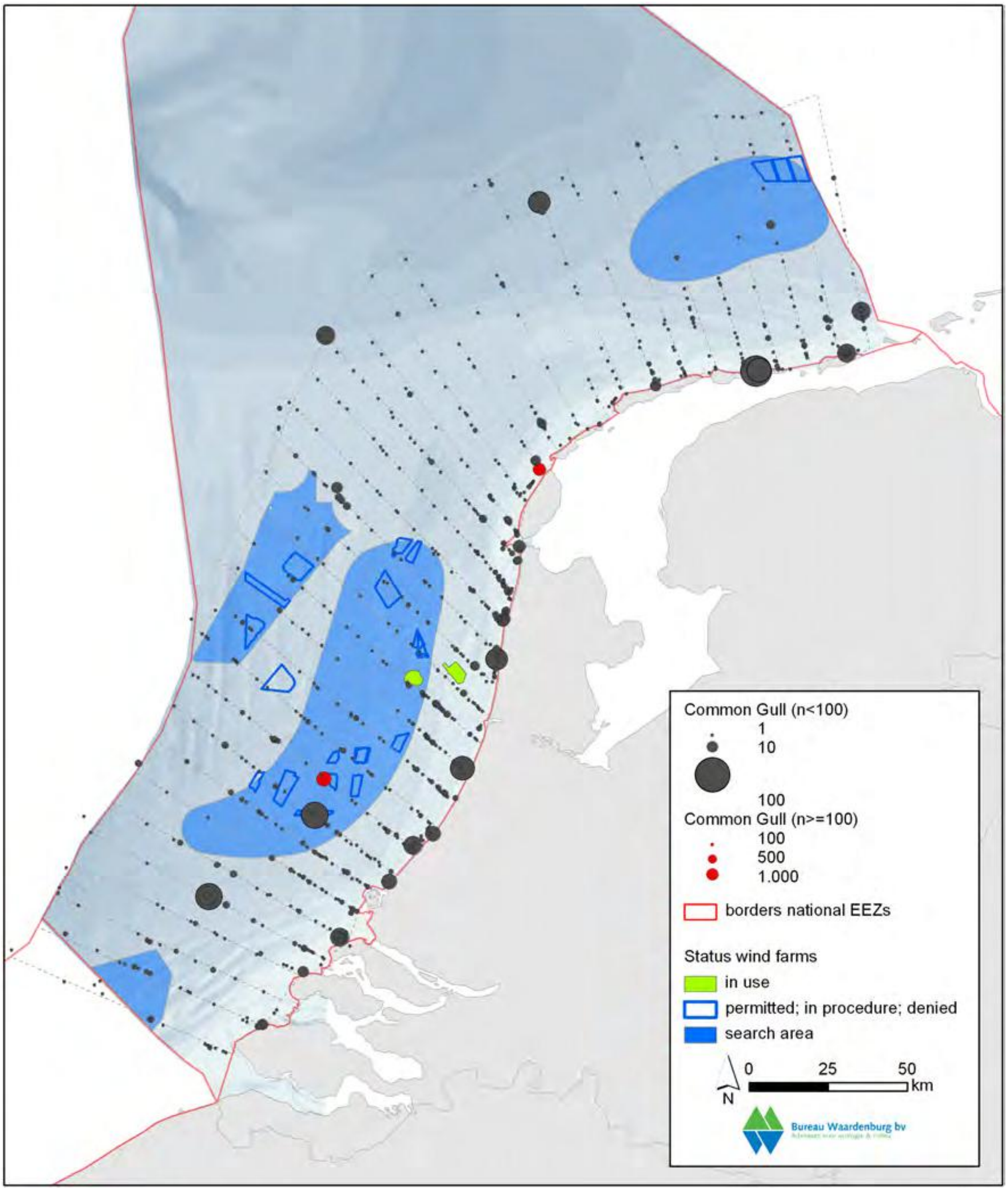


Figure 3.2.10.1 Cumulative distribution of Common Gull observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).

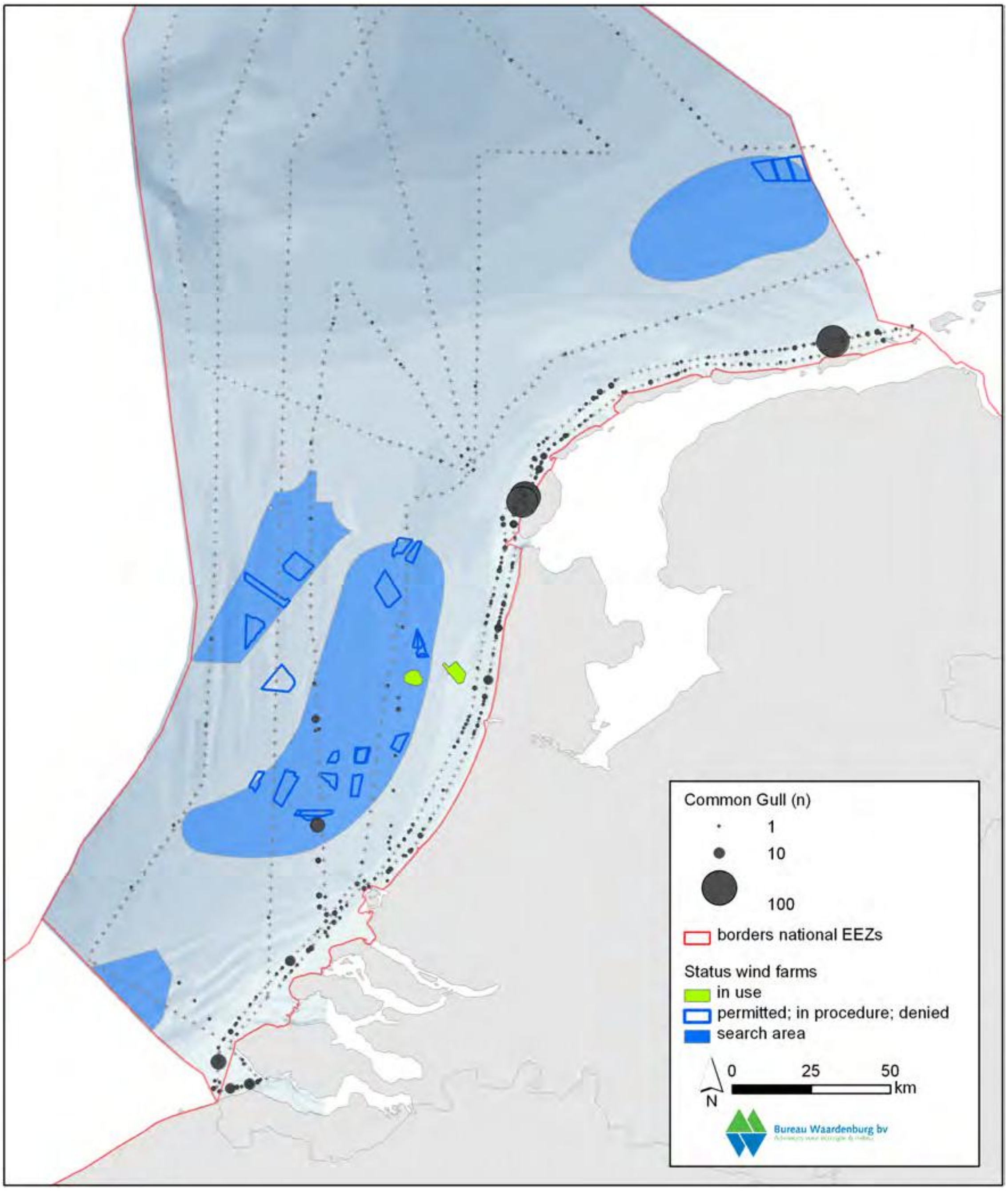


Figure 3.2.10.2 Cumulative distribution of Common Gull observed during the aerial-based survey of the MWTL monitoring (six surveys in the period April 2010 – March 2011).

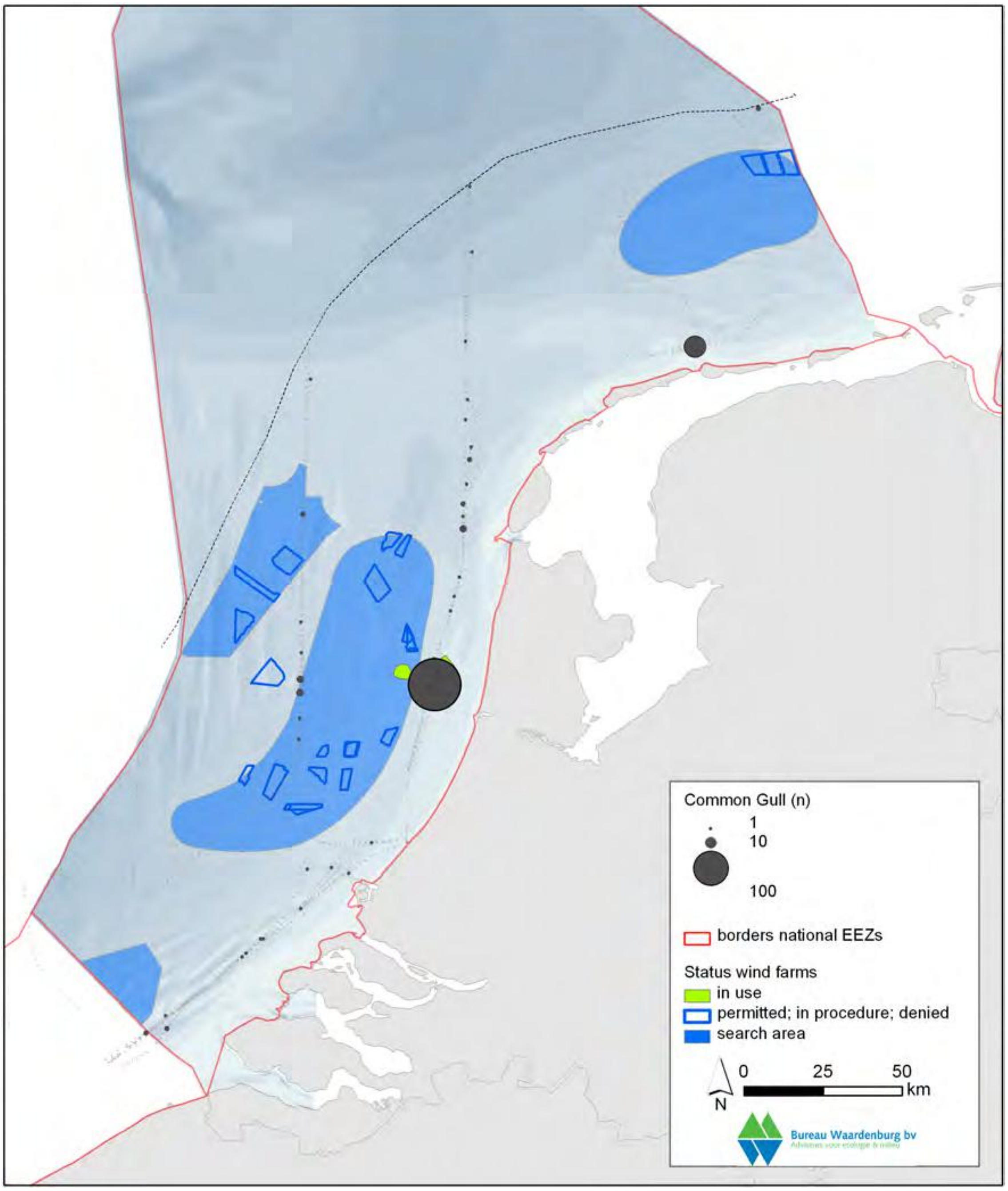


Figure 3.2.10.3 Cumulative distribution of Common Gull observed during the ship-based survey monitoring Shortlist Masterplan project (surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).

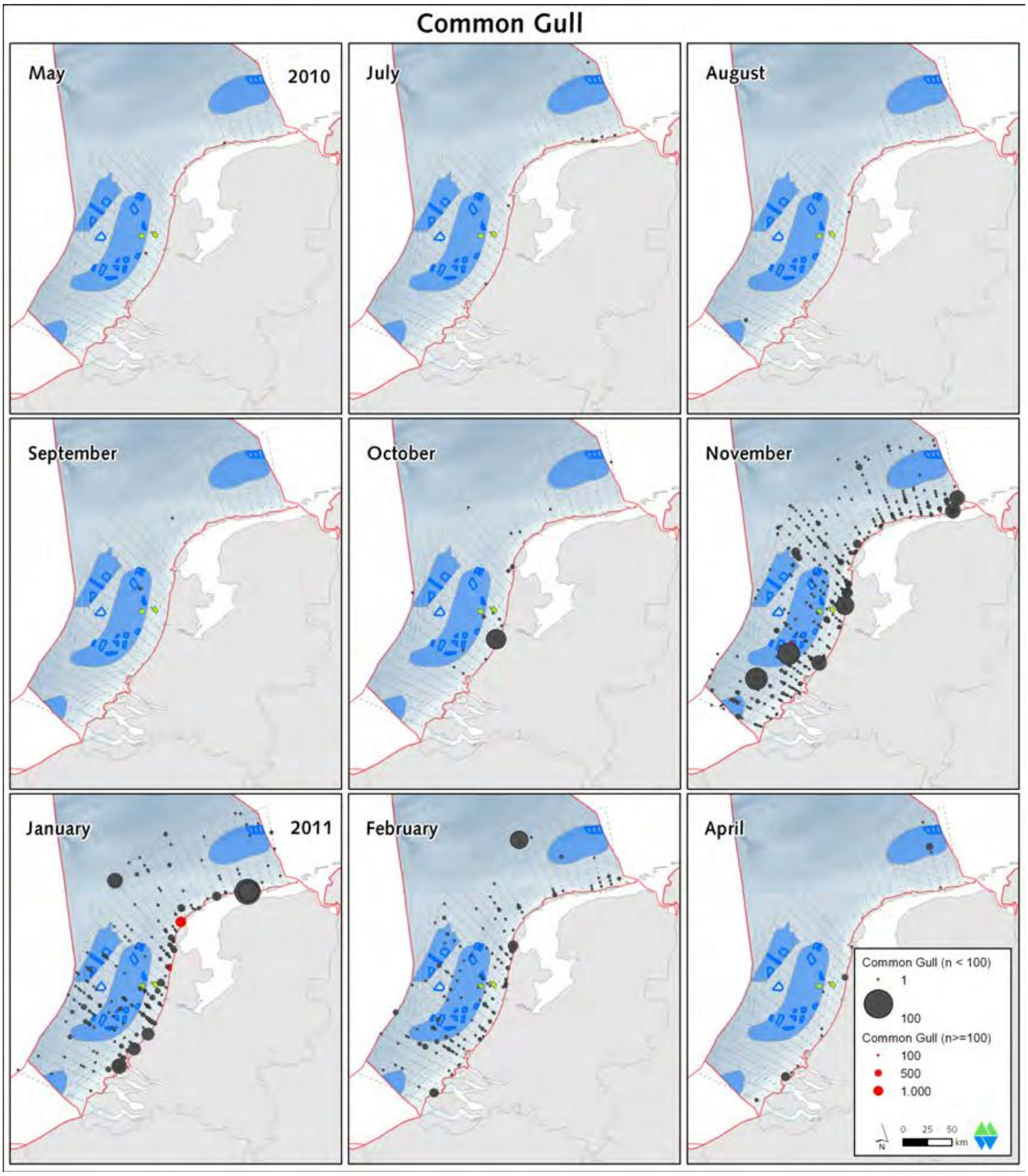


Figure 3.2.10.4 *Distribution of Common Gull observed during the aerial-based survey monitoring Shortlist Masterplan project per month (nine surveys in the period May 2010 – April 2011).*

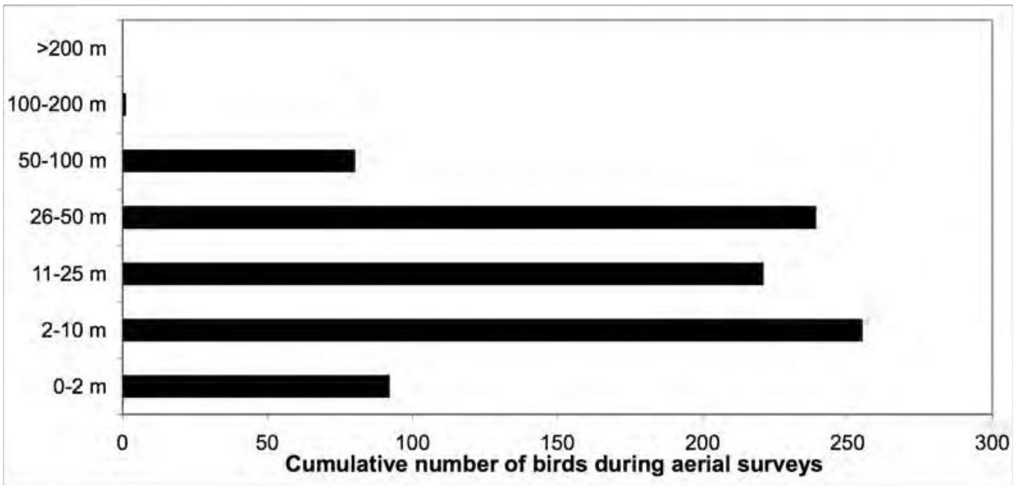


Figure 3.2.10.5 *Cumulative number of Common Gull flying at different altitudes during the aerial-based survey monitoring Shortlist Masterplan project (nine surveys in the period May 2010 – April 2011, birds associated with ships excluded).*

3.2.11 Lesser Black-backed Gull

Observations in this study

Lesser Black-backed Gulls were observed throughout the study area and were even encountered far offshore (Figure 3.2.11.1). Numbers of Lesser Black-backed Gulls in the Dutch North Sea increase in April, as birds arrive from their more southerly wintering areas, and show a gradual decline over the summer, as birds depart (Figure 3.2.11.2). In August and September most birds have already left on their southward migration, however, small numbers do remain in the study area during winter and Lesser Black-backed Gulls were seen during all surveys. In summer, birds tend to concentrate along the coast with increasing numbers towards the main colonies (i.e. Maasvlakte, IJmuiden, Wadden Islands).

No visible disturbance of Lesser Black-backed Gulls was observed when flying overhead and also sea state did not influence the possibility of detecting Lesser Black-backed Gulls. In larger groups of gulls or at greater distances, adult Lesser Black-backed Gulls may be confused with the similarly looking Great Black-backed Gull, although the incidence of these mistakes is thought to be small.

Associations with other species, fronts or human activities

Lesser Black-backed Gulls were often associated with fishing vessels in the study area in sometimes large numbers (a maximum of 1820 individuals behind a single vessel was observed). They were often part of associations with other gulls, mainly European Herring Gulls. Lesser Black-backed Gulls were also seen in association with floating litter and fronts. Platforms and wind turbines also attracted Lesser Black-backed Gulls. They used these as resting platforms or were also seen resting on the water surface in the vicinity of these structures.

Flight altitude

Lesser Black-backed Gulls were recorded at all altitudes but the majority of birds were spread throughout the altitude column below 100 metres (Figure 3.2.11.5). Most Lesser Black-backed Gulls were flying between two and 10 metres above sea level. About 19% of all flying birds were flying above 25 metres above sea level (32% if birds associated with ships are excluded). The distribution of individuals over the different flight-heights corresponds with the results from the ship-based surveys.

Comparison with ship-based data

The distribution of Lesser Black-backed Gulls during the ship-based surveys was in general similar to the patterns found during the aerial surveys although due to the location of transect lines and the number of transects the ship-based observations were more scattered (Figure 3.2.11.3). Peak numbers were found off the coast of Zeeland and off Zuid- and Noord-Holland, often in association with fishing vessels. Relatively small numbers were found north of the Wadden Islands when compared with the aerial surveys. Identification issues are not likely to explain the difference between the two survey methods.

Comparison with MWTL data

The distribution patterns of Lesser Black-backed Gulls during the MWTL and the Shortlist Masterplan aerial surveys are highly similar both on a spatial and temporal scale. The largest numbers of birds were found between April and September (Figure 3.2.11.4). Most birds were confined to a coastal band of a few tens of kilometers with clear seaward extension zones related to the coastal colonies, however birds were also recorded far offshore. Due to the common occurrence of this species the difference of the transect layout between the two types of aerial surveys seem not have influenced the general recorded distribution patterns of this species, although the perpendicular survey design of the Shortlist Masterplan yield a much more detailed picture.

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea

Since the 1970s there has been a rapid increase in the numbers of Lesser Black-backed Gulls breeding along the Dutch coast with up to about 90,000 pairs in 2007 (Bijlsma *et al.* 2001; Hustings *et al.* 2009; Boele et al. 2011; Strucker *et al.* 2011). Most of these breeding birds forage in the Dutch North Sea and can make foraging flights far offshore. During the breeding season, Lesser Black-backed Gulls can forage up to 100-200 km from the colony with the maximum foraging distances being estimated at 400 km (Ens *et al.* 2009). Most birds, however, forage within a few tens of km (Camphuysen *et al.* 2008). During the Shortlist Masterplan aerial surveys the stretches of sea around these colonies yielded the largest numbers of Lesser Black-backed Gulls yet foraging birds were also seen further offshore. Lesser Black-backed Gulls are known to associate with fishing vessels as well and it has recently been suggested that breeding success of this species is related to the availability of discards of the fishing industry (Camphuysen *et al.* 2008; Camphuysen 2010).

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms

Lesser Black-backed Gulls were observed in all search areas for future wind farm development with the largest numbers in the large search area off the coast of Zuid- and Noord-Holland and the smallest numbers in the northern search areas. Lesser Black-backed Gulls were recorded at higher altitudes than other seabirds and tend to frequently exploit the altitudes within the rotor-swept zone.

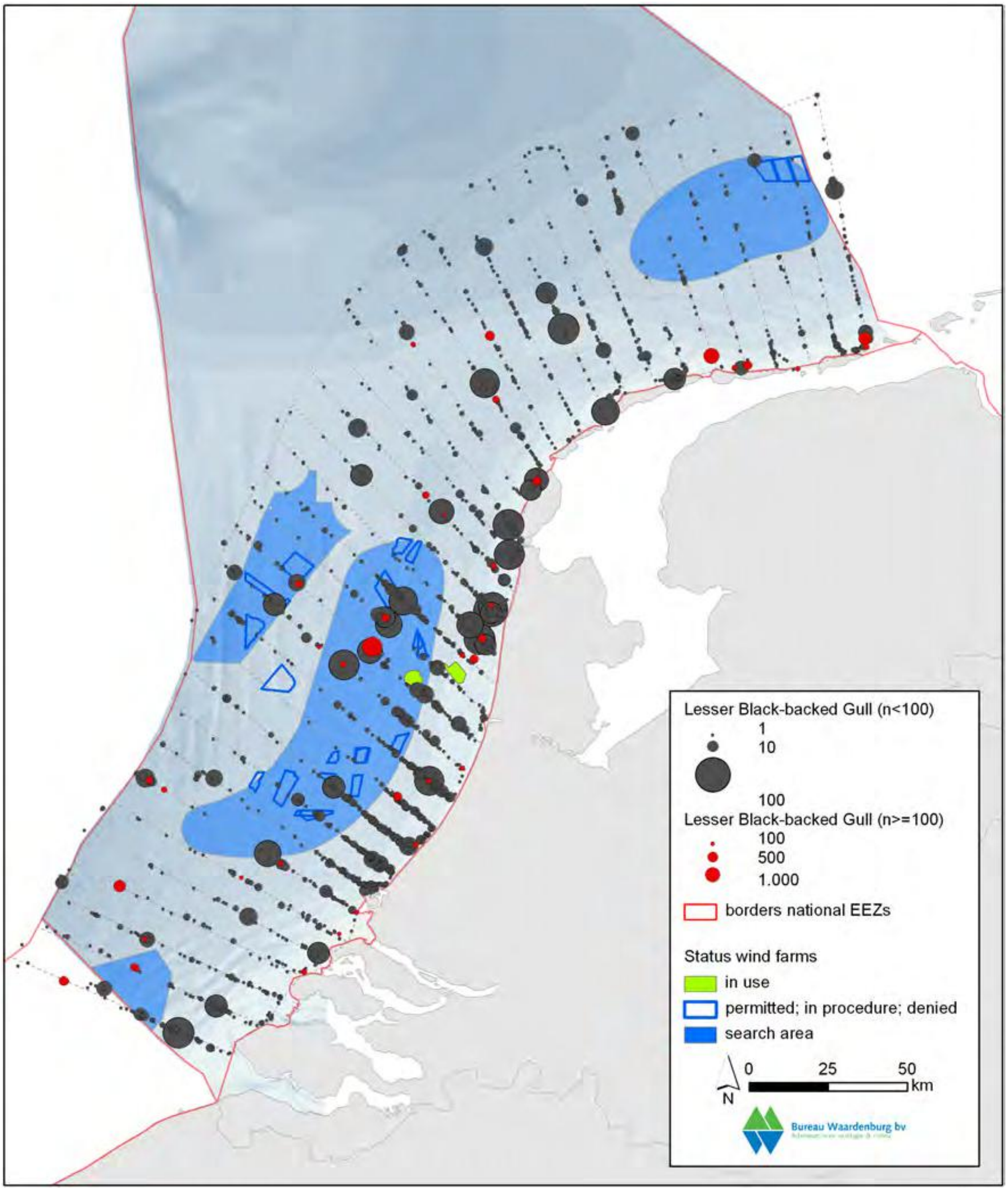


Figure 3.2.11.1 Cumulative distribution of Lesser Black-backed Gull observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).

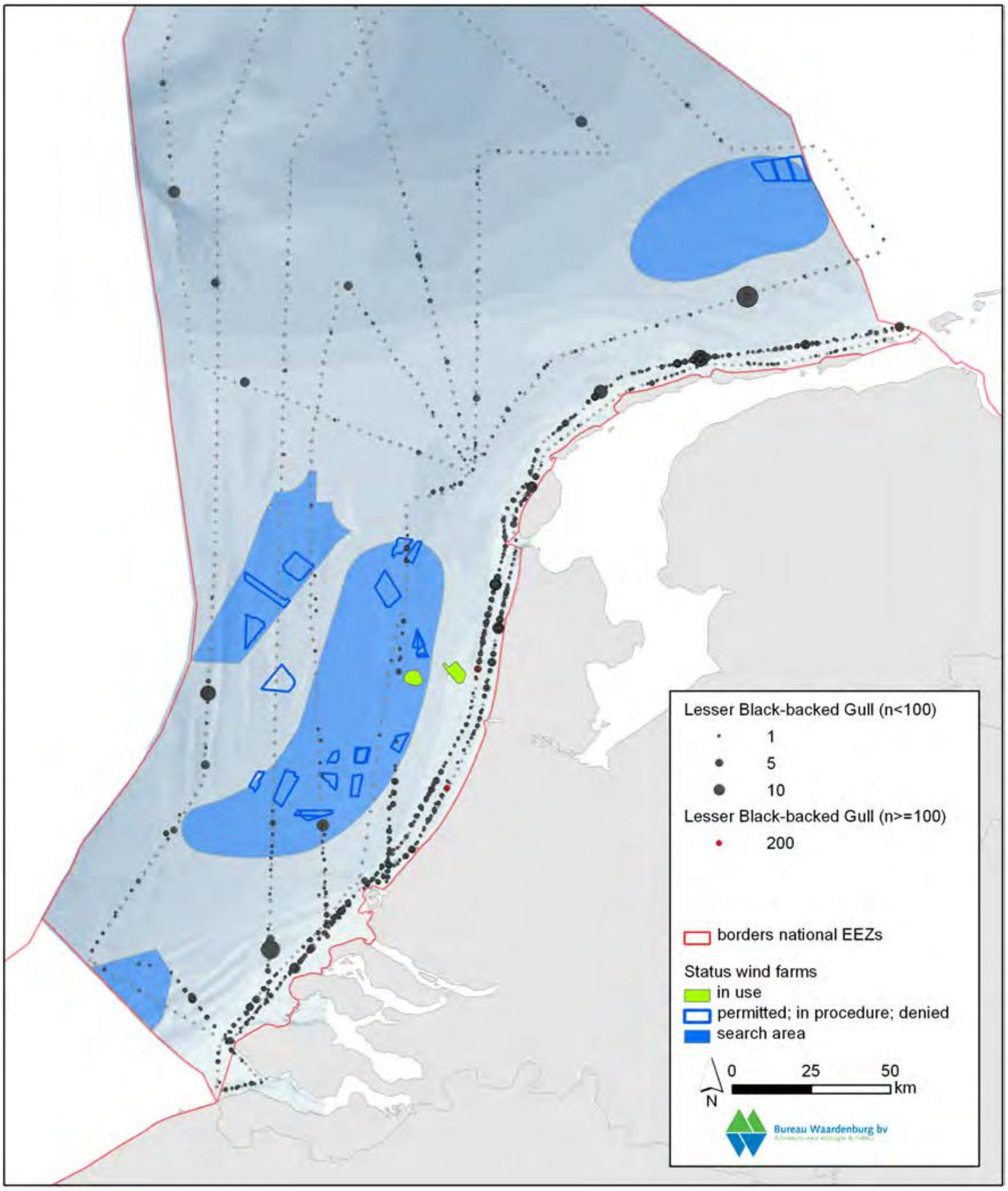


Figure 3.2.11.2 *Cumulative distribution of Lesser Black-backed Gull observed during the aerial-based survey of the MWTL monitoring (six surveys in the period April 2010 – March 2011).*

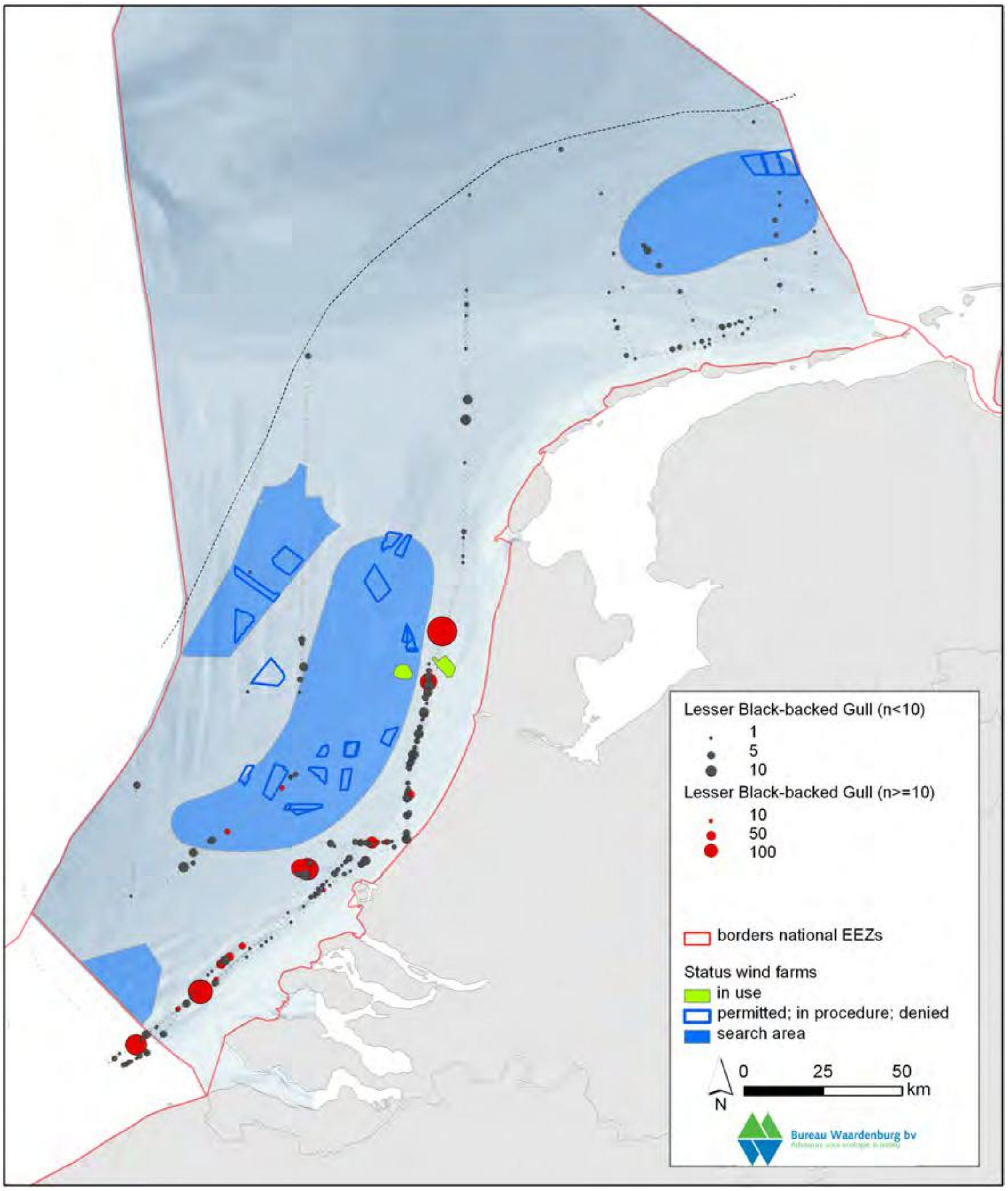


Figure 3.2.11.3 Cumulative distribution of Lesser Black-backed Gull observed during the ship-based survey monitoring Shortlist Masterplan project (surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).

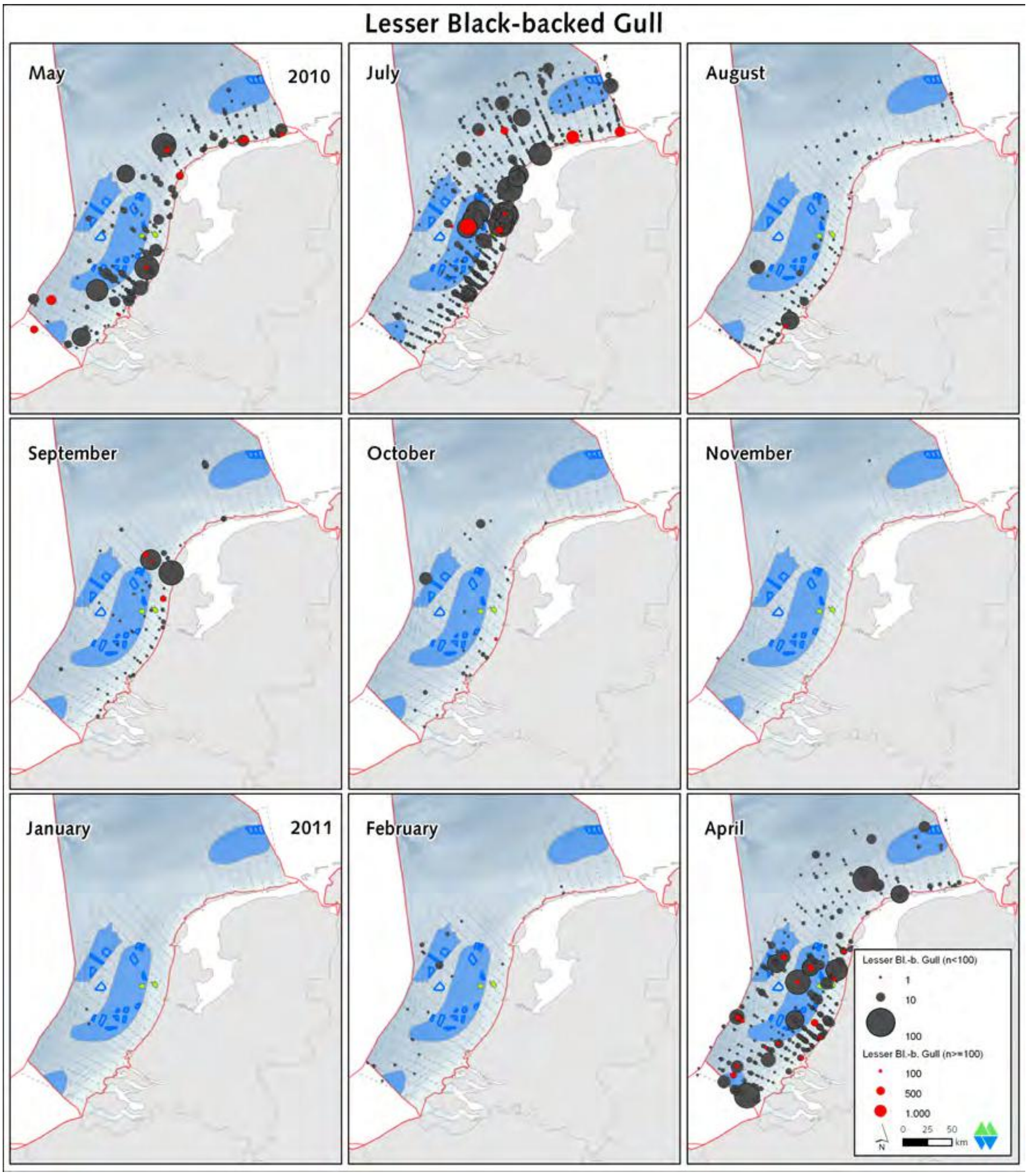


Figure 3.2.11.4 Distribution of Lesser Black-backed Gull observed during the aerial-based survey monitoring Shortlist Masterplan project per month (nine surveys in the period May 2010 – April 2011).

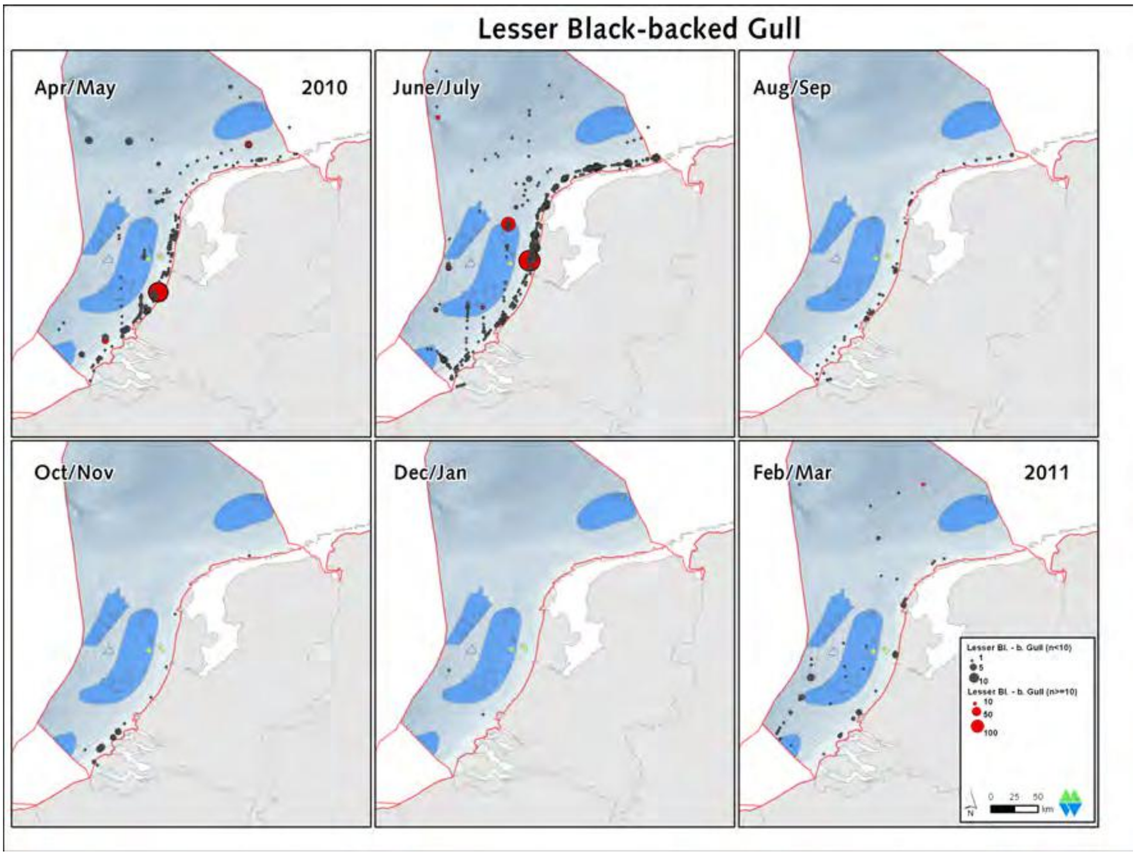


Figure 3.2.11.5 *Distribution of Lesser Black-backed Gull observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).*

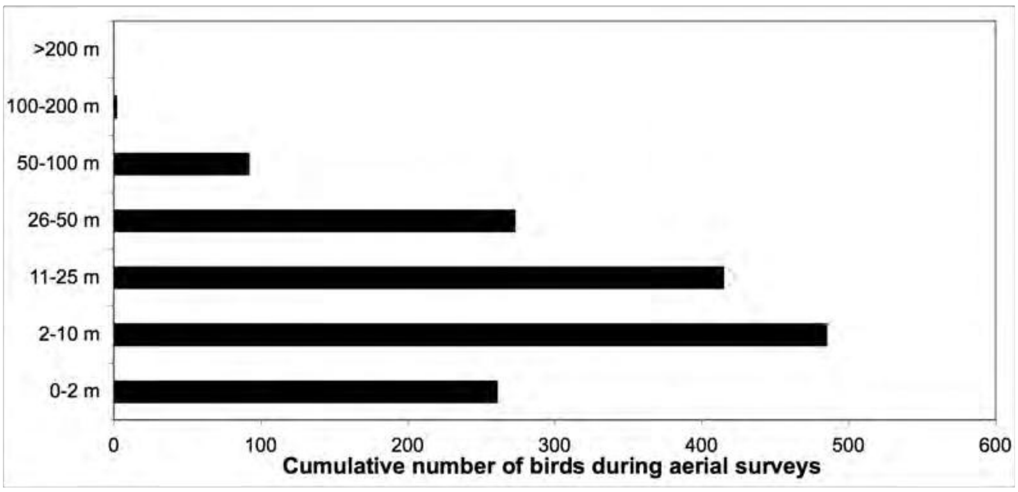


Figure 3.2.11.6 *Cumulative number of Lesser Black-backed Gull flying at different altitudes during the aerial-based survey monitoring Shortlist Masterplan project (nine surveys in the period May 2010 – April 2011, birds associated with ships excluded).*

3.2.12 European Herring Gull

Observations in this study

European Herring Gulls were observed throughout most of the study area although the largest numbers were found close to the coast (Figure 3.2.12.1). The highest concentrations of European Herring Gulls were along the Dutch coast between Zeeland and Noord-Holland and along the western Wadden Islands. Peak numbers were recorded during autumn (October and November) with large numbers also noted in January and May. European Herring Gulls were at their fewest during the August survey, coinciding with the period when most birds have left their breeding colonies (Figure 3.2.12.4).

Associations with other species, fronts or human activities

Fishing vessels did often attract groups of European Herring Gulls. European Herring Gulls were also attracted to platforms with groups often being observed resting close to or on top of offshore platforms.

Flight altitude

European Herring Gulls were common in all altitude bands up to 100 metres. Most birds were recorded in between two and 10 metres of altitude (Figure 3.2.12.6). During the aerial surveys of the shortlist program about 31% of all European Herring Gulls were flying above 25 metres above sea level (40% if birds associated with ships are excluded). This is slightly higher than the results of the ship-based surveys of the shortlist program and is probably due to the fact that the flight altitude was not recorded for a large amount of flying Herring Gulls during the aerial surveys. In particular, flight altitude is frequently not recorded for those birds associated with ships. As these birds are predominantly flying at relative low altitudes (<25 metres) the average flight altitude is overestimated.

Comparison with ship-based data

The distribution of European Herring Gulls during the ship-based surveys was in general similar to the patterns found during the aerial surveys, however, due to the location of transect lines and the limited number of transects close to the coast far fewer observations of this species were made during the ship-based surveys (Figure 3.2.12.3). Most birds were observed close to the coast of Zuid-Holland, although this is largely a reflection of where the transect lines passed close to the coast. Identification issues seem unlikely to have caused major differences between the two survey methods.

Comparison with MWTL data

The distribution patterns of European Herring Gulls during the MWTL and the Shortlist Masterplan aerial surveys were largely similar, both spatially and temporally. The largest numbers were found between October and November and the fewest in August and September (Figure 3.2.12.5). Most birds were confined to the coast, although concentrations were occasionally found further offshore, often associated with fishing vessels. For this species the difference of survey altitude and transect layout between the two types of aerial surveys is unlikely to have influenced the recorded distribution patterns.

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea

Over the last 20 years the Dutch breeding population has shown a slight decline with the 2007 breeding population estimated at between 40,000 and 49,000 pairs (Van Dijk *et al.* 2009; Boele *et al*. 2011). The breeding distribution is largely coastal with the most important breeding areas being the Wadden Islands, Saeftinghe, Maasvlakte, and Kop van Schouwen in the Delta (Strucker *et al.* 2005; Van Dijk *et al.* 2009; Strucker *et al.* 2011; Boele *et al*. 2011). The majority of birds forage up to 50 km from the colony with 100 km thought to be the maximum range for breeding birds (Ens *et al.* 2009). Camphuysen and Leopold (1994) suggest that most European Herring Gulls scavenging at trawls were found within 10 km of the coast and most foraging birds within five km. In recent years the numbers of European Herring Gulls foraging offshore has declined dramatically (Arts 2010). During the Shortlist Masterplan aerial surveys the coastal areas and those around colonies yielded the largest numbers of European Herring Gulls. European Herring Gulls are known to associate with fishing vessels and it has been suggested recently that the breeding success of this species is related to the availability of discards from the fishing industry (Camphuysen *et al.* 2008; Camphuysen 2010).

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms

European Herring Gulls were observed in many of the search areas for future wind farm development, with the largest numbers in the large search area off the coast of Zuid- and Noord-Holland and the smallest numbers in the northern search areas. Occurrence in these areas is more likely to be related to fishing activity than to specific characteristics of these areas. This species was recorded at higher altitudes than many other seabirds and apparently exploits the altitudes of the rotor-swept zone.

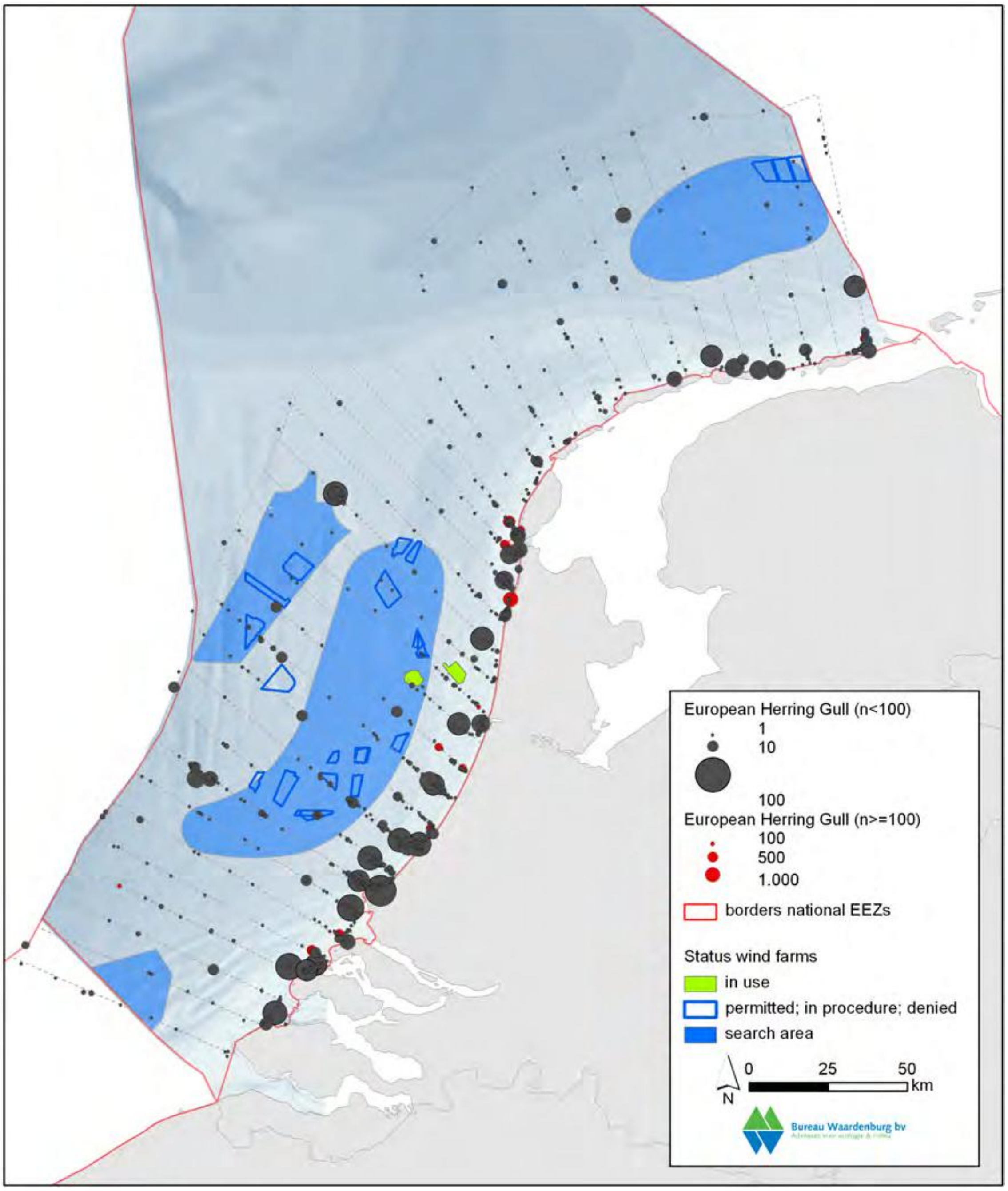


Figure 3.2.12.1 *Cumulative distribution of European Herring Gull observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).*

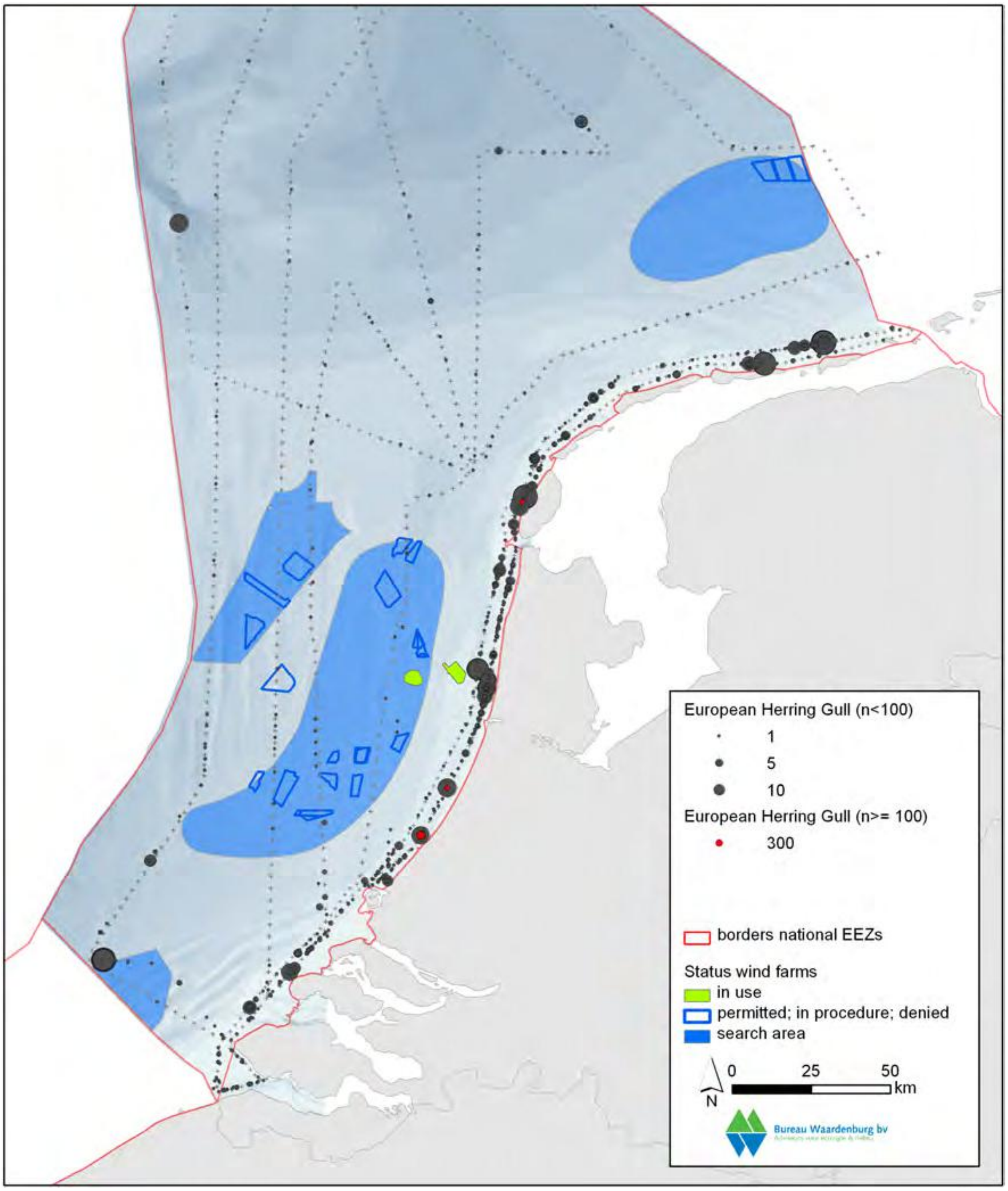


Figure 3.2.12.2 Cumulative distribution of European Herring Gull observed during the aerial-based survey of the MWTL monitoring (six surveys in the period April 2010 – March 2011).

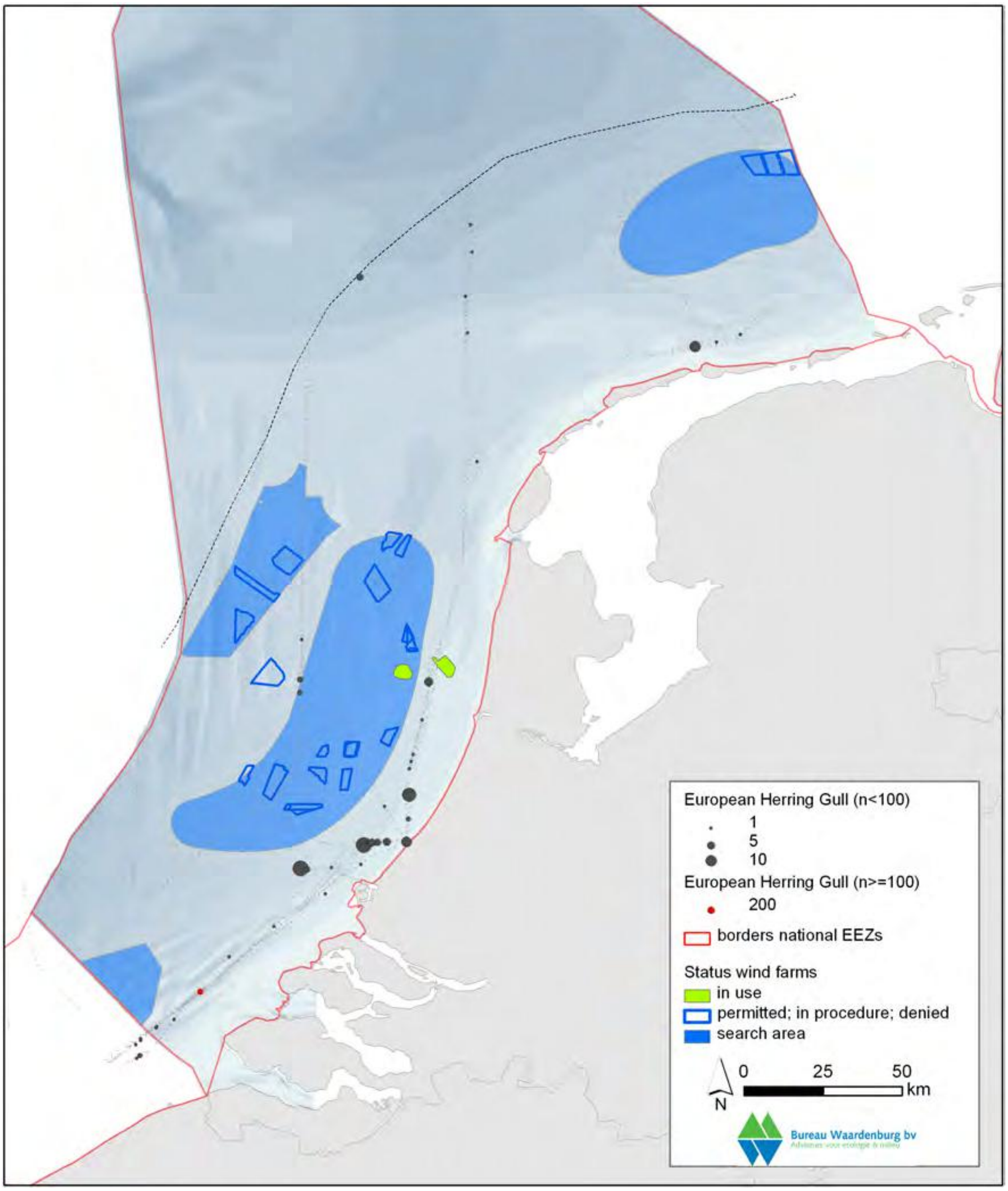


Figure 3.2.12.3 *Cumulative distribution of European Herring Gull observed during the ship-based survey monitoring Shortlist Masterplan project (surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).*

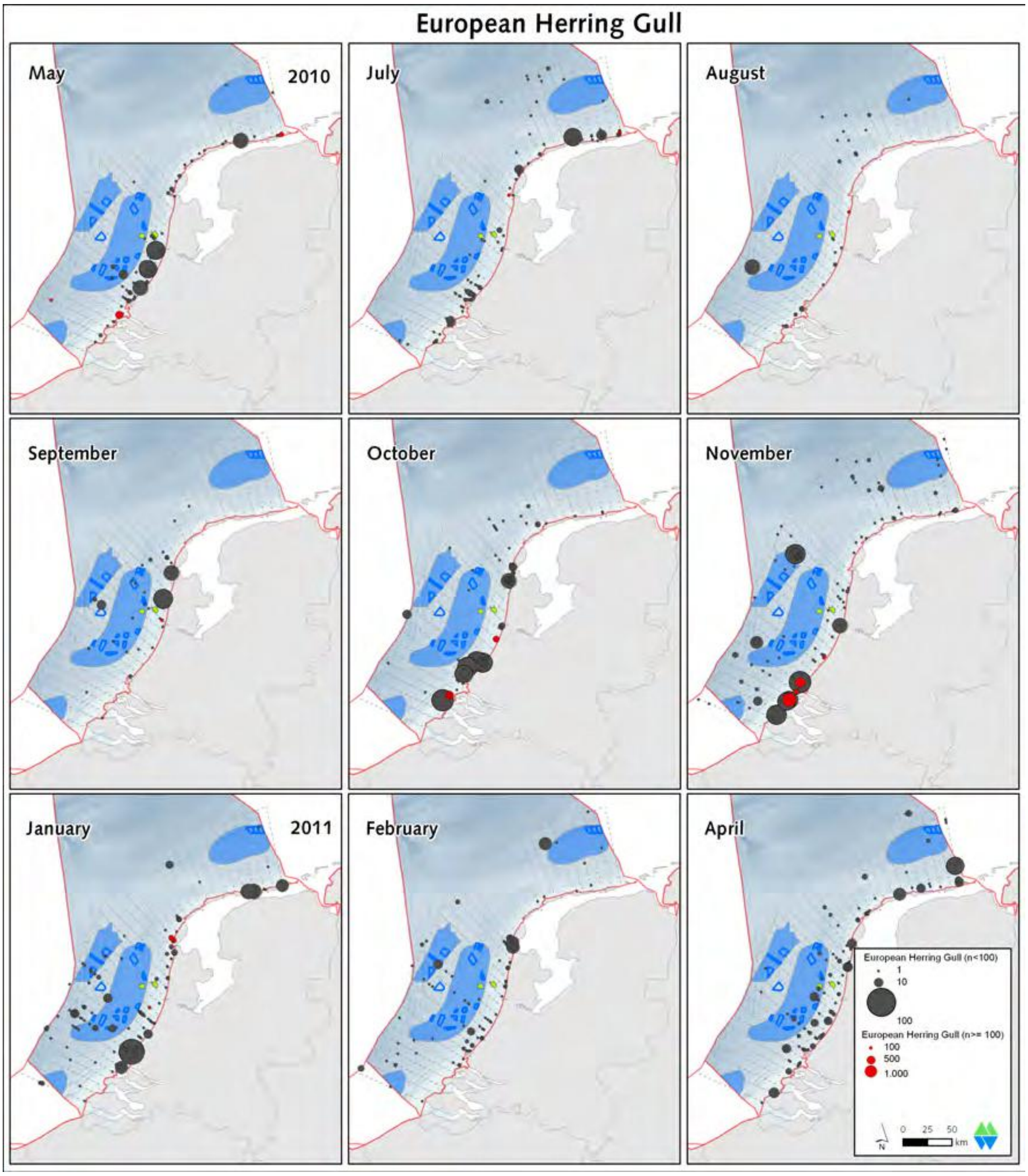


Figure 3.2.12.4 *Distribution of European Herring Gull observed during the aerial-based survey monitoring Shortlist Masterplan project per month (nine surveys in the period May 2010 – April 2011).*

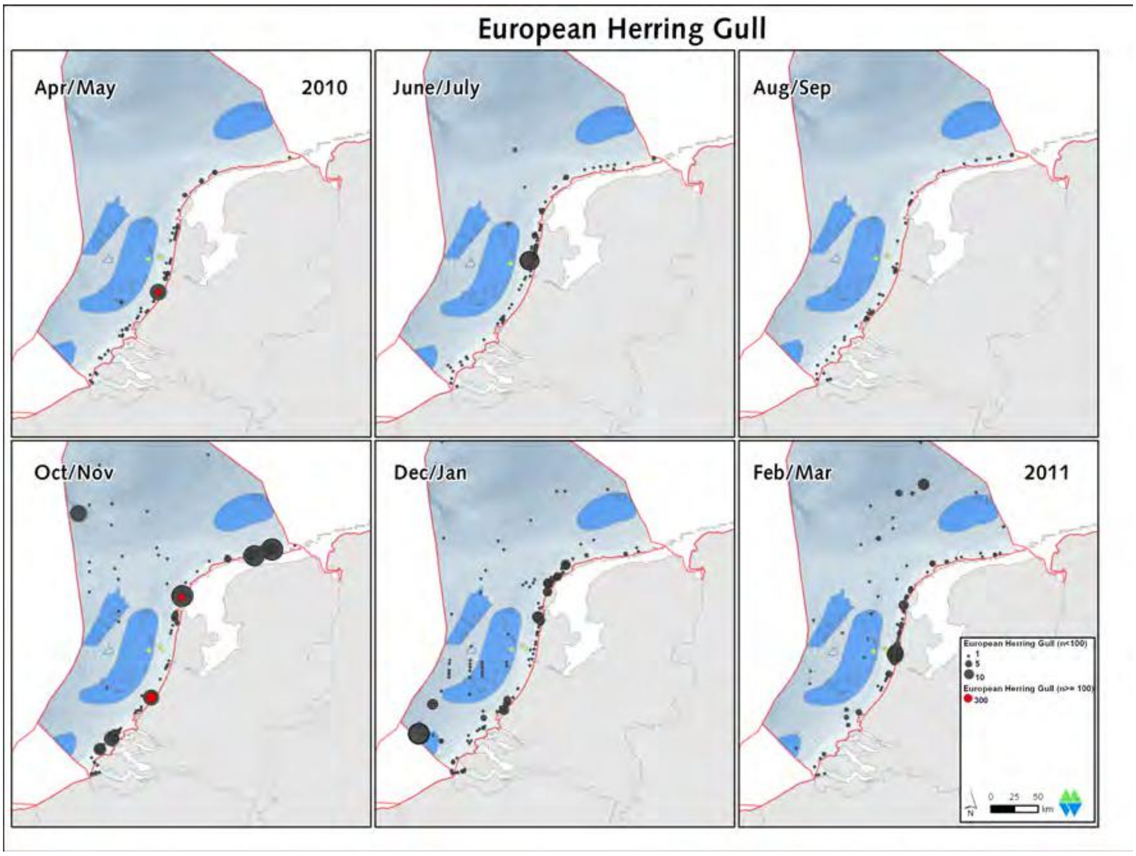


Figure 3.2.12.5 *Distribution of European Herring Gull observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).*

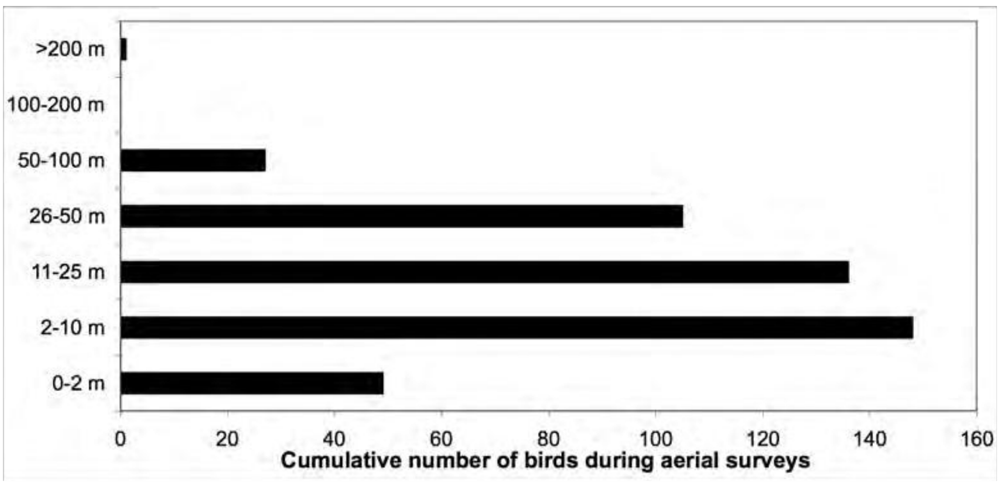


Figure 3.2.12.6 *Cumulative number of European Herring Gull flying at different altitudes during the aerial-based survey monitoring Shortlist Masterplan project (nine surveys in the period May 2010 – April 2011, birds associated with ships excluded).*

3.2.13 Great Black-backed Gull

Observations in this study

Great Black-backed Gulls are present in the Dutch North Sea in all months of the year, with peak numbers present in autumn (September-October). Birds occur individually or in small groups (up to 50 birds). In autumn, larger groups of up to 350 birds are recorded. Groups consisting of more than 50 birds are rare in winter and spring. Overall Great Black-backed Gulls show a rather widespread distribution with highest densities along the mainland coast of Noord-Holland and Zuid-Holland. Lowest densities are found north of the Wadden Islands. In January and February, distribution patterns shift towards the south and further offshore. Large groups are associated with fish trawlers and their distribution is therefore heavily influenced by the presence or absence of these vessels. Many Great Black-backed Gulls are searching for food at high altitudes (50 metres). Occasionally these higher-flying birds escape detection by the observer in the approaching aeroplane. As a consequence the number birds in strip A is likely to be underestimated. During windy weather conditions and high sea states more birds apparently rest on platforms. In these occasions numbers may be underestimated. Overall numbers are likely to be underestimated because of identification problems, a large number of juvenile or immature Great Black-backed Gulls are included within the cohort 'large gull'.

Associations with other species, fronts or human activities

Great Black-backed Gulls are often flying at relatively high altitudes scavenging for food (fish or dead animals), or looking for fishing vessels. Great Black-backed Gulls often also behave like birds of prey, hunting on weak birds (passerines, but also medium sized seabirds) flying at low altitudes (just above sea level). Great Black-backed Gulls resting on the water are sometimes associated with Guillemots where kleptoparasitism is possibly to occur.

Flight altitude

Great Black-backed Gulls were seen at all altitudes, although only a very few were recorded above 100 metres above sea level. The majority of birds were flying in between 26 and 50 metres above sea level (Figure 3.2.13.6). During the aerial surveys of the shortlist program 41% of all Great Black-backed Gulls were flying above 25 metres above sea level. When birds associated with ships are excluded almost all Great Black-backed gulls (97%) are flying above 25 metres above sea level. Compared with the results of the ship-based surveys of the shortlist program this is remarkably higher. This is probably due to the fact that the flight altitude is not recorded for a large amount of birds being associated with ships. As these birds are predominantly flying at relative low altitudes (<25 metres) the average flight altitude is overestimated.

Comparison with ship-based data

Similar to the results in the European Herring Gull the distribution of the Great Black-backed Gulls during the ship-based surveys in general fits in the patterns found during the aerial surveys, however, due to the location of transect lines and the limited number of transects close to the coast far fewer observations of this species were made during the ship-based surveys (Figure 3.2.13.3). Most birds were observed close to the coast of Zuid-Holland, although this might be largely a reflection of where the transect lines passed close to the coast. Identification issues seem unlikely to have caused major differences between the two survey methods.

Comparison with MWTL data
The results of the MWTL monitoring differ from the aerial surveys of the shortlist program. First, the distribution pattern derived from MWTL show only the high densities near shore, but does not show the wide occurrence further offshore. This is due to the survey design with transects parallel to the coast and a lower density of transects further from the coast. Moreover the results of MWTL show smaller numbers. This is due to the methodology, which focuses on a narrow strip nearby the aeroplane. Groups behind fishing vessels at larger distances are not recorded.

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea
In the Dutch North Sea zone, Great Black-backed Gulls occur predominantly as a non-breeding species and mainly are present between August and May (Camphuysen & Leopold 1994). Peak numbers occur during autumn (as shown during the shortlist program) when up to 60,000-90,000 were estimated to be in the region (Bijlsma *et al.* 2001).

The origin of the Dutch wintering population at sea consists of birds coming from a very wide range of northern breeding areas, covering mainly the coasts of Scandinavia and northern Russia. This breeding population consist of a total of more than 300,000 breeding pairs.

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms
Given the widespread distribution of the Great Black-backed Gulls in the Dutch North Sea the species occur in the search areas for wind farms as well. The search areas for wind farms were frequently used by foraging Great Black-backed Gulls in the period from autumn (late summer) until early spring. This species was recorded at higher altitudes than many other seabirds and exploits the altitudes of the rotor-swept zone.

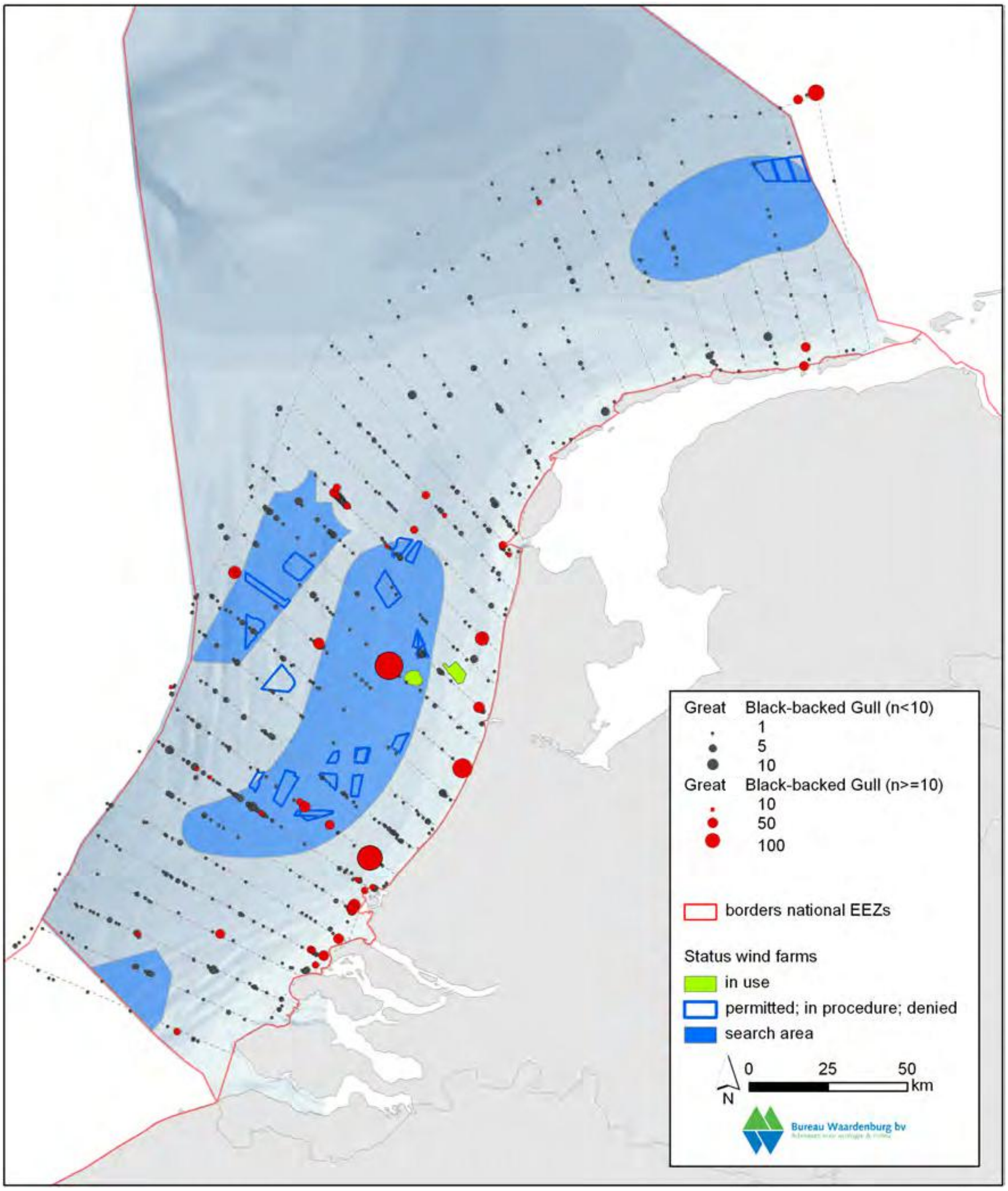


Figure 3.2.13.1 Cumulative distribution of Great Black-backed Gull observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).

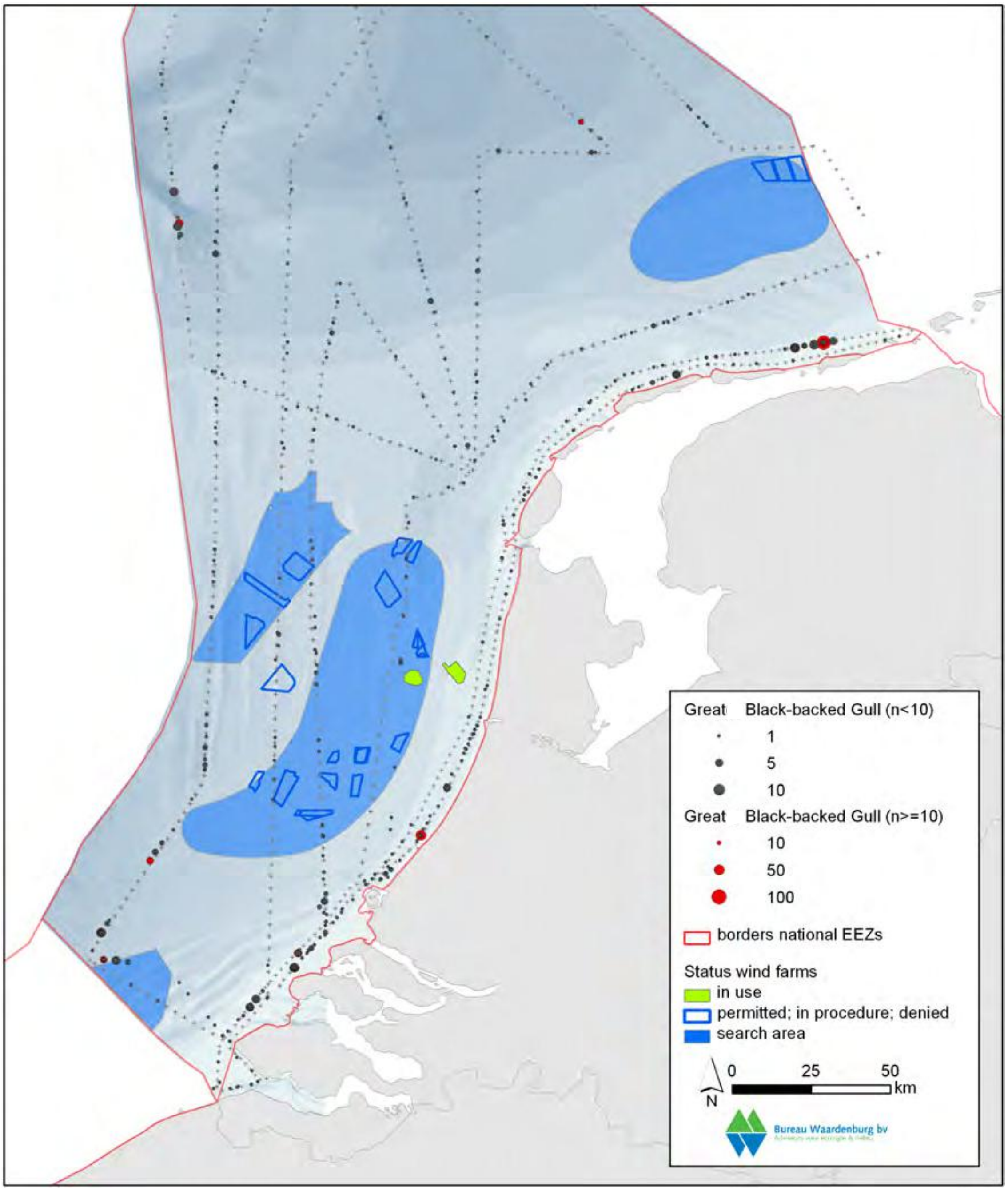


Figure 3.2.13.2 *Distribution of Great Black-backed Gull observed during the aerial-based survey of the MWTL monitoring (six surveys in the period April 2010 – March 2011).*

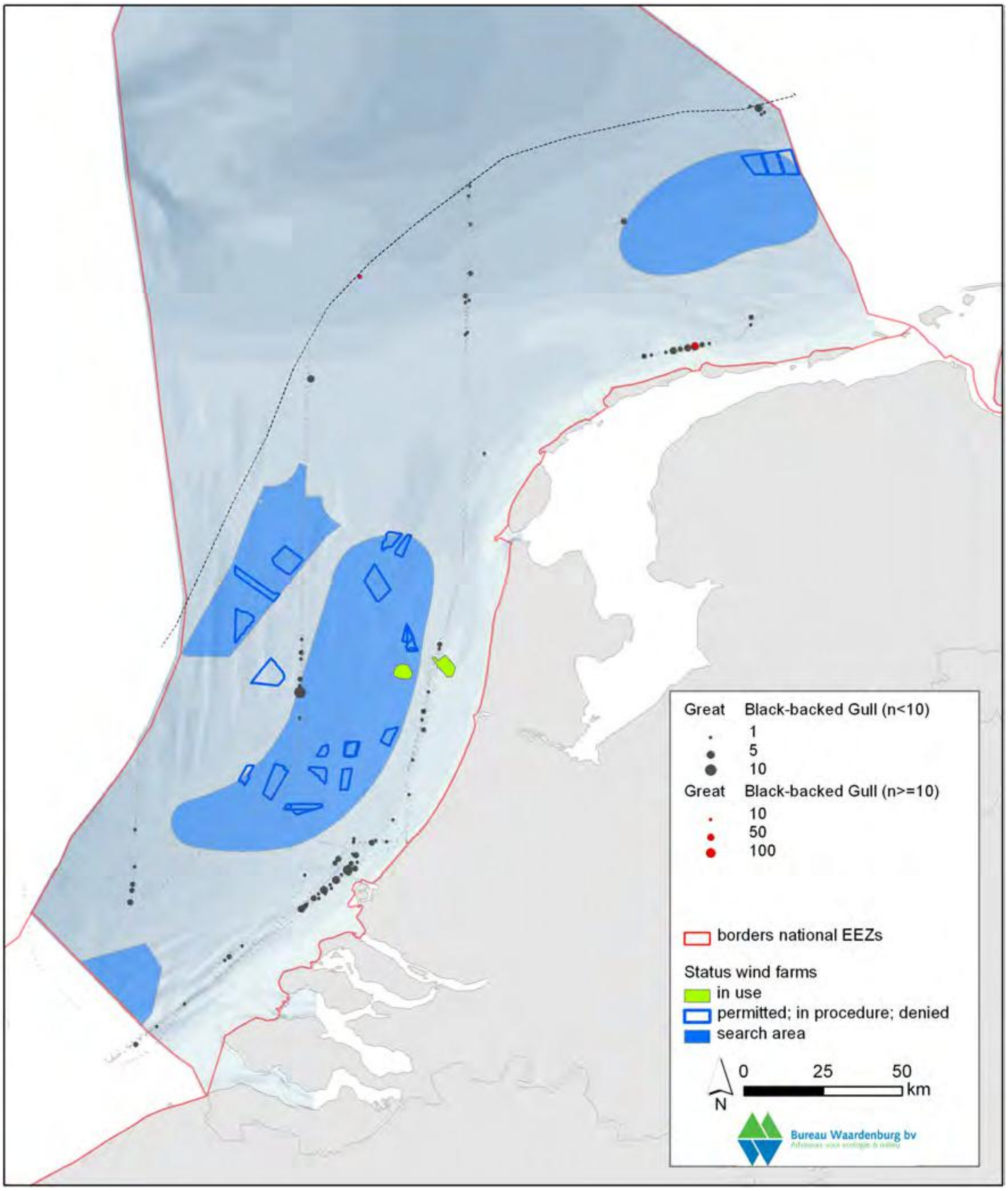


Figure 3.2.13.3 Cumulative distribution of Great Black-backed Gull observed during the ship-based survey monitoring Shortlist Masterplan project (surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).

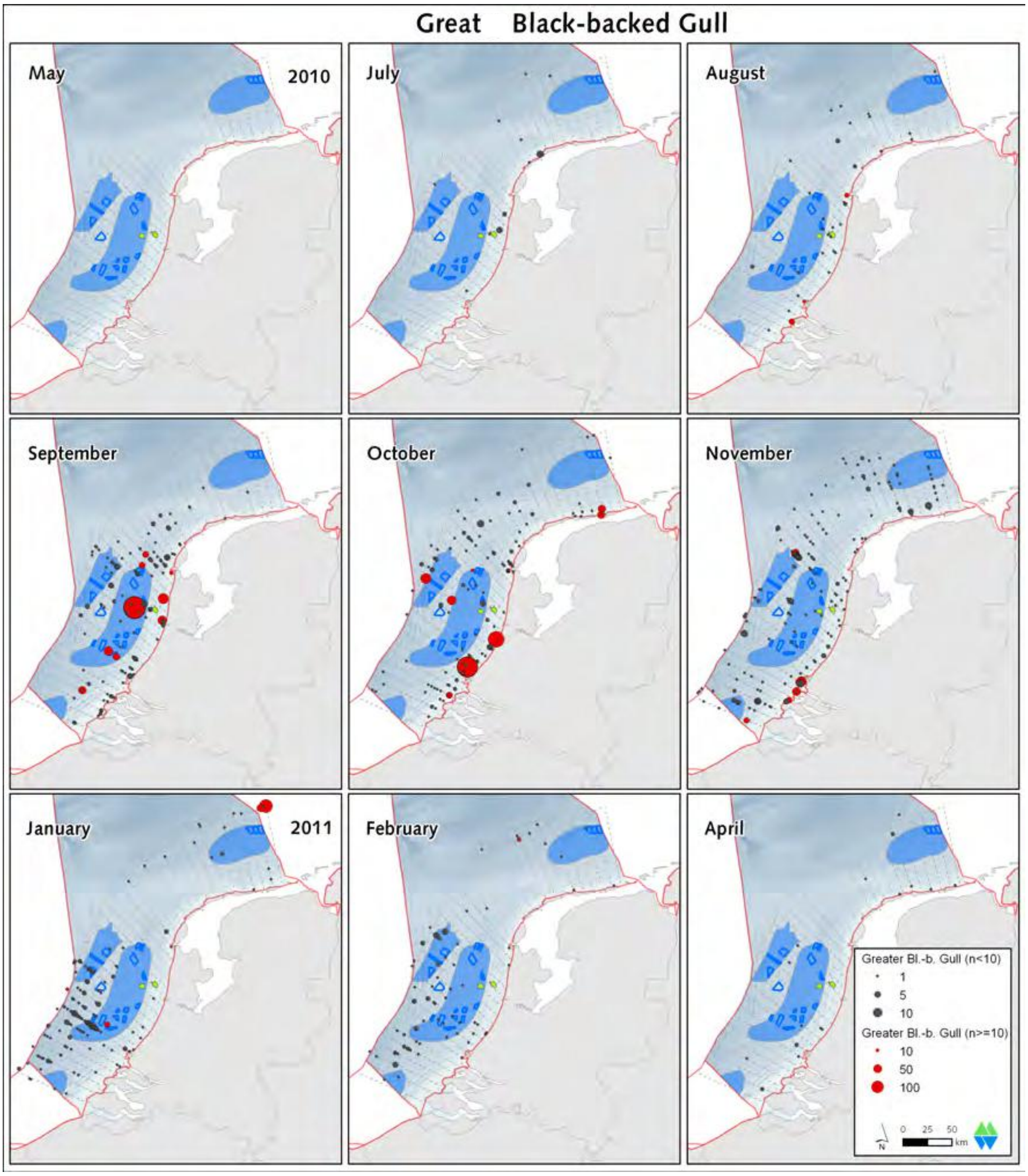


Figure 3.2.13.4 *Distribution of Great Black-backed Gull observed during the aerial-based survey monitoring Shortlist Masterplan project per month (nine surveys in the period May 2010 – April 2011).*

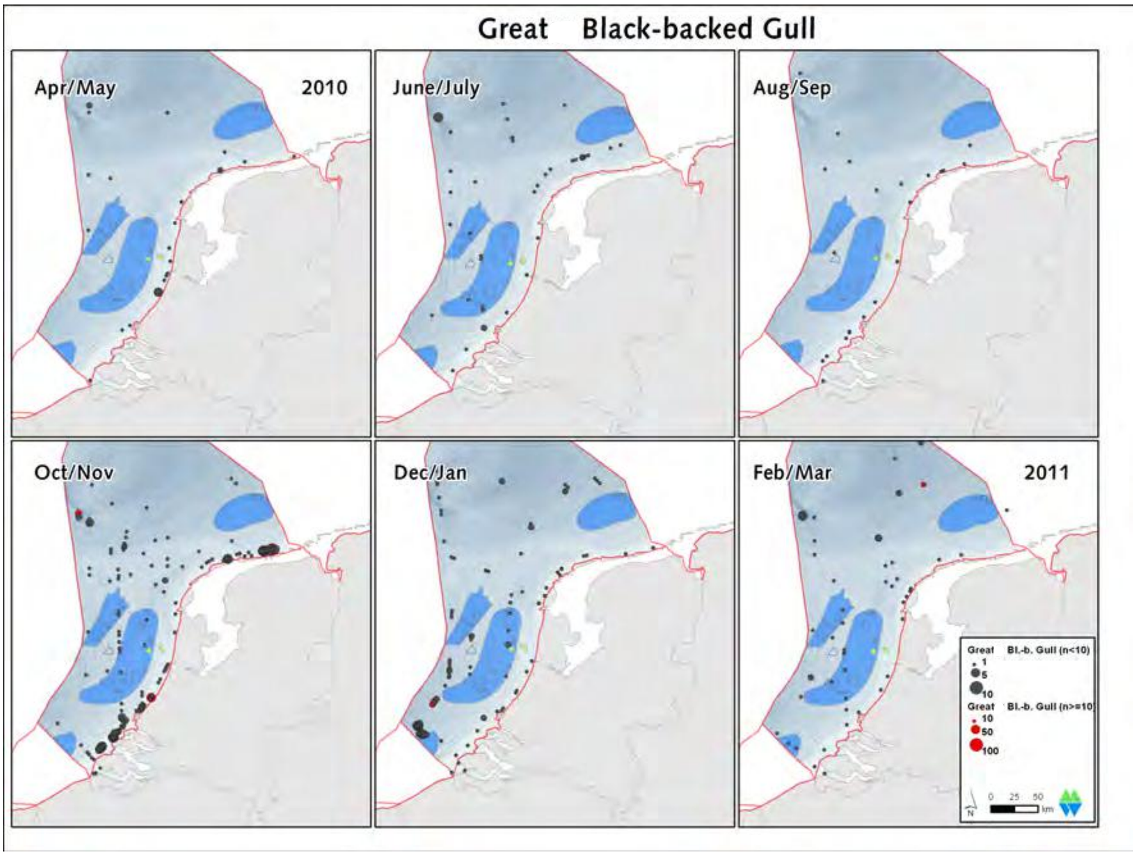


Figure 3.2.13.5 *Distribution of Great Black-backed Gull observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).*

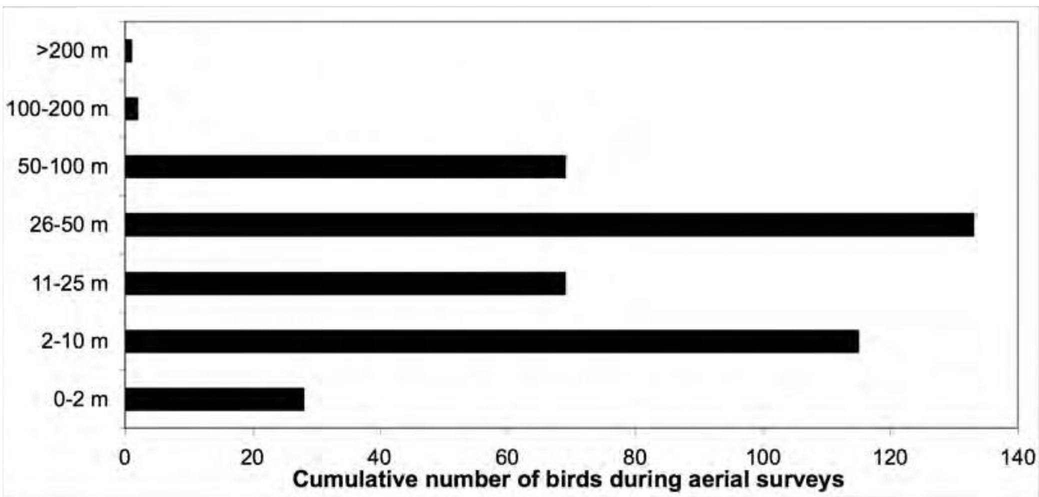


Figure 3.2.13.6 *Cumulative number of Great Black-backed Gull flying at different altitudes during the aerial-based survey monitoring Shortlist Masterplan project (nine surveys in the period May 2010 – April 2011, birds associated with ships excluded).*

3.2.14 'Large gulls' (Unidentified large gulls, Common, Lesser Black-backed, Herring and Great Black-backed Gulls combined)

Observations in this study

'Large gulls' were observed year-round and throughout the study area. There can be several reasons why some gulls sometimes have to be recorded as 'large gulls'. Firstly, large gulls that cannot be identified to the species level due to observation difficulties. Secondly, gulls that fly far from the aeroplane can be detected, but cannot always be identified to the species level. Thirdly, large groups of gulls cannot always be properly identified to the species level. The latter generally occurs on or near shores and sand banks and locations in the vicinity of fishing vessels.

The general distribution shows that highest densities of 'large gulls' were observed near the western shores of the Dutch coast. The distribution further offshore is generally scattered in low densities with occasionally some aggregations with large numbers of birds. No obvious patterns related to seasonal migration can be detected. This can be the result of differences in migration strategies between species. Low densities of 'large gulls' to the northwest of Texel may be related to high densities of platforms in this area. It should be further investigated if this relationship exists and whether this can be attributed to avoidance from or attraction to platforms. Since most of the platforms are located far from the transect routes this could not be determined from the survey data.

'Large gulls' are generally easily detected. During severe weather conditions and rough sea states, observation issues play a role, particularly in the detection of gulls sitting on the water.

Associations with other species, fronts or human activities

'Large gulls' are frequently associated with ships, particularly fishing vessels. This was regularly observed during the Shortlist Masterplan surveys. This behaviour accounts for most of the observed aggregations of 'large gulls' further offshore. These results correspond well with data regarding the importance of commercial fishing for Herring Gull and Lesser Black-backed Gull (Camphuysen *et al.* 2008).

Flight altitude

The observed flight altitude of large gulls ranged from category sea level up to 100-200 metres (Figure 3.2.14.6). The majority of large gulls were flying between two and 25 metres above sea level. About 19% of all flying birds flew above 25 metres above sea level (46% if birds associated with ships are excluded). The relatively large numbers of 'large gulls' is probably dominated by the appearance of unidentified large gulls. The identified large gulls (Lesser Black-backed Gull, Great Black-backed Gull and European Herring Gull) are more abundant at higher altitudes (10-25 metres above sea level).

Only very few large gulls were flying above 100 metres. Since these high altitudes are above the height of the aeroplane and above the observers it cannot be ruled out that birds above this height were not detected.

Comparison with ship-based data

The general pattern of higher densities near the coast and lower densities offshore is similar to the results of the Shortlist Masterplan surveys. The frequency of encounters with fishing vessels is generally lower during ship-based surveys due to the lower effort. This also explains the lower frequencies in observed gull aggregations further offshore.

Comparison with MWTL data

The general pattern of higher densities near the coast and lower densities offshore is again similar to the results of the Shortlist Masterplan surveys. The quantity of large concentrations is lower, but higher in comparison to the ship-based data, but this is related to the observation effort. The data provided by the shortlist Masterplan aerial surveys gives a more detailed overview of the spatial distribution of large gulls throughout the research area.

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea

'Large gulls' are very common to abundant throughout the year. As 'large gulls' is a mixed species group no information as to the proportions of each species within different seasons is available and therefore, details about the distribution throughout the year are of limited value.

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms

This study provides detailed information about the distribution patterns of 'large gulls' throughout the entire research area. This is only partially true for the MWLT survey data and limited in the ship-based survey data. Based on this study the distribution of 'large gulls' in search areas for new offshore wind farms was occasionally high in the northern part of 'Hollandse kust' and the eastern part of 'Borssele'. 'Large gulls' were present in relatively small numbers or even absent in the search areas for new offshore wind farms, particularly south of 'Hollandse kust', west of 'Borssele' and the 'Waddensea'. In general, the search areas for wind farms are not of particular importance for 'large gulls' (Figure 3.2.14.1).

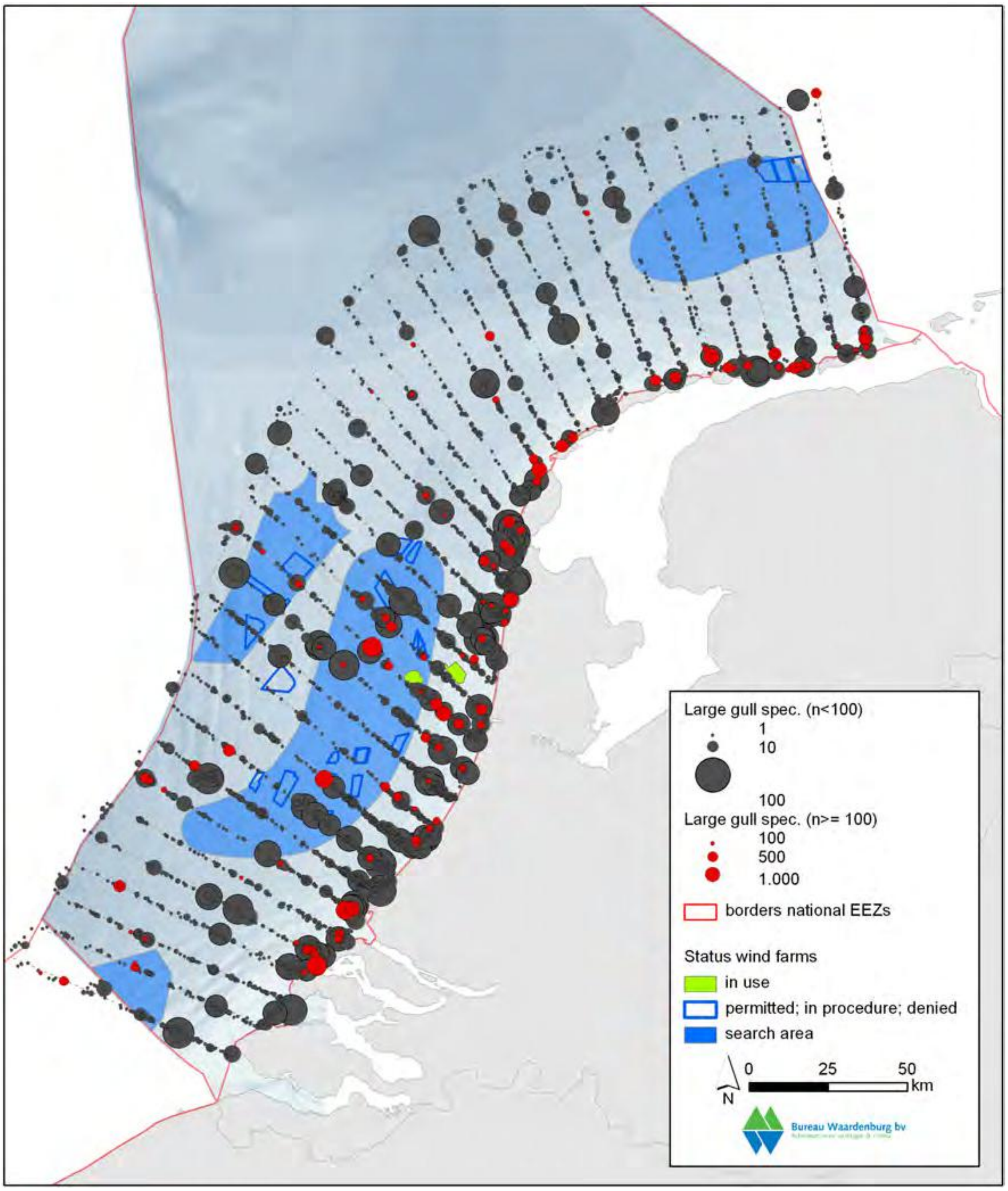


Figure 3.2.14.1 Cumulative distribution of the species group 'large gulls' observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).

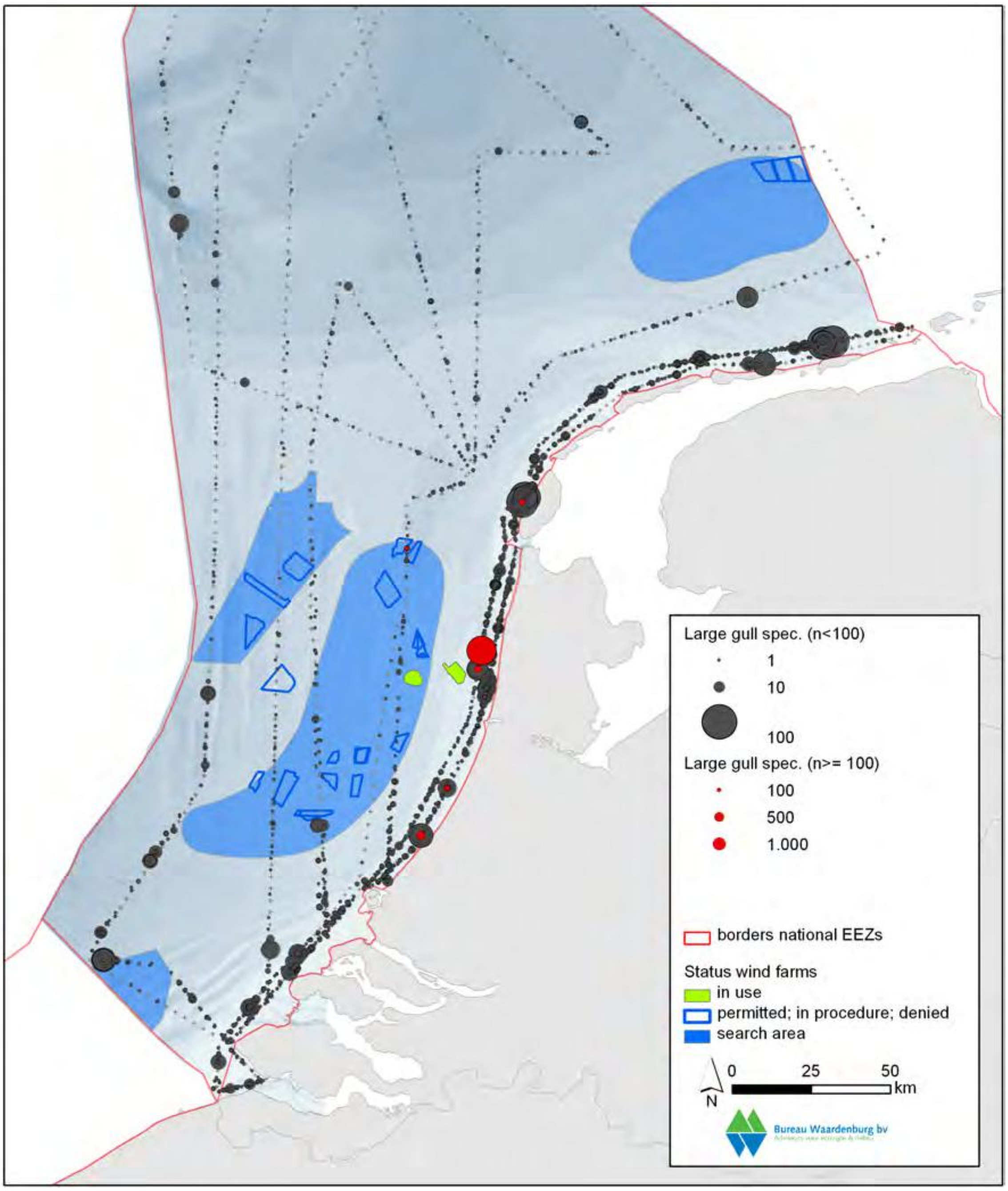


Figure 3.2.14.2 *Cumulative distribution of the species group 'large gulls' observed during the aerial-based survey of the MWTL monitoring (six surveys in the period April 2010 – March 2011).*

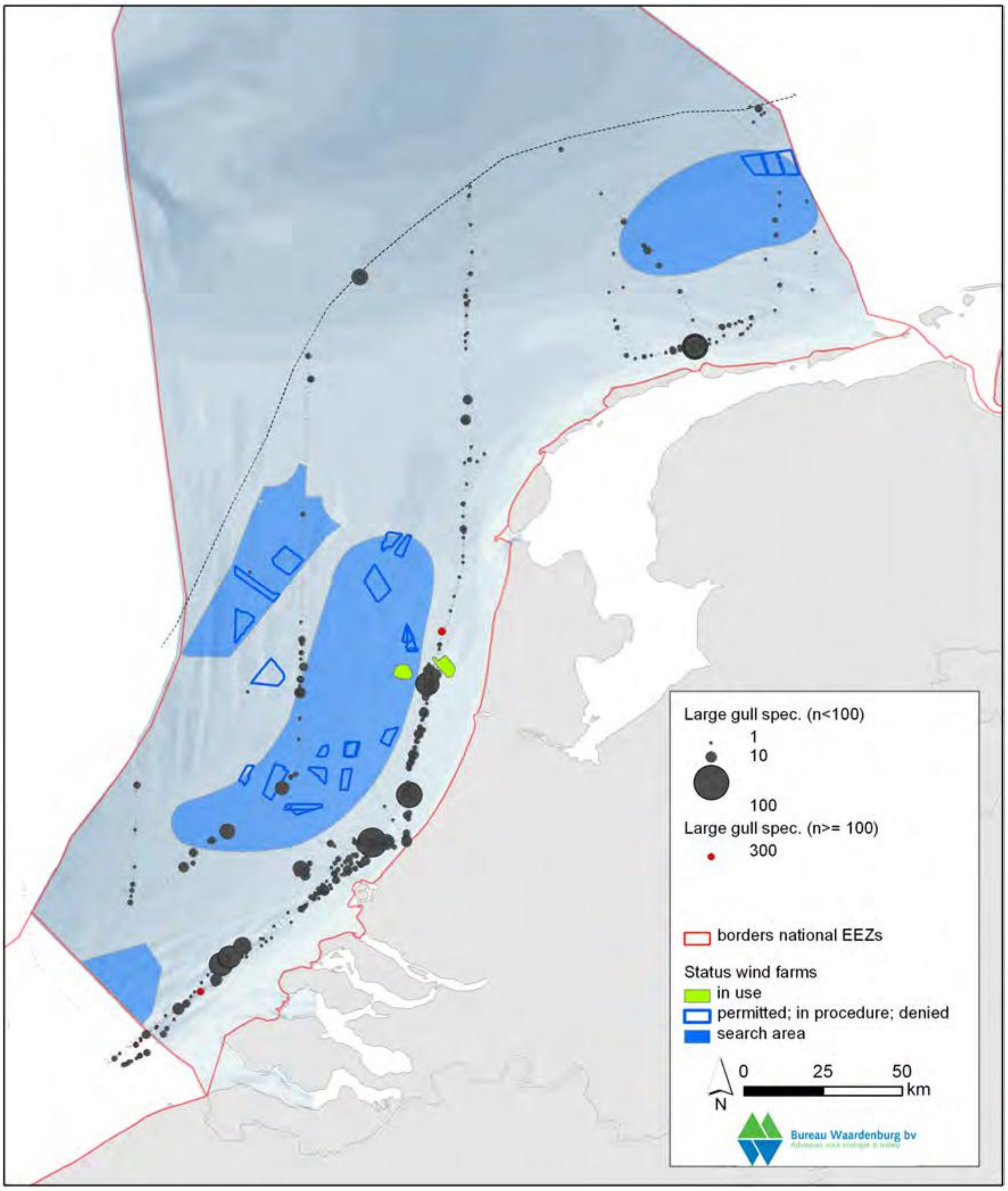


Figure 3.2.14.3 *Cumulative distribution of the species group 'large gulls' observed during the ship-based survey monitoring Shortlist Masterplan project (surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).*

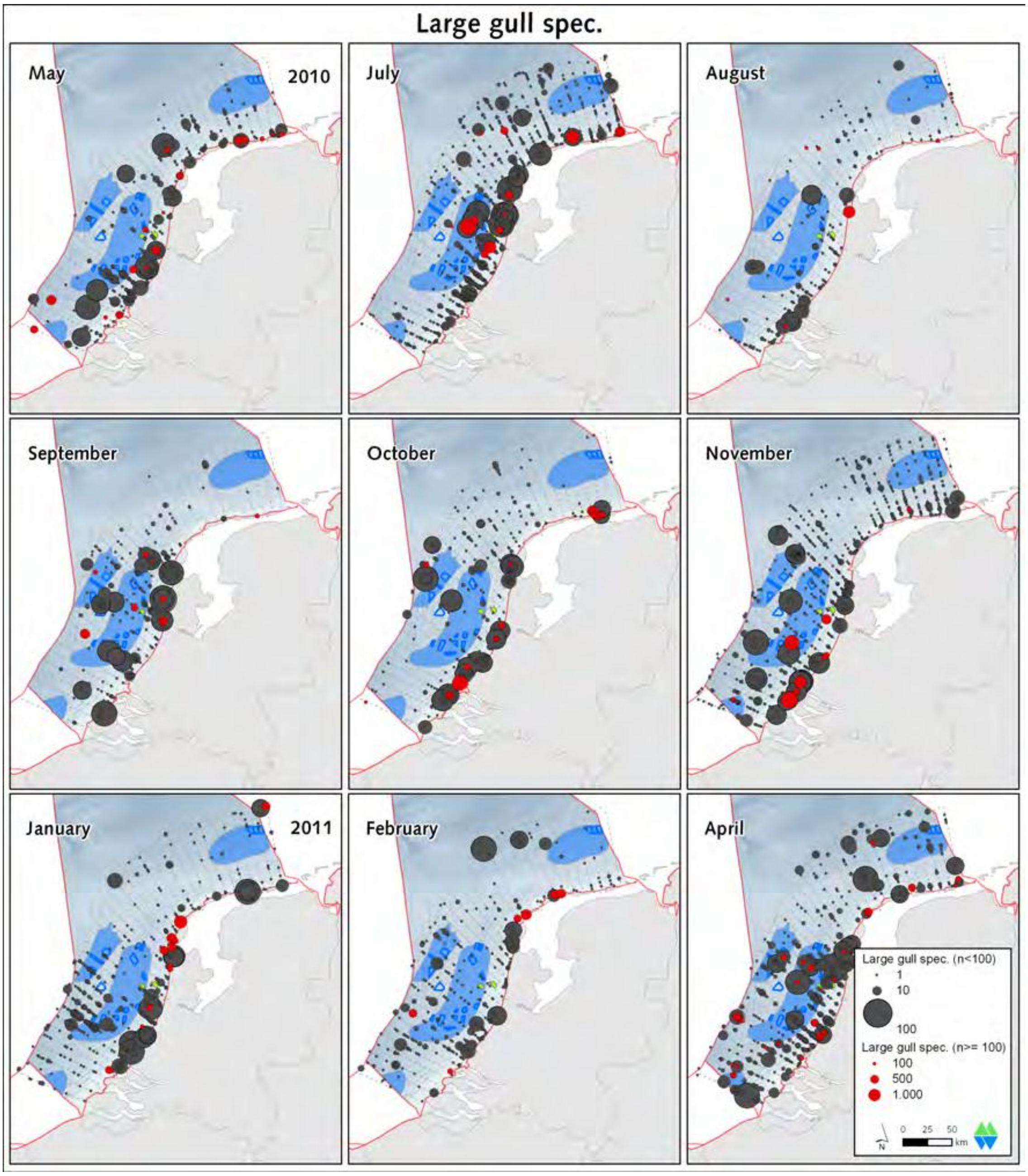


Figure 3.2.14.4 *Distribution of the species group 'large gulls' observed during the aerial-based survey monitoring Shortlist Masterplan project per month (nine surveys in the period May 2010 – April 2011).*

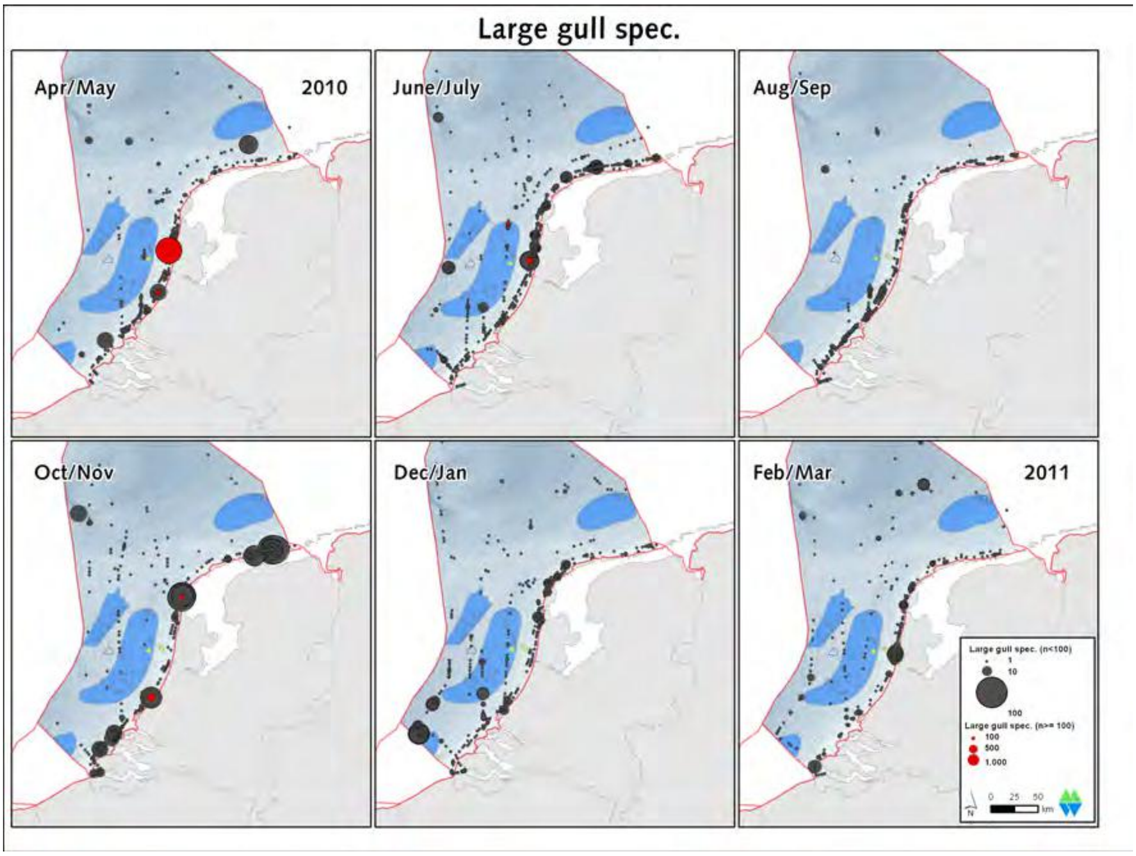


Figure 3.2.14.5 *Distribution of the species group 'large gulls' observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).*

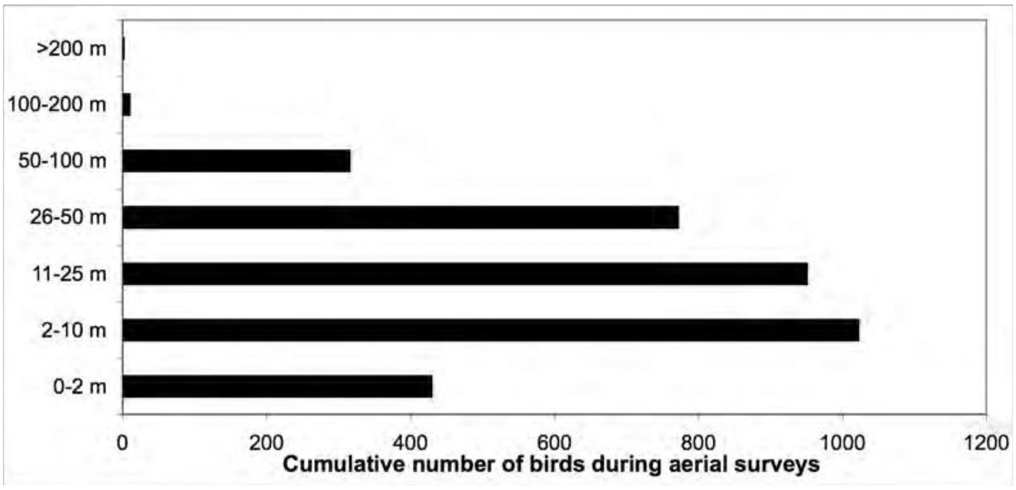


Figure 3.2.14.6 *Cumulative number of the species group 'large gulls' flying at different altitudes during the aerial-based survey monitoring Shortlist Masterplan project (nine surveys in the period May 2010 – April 2011, birds associated with ships excluded).*

3.2.15 Sandwich Tern

Observations in this study

The largest numbers of Sandwich Terns were recorded between April and August with fewer in September (Figure 3.2.15.4). Sightings outside of this period were rare. The highest concentrations were found along the coasts of the Wadden Islands, particularly Schiermonnikoog/Ameland, Terschelling and Texel, Noord-Holland and Zeeland (Figure 3.2.15.1), which corresponds with many of the main breeding colonies. Sandwich Terns were found throughout much of the study area, although notably higher concentrations were found closer to the coast, particularly during the breeding season. In Zeeland, most birds were found within 20 km of the coast whereas north of the Wadden Islands numbers remained fairly high up to 40 and even 50 km from the coast. During April and August, Sandwich Terns were fairly frequently recorded far offshore and these records are likely to refer largely to migratory movements.

Associations with other species, fronts or human activities

During the migration periods when the species occurs further offshore Sandwich Terns frequently make us of human structures, particularly smaller structures such as buoys and other floating objects (debris), and close to the coast they make use of sand banks on which to rest.

Flight altitude

Sandwich Terns were recorded flying at low altitudes, with the largest numbers between two and 10 metres above sea level (Figure 3.2.15.6). Only 7% of all flying birds were flying above 25 metres above sea level and no Sandwich Terns were recorded above 100 metres above sea level. The distribution pattern of Sandwich Terns corresponds with the results of the ship-based surveys. Overall, Sandwich Terns fly higher than both Common and Arctic Terns.

Comparison with ship-based data

Ship-based surveys recorded very few Sandwich Terns in comparison with the aerial surveys. Although this is likely to be largely due to the locations of the transects of the ship-based surveys, with relatively few close to the coast, an absence of records further offshore is apparent. This may be partly explained by the timing of surveys, with Sandwich Terns being present further offshore for a relatively restricted period within the year (mainly April and September). Another reason could be that further offshore with relatively low densities the flying terns are proportionally more missed by ship-based observers.

Comparison with MWTL data

The MWTL data clearly shows similar distributions of Sandwich Terns to the aerial Shortlist Masterplan surveys, with birds largely aggregated close to the coasts but also with occasional records further offshore, however, it is clear that the relationship with distance to coast is clearer with the transect layout of the aerial Shortlist Masterplan surveys. The vast majority of offshore records were in April and September with fewer sightings further offshore in June and July.

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea

Although Sandwich Terns are a fairly abundant breeding bird in the Netherlands, with around 19,000 pairs in recent years, they are restricted to a small number of colonies in the Wadden Sea and the Delta areasareas (Boele *et. al.* 2011, Strucker *et al.* 2011). The relative importance of each of the breeding areas, almost three-quarters breed in the Wadden Sea, was clear from the aerial surveys, although obviously the colony at Griend was outside of the study area. During the breeding season, Sandwich Terns can forage up to 30 to 45 km from the colony. Most birds however forage much closer to the colony with numbers at 5-10 km from the colony being half of those within five km of the colony (Garthe & Flore 2007). Again this pattern was evident from the aerial survey data. According many sources, such as Camphuysen & Leopold (1994), relatively few Sandwich Terns occur offshore and in particular they remain close to the breeding colonies (Camphuysen & Leopold 1994). This held true for surveys during the core breeding season but during the migration period, the aerial Shortlist Masterplan surveys revealed that many Sandwich Terns were present further offshore.

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms

Remarkably, Sandwich Terns were found in most of the search areas for wind farm development, however, their far offshore occurrence was only noted within a restricted period, most notably in April and August.

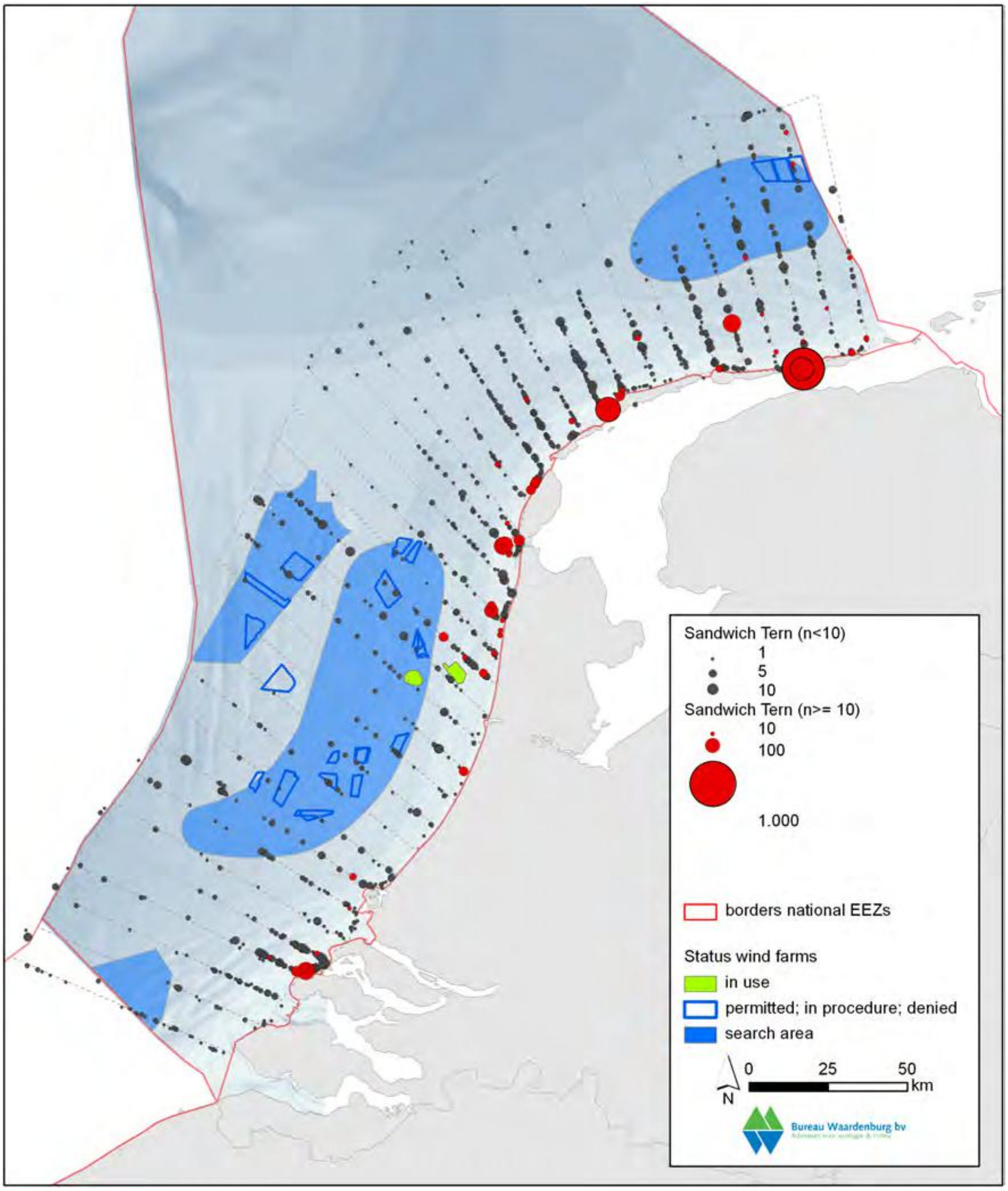


Figure 3.2.15.1 Cumulative distribution of Sandwich Tern observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).

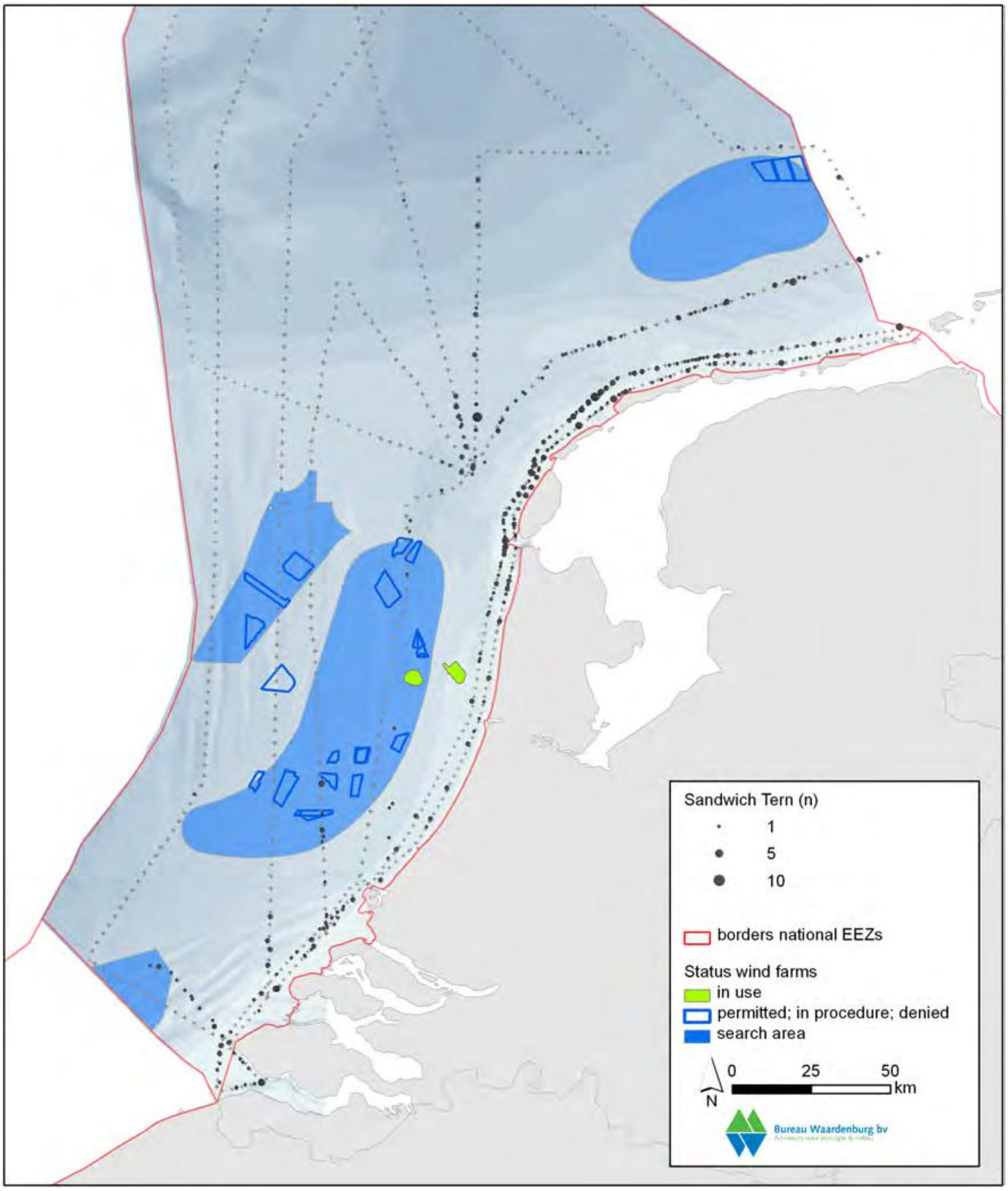


Figure 3.2.15.2 Cumulative distribution of Sandwich Tern observed during the aerial-based survey of the MWTL monitoring (six surveys in the period April 2010 – March 2011).

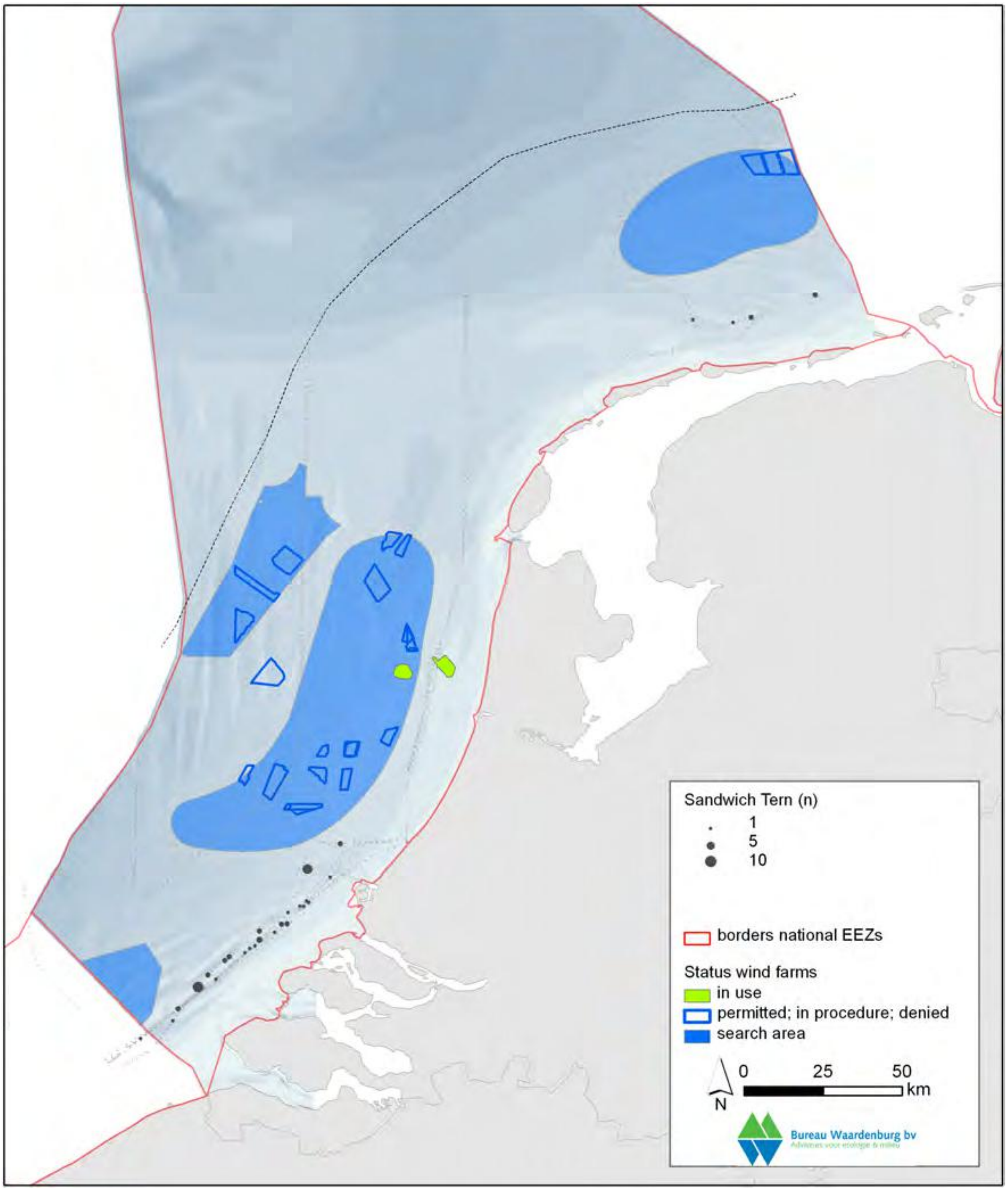


Figure 3.2.15.3 Cumulative distribution of Sandwich Tern observed during the ship-based survey monitoring Shortlist Masterplan project (surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).

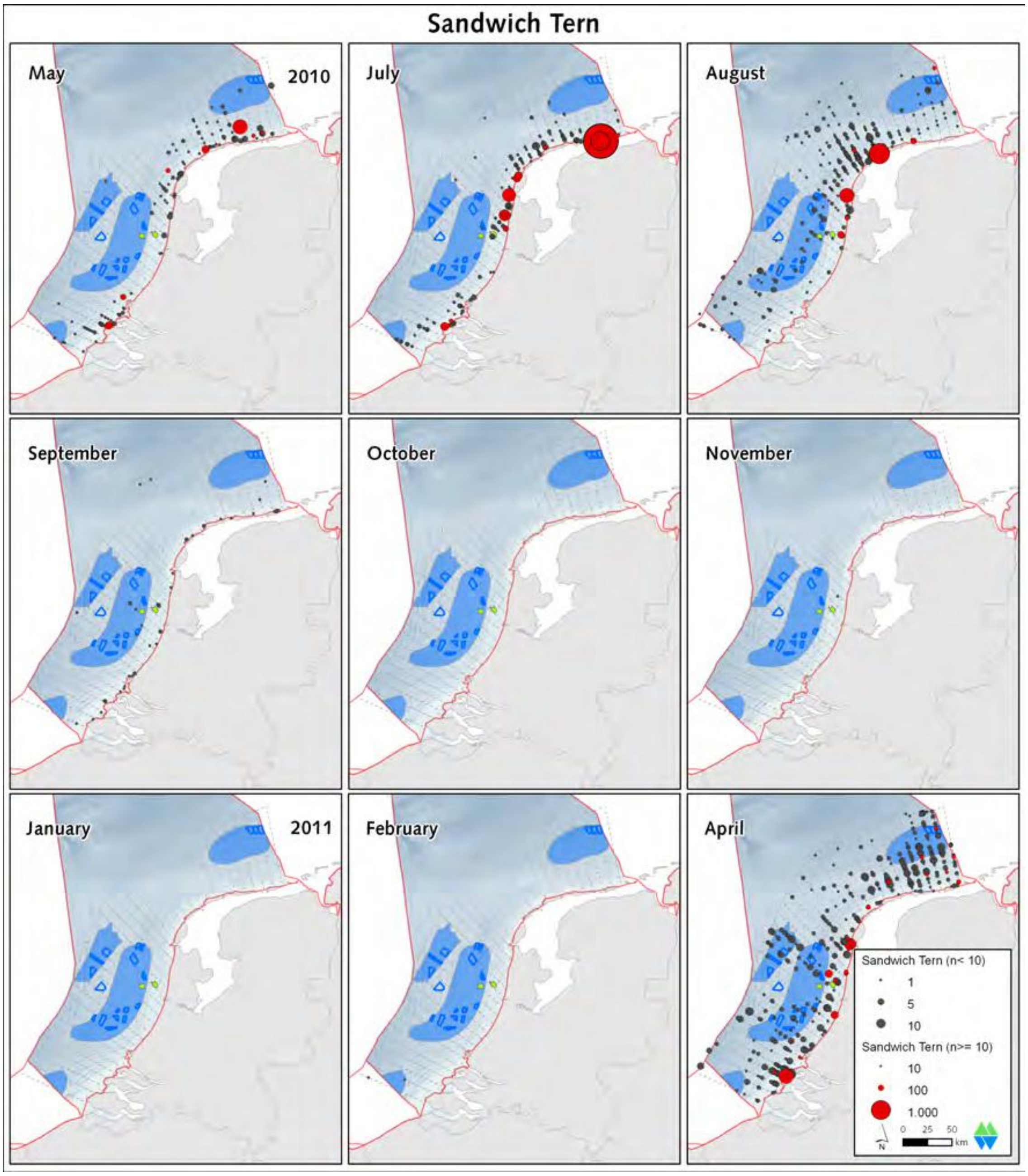


Figure 3.2.15.4 *Distribution of Sandwich Tern observed during the aerial-based survey monitoring Shortlist Masterplan project per month (nine surveys in the period May 2010 – April 2011).*

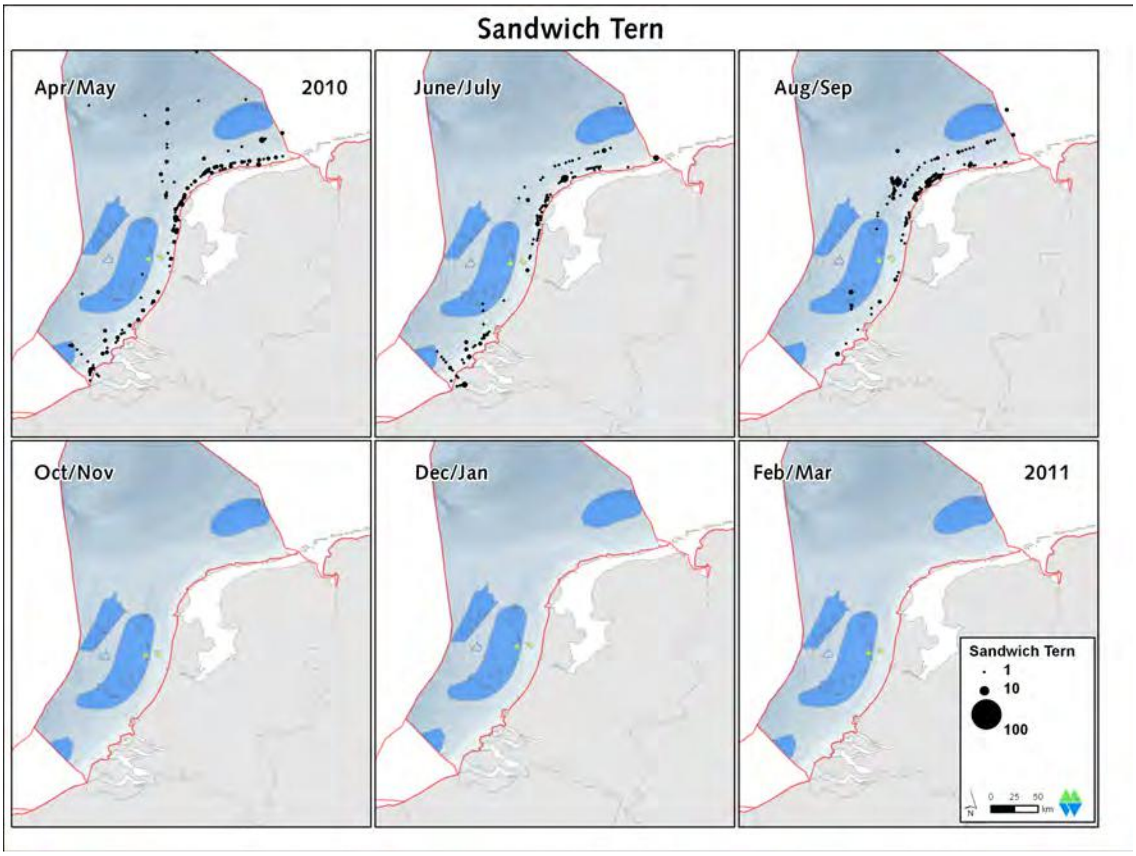


Figure 3.2.15.5 *Distribution of Sandwich Tern observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).*

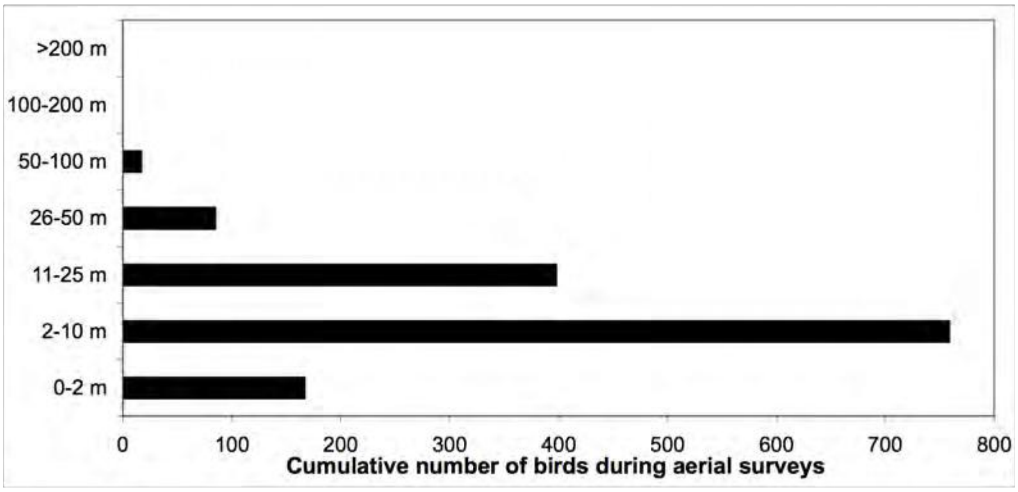


Figure 3.2.15.6 *Cumulative number of Sandwich Tern flying at different altitudes during the aerial-based survey monitoring Shortlist Masterplan project (nine surveys in the period May 2010 – April 2011, birds associated with ships excluded).*

3.2.16 'Comic tern' (Common and Arctic Terns and unidentified small terns)

Common and Arctic Terns are not easy to identify during aerial-surveys under normal survey conditions. In case light conditions are poor, identification is even harder. For those reasons these two species are usually grouped under the name of 'comic tern' during aerial-surveys. In this report this category also includes a few records of smaller terns that could have belonged to other small tern species such as Black Tern and Little Tern. Since the majority of smaller terns breeding along the Dutch coast are Common Terns most individuals seen in this survey (especially during the breeding season) presumably belong to that species.

Observations in this study
'Comic terns' were found throughout much of the study area, although most notably to the northwest of the Wadden Islands and in the Voordelta (Figure 3.2.16.1). Few birds were present outside of the main breeding period, April to August (Figure 3.2.16.4). Most records further offshore were during August, although concentrations were present in April and May and probably refer to migrant and feeding activity, respectively.

Associations with other species, fronts or human activities
All of the small terns can be found resting on smaller human structures such as buoys and during migration concentrations may gather on other structures. In the turbid coastal waters regular foraging concentrations were associated with tidal fronts.

Flight altitude
Common Terns were flying at low altitudes with peak numbers just above the water surface (0-2 metres above sea level). No birds were recorded above 25 metres above sea level. Compared with the results of the ship-based surveys of the shortlist program the abundance of Common Terns at lowest altitudes is slightly higher, although according to the results of the ship-based surveys Common Terns rarely fly above 25 metres above sea level.

Comparison with ship-based data
Ship-based data revealed a similar pattern to the distribution of 'comic terns' to the aerial Shortlist Masterplan surveys (Figure 3.2.16.3). The detection of 'comic terns' is likely to be similar during both aerial and ship-based surveys; however, identification of species is easier with the longer viewing time and side-on view of the ship-based survey, see further paragraph 4.1.

Comparison with MWTL data
Distributions between MWTL and the aerial Shortlist Masterplan surveys were similar with birds being recorded in higher numbers and much further offshore during the key migratory periods, April/May and August/September (Figure 3.2.16.5). Identification of species is difficult during both aerial survey programs, particularly compared with ship-based surveys, although detection may be slightly higher with the lower height of the aerial Shortlist Masterplan surveys, see furher paragraph 4.1.

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea

Approximately one third of the Dutch population of Common Terns breeds in the Delta (Strucker *et al.* 2011), with other colonies along the Wadden Islands. Most Common Terns are thought to forage within 10 km of the coast. Arctic Terns, Common Terns and even Little Terns occur further offshore following the breeding season.

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms

Like in Sandwich Tern a similar far offshore occurrence was found in 'comic terns' but the densities in the search areas were much lower. Common Terns breeding along the Dutch coast forage within 10 km of the coast. The far offshore occurrence of 'comic terns' in or near the search areas was also mainly confined to the post-breeding period when birds can forage further from the coast and the migration periods when birds migrate in broad front over sea.

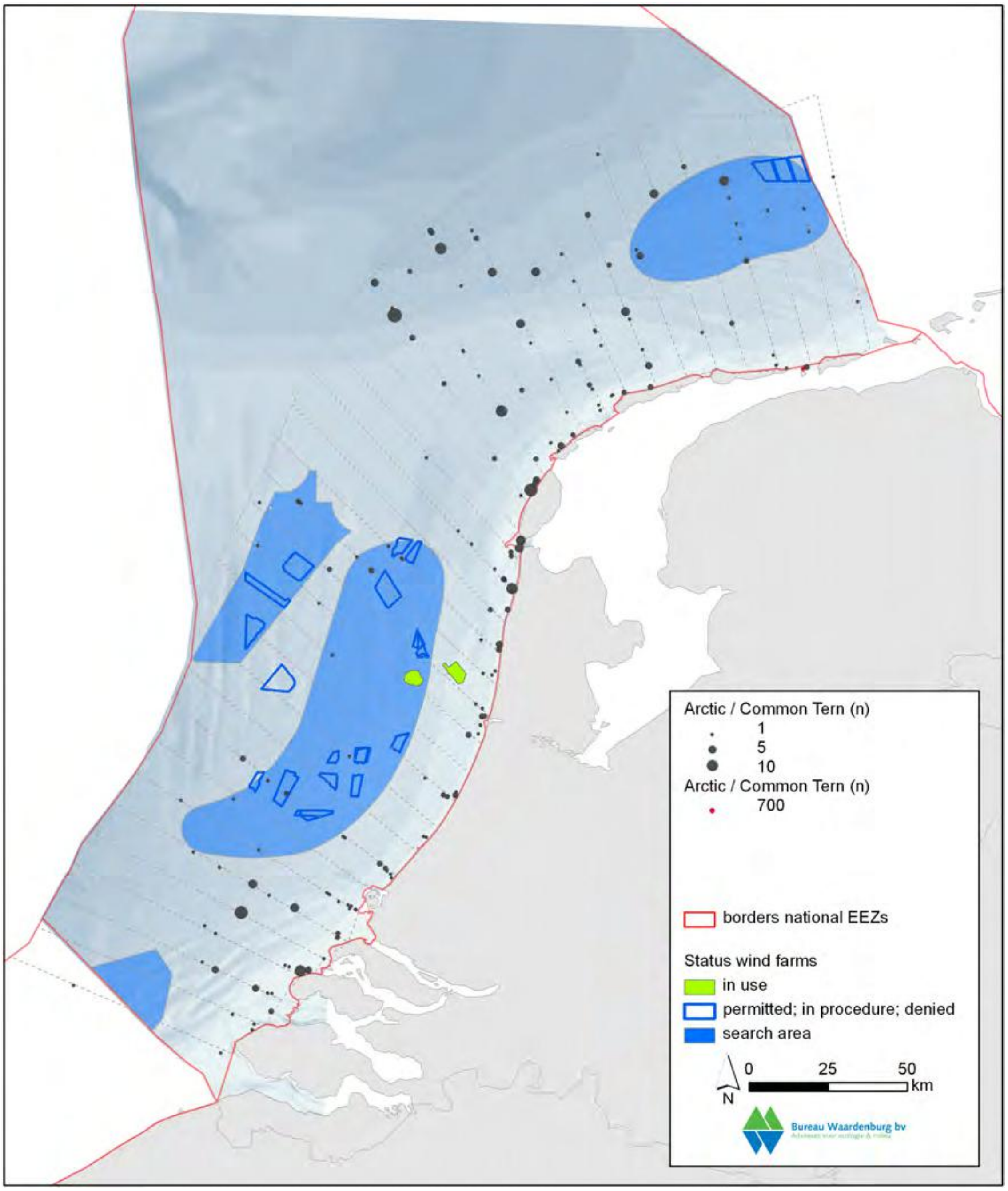


Figure 3.2.16.1 Cumulative distribution of 'comic tern' observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).

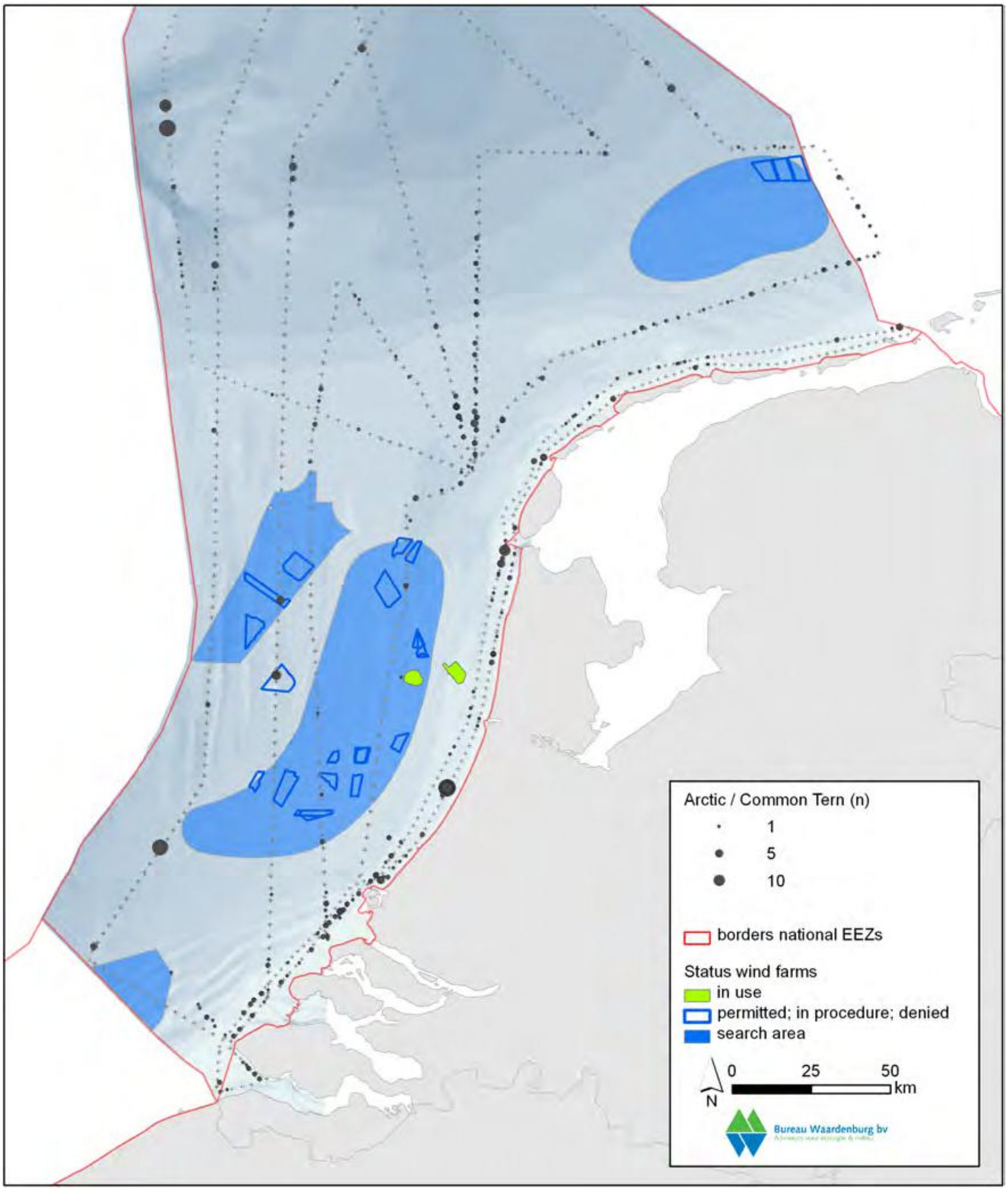


Figure 3.2.16.2 Cumulative distribution of 'comic tern' observed during the aerial-based survey of the MWTL monitoring (six surveys in the period April 2010 – March 2011).

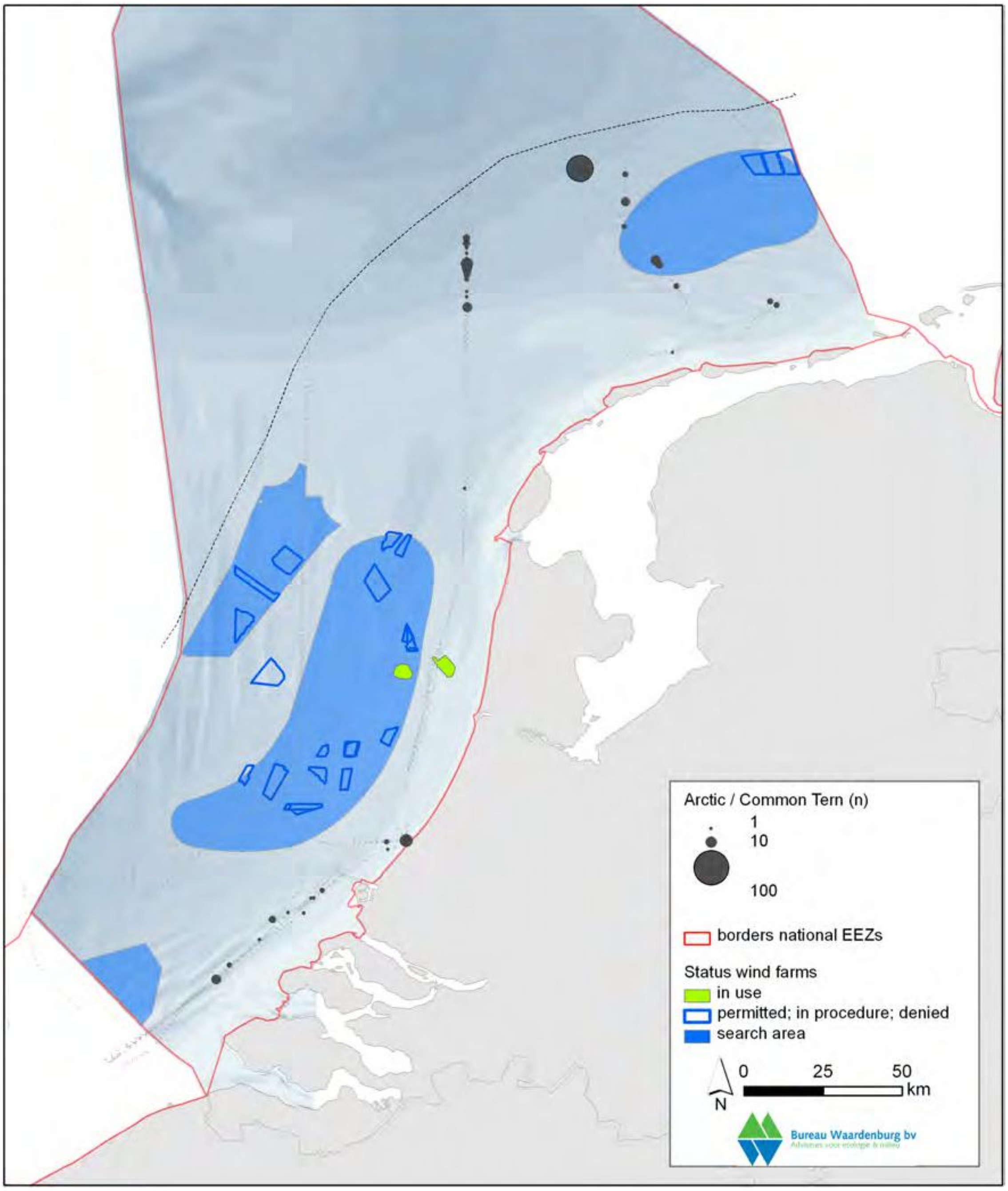


Figure 3.2.16.3 *Cumulative distribution of 'comic tern' observed during the ship-based survey monitoring Shortlist Masterplan project (surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).*

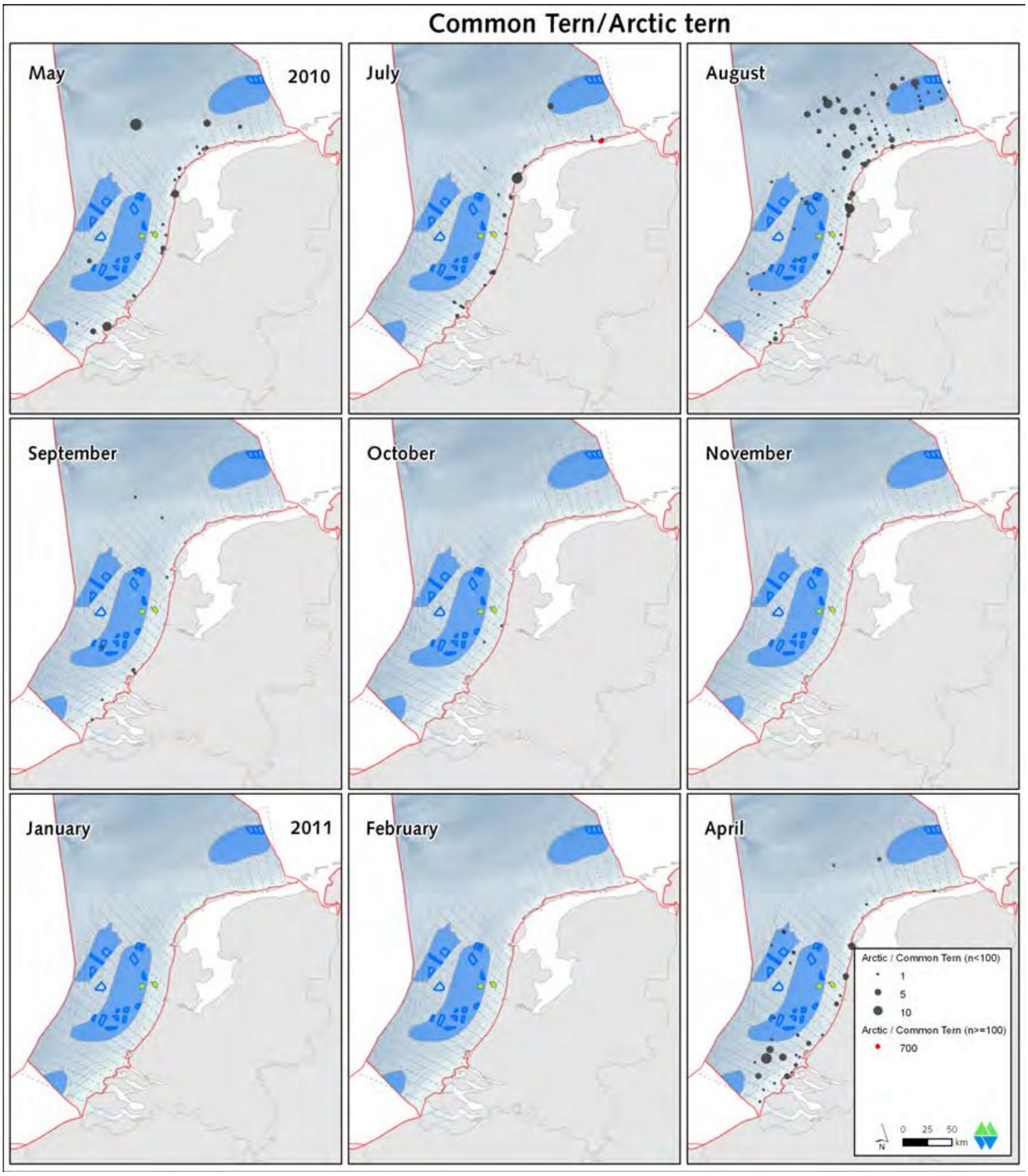


Figure 3.2.16.4 Distribution of 'comic tern' observed during the aerial-based survey monitoring Shortlist Masterplan project per month (nine surveys in the period May 2010 – April 2011).

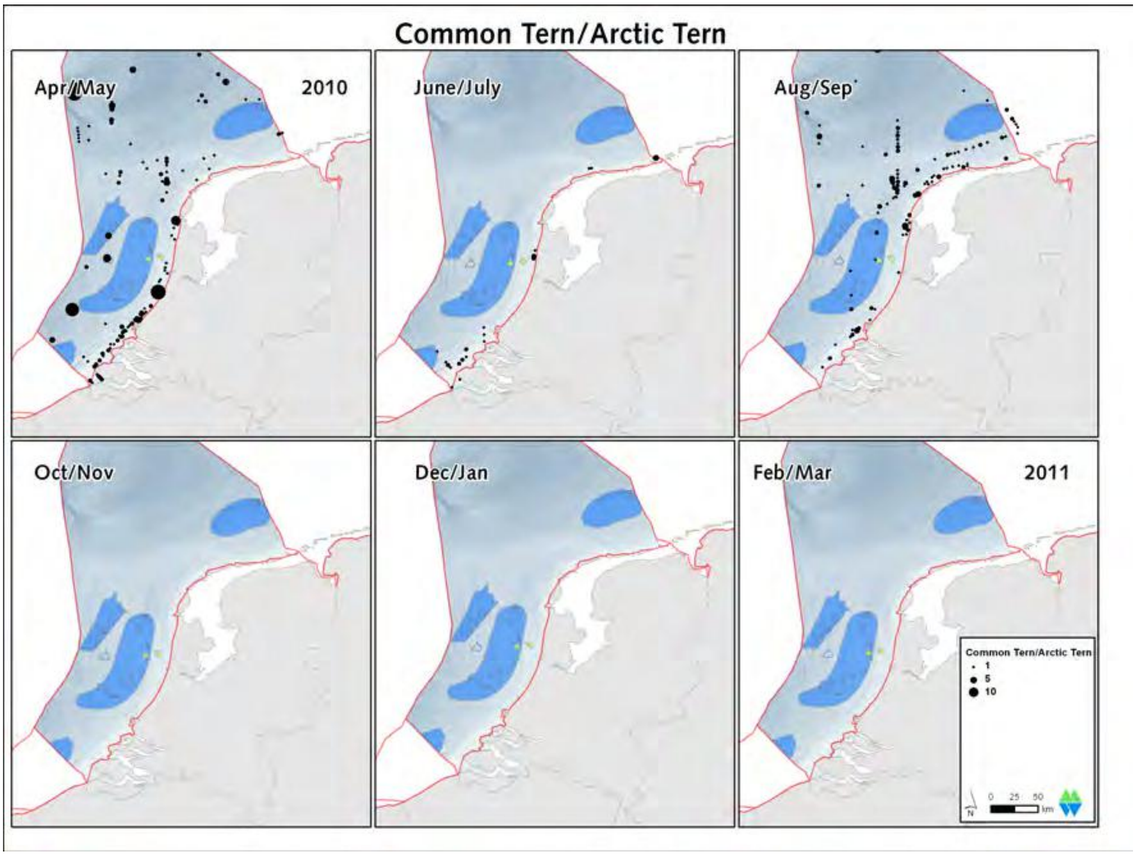


Figure 3.2.16.5 *Distribution of 'comic tern' observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011, birds associated with ships excluded).*

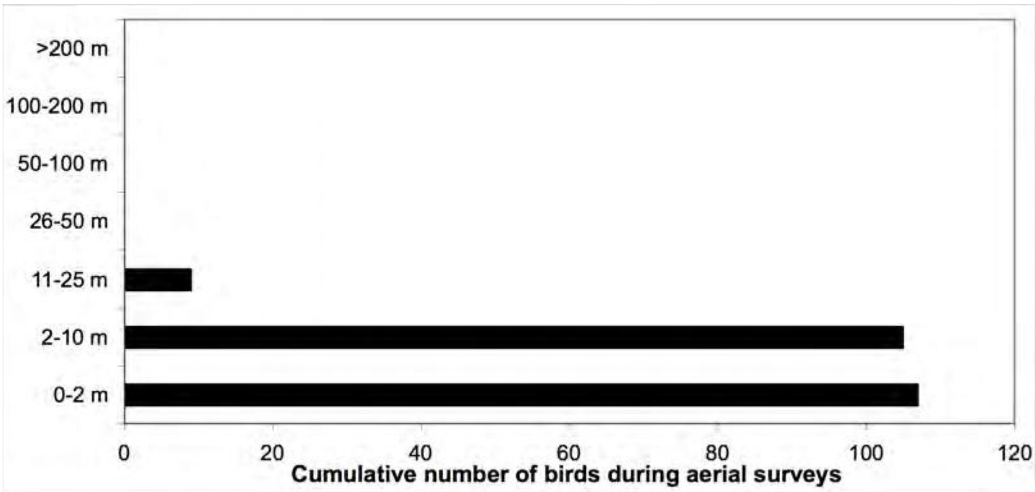


Figure 3.2.16.6 *Cumulative number of 'comic tern' flying at different altitudes during the aerial-based survey monitoring Shortlist Masterplan project (nine surveys in the period May 2010 – April 2011).*

3.2.17 Guillemot

Observations in this study

The cumulative pattern of the Guillemot distribution is truly a composite of different distribution patterns. In May, hardly any birds were present within the boundaries of the Dutch EEZ, but in July the well-known occupation of the Frisian Front occurred. Almost all birds were present north of the 30 m depth contour. An isolated concentration of birds was recorded along one of the transect lines in the Brown Ridge area. In this area, observations consisted of pairs of an adult bird and an associated young. In the Frisian Front area the same was found although large numbers of young birds were not seen, possibly indicating a low breeding success along the eastern coast of the UK.

The total number of birds and patterns in observed numbers within a survey are partly the result of differences in observation conditions. Sea state and sun glare during cloud free days were the most imported factors contributing to different detection levels. Poor observation conditions resulted in a decrease in identification rates to the species level. Under these conditions a shift occurred towards a higher proportion of birds recorded as ‘auks’.

Disturbance effects by the aeroplane were been observed. Birds were frequently observed diving under the water in front of the aeroplane, while taking flight was a relatively rare response. Furthermore, in situations with a tailwind, differences in bird numbers between the two sides of the aeroplane were recorded. This further indicates that fleeing behaviour under certain conditions may result in lower counts. In general, birds remained on the water surface. It is therefore assumed that the majority of Guillemots were not affected by the aeroplane.

Associations with other species, fronts or human activities

Both Kittiwakes and Little Gulls were been seen associating with Guillemots. Most recorded associations apply to gulls flying closely above or sitting next to recently surfaced Guillemots. In cases where Guillemots are still foraging under water, the association is missed and only the flying or foraging flying gull is registered. Therefore, since an aeroplane flies over very quickly the occurrence of associations between Guillemots and these two gull species are underestimated.

Flight altitude

The majority of Guillemots were recorded at sea level with only 120 birds being recorded in flight. The majority of flying birds were below 10 metres above sea level (Figure 3.2.17.4). Only one bird (1,3%) was flying above 25 metres above sea level. This distribution pattern corresponds with the results of the ship-based surveys.

Comparison with ship-based data

Most observations of Guillemots are of birds sitting on surface. Sea state and sun glare have large effects on the levels of detection. The ship-based surveys have longer observation times and therefore better detection levels in situations with less than ideal circumstances. Due to the slower travelling speed and the effects of disturbance of birds coming up in front of the ship, detection levels are generally higher for ship-based surveys compared to aerial-based surveys.

Due to the restricted survey design the ship-based data gives limited insight in the overall distribution of Guillemots throughout the research area.

Comparison with MWTL-data

Due to the higher flight altitudes of the aeroplane the distinction between Guillemots and Razorbills is difficult. Therefore, the MWTL monitoring scheme makes no distinction between these species (see also texts Razorbill and auks). The clear distribution pattern in relation to the Frisian Front as found in this Shortlist Masterplan and the lack of it in any of the summer 'auks' maps of the MWTL monitoring scheme has to be attributed to the differences in survey design. For several years it has been known that the Frisian Front area is poorly monitored, mainly due to the restrictions in surveying over the restricted-fly zone above the eastern Wadden Islands.

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea

The Dutch North Sea is of importance to birds breeding in Eastern England and South-eastern Scotland, particularly in late summer and early autumn. In addition, birds from Western Scotland are also known to occur in Dutch waters during winter (Camphuysen & Leopold 1994), from ringing recoveries of dead birds found along the Dutch coast.

The species does not breed in the Netherlands. Numbers generally build up during late summer as breeding birds arrive with their offspring. An estimated number of 15,000-45,000 chicks with accompanying parent can be present in Dutch waters during this time (Bijlsma *et al.* 2001). Peak numbers occur during October and November when an estimated 240,000 individuals may be present in the southern North Sea (Camphuysen & Leopold 1994). Numbers gradually decrease throughout the winter, although winter storms may drive birds into the Dutch North Sea region again. Most birds occur in the offshore zone with fewer birds nearer to the coast.

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms

This study provides detailed information about the distribution patterns of Guillemots throughout the entire research area. This is only partially true for the MWLT survey and the ship-based survey data.

Based on these studies the distribution of Guillemots in the search areas for new offshore wind farms was relatively low. Only during specific periods were numbers relatively high in the northern part of 'IJmuiden'. Smaller numbers are present north of 'Hollandse kust', the 'Waddensea' and 'Borselle'. The distribution of Guillemots is relatively low or absent in the search areas for new offshore wind farms south of

‘Hollandse kust’. In general, the search areas for wind farms are not of particular importance for Guillemots (see Figure 3.2.17.1 – 3.2.17.3).

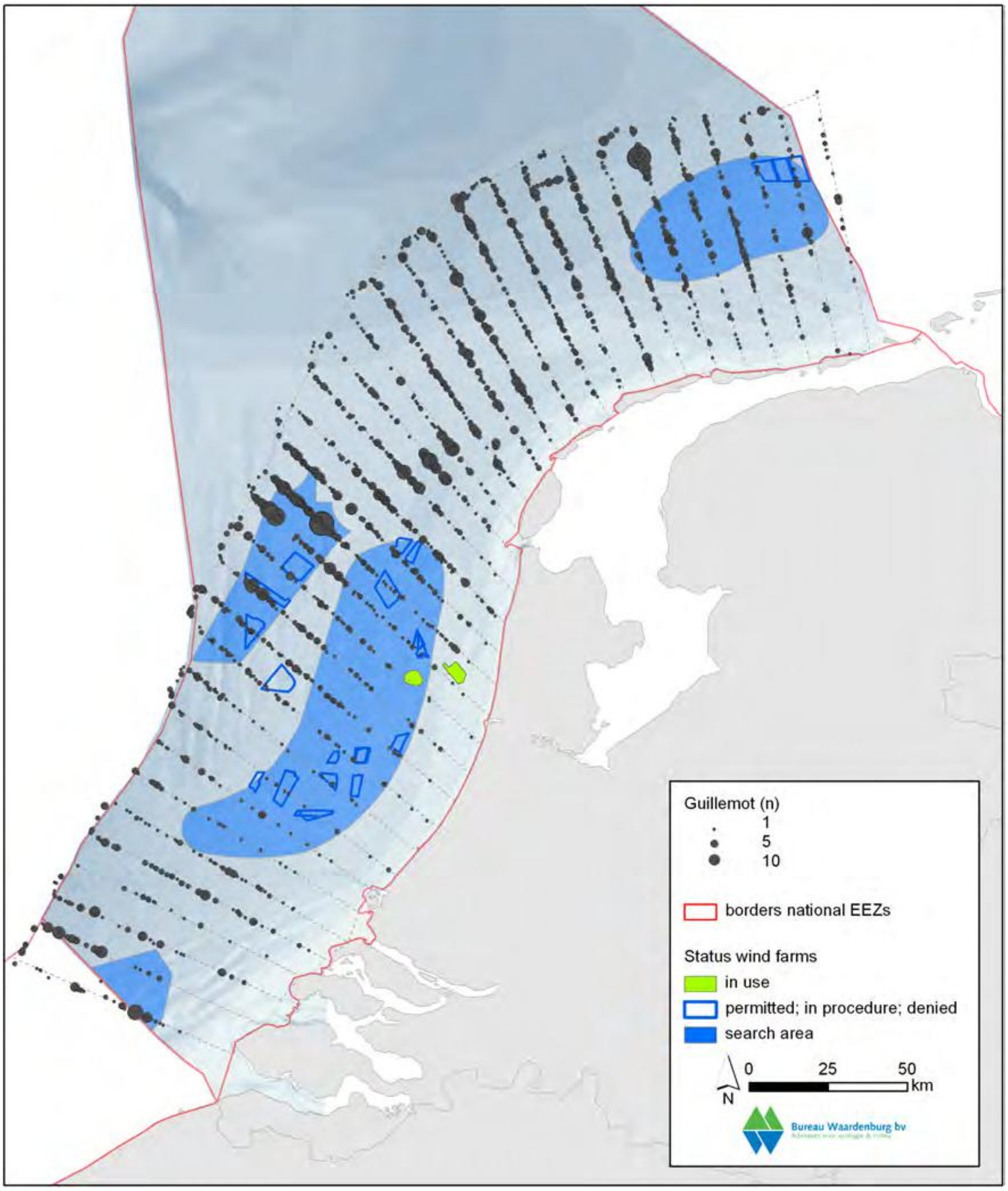


Figure 3.2.17.1 *(left page) Cumulative distribution of Guillemot observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).*

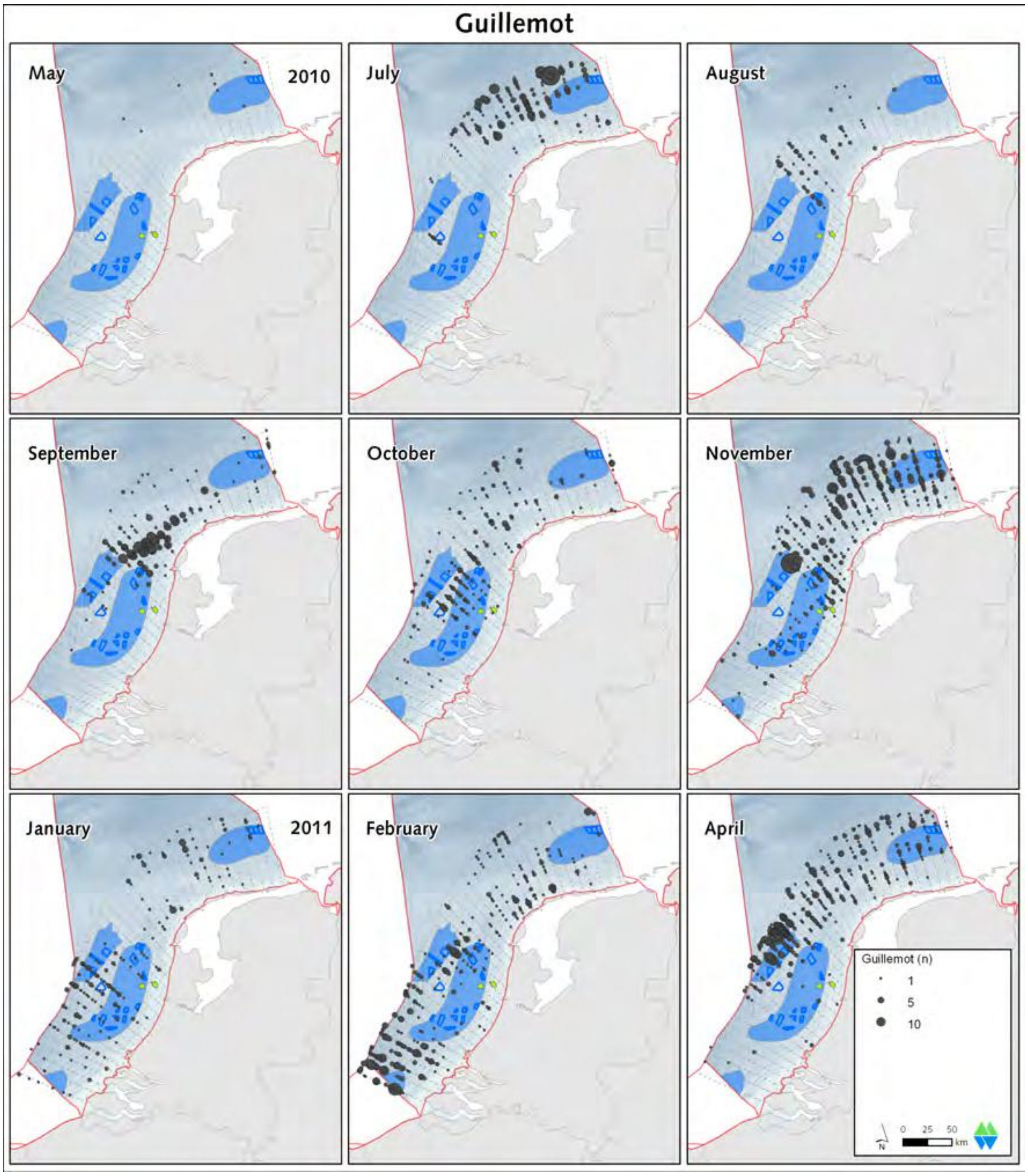


Figure 3.2.17.2 *Distribution of Guillemot observed during the aerial-based survey monitoring Shortlist Masterplan project per month (nine surveys in the period May 2010 – April 2011).*

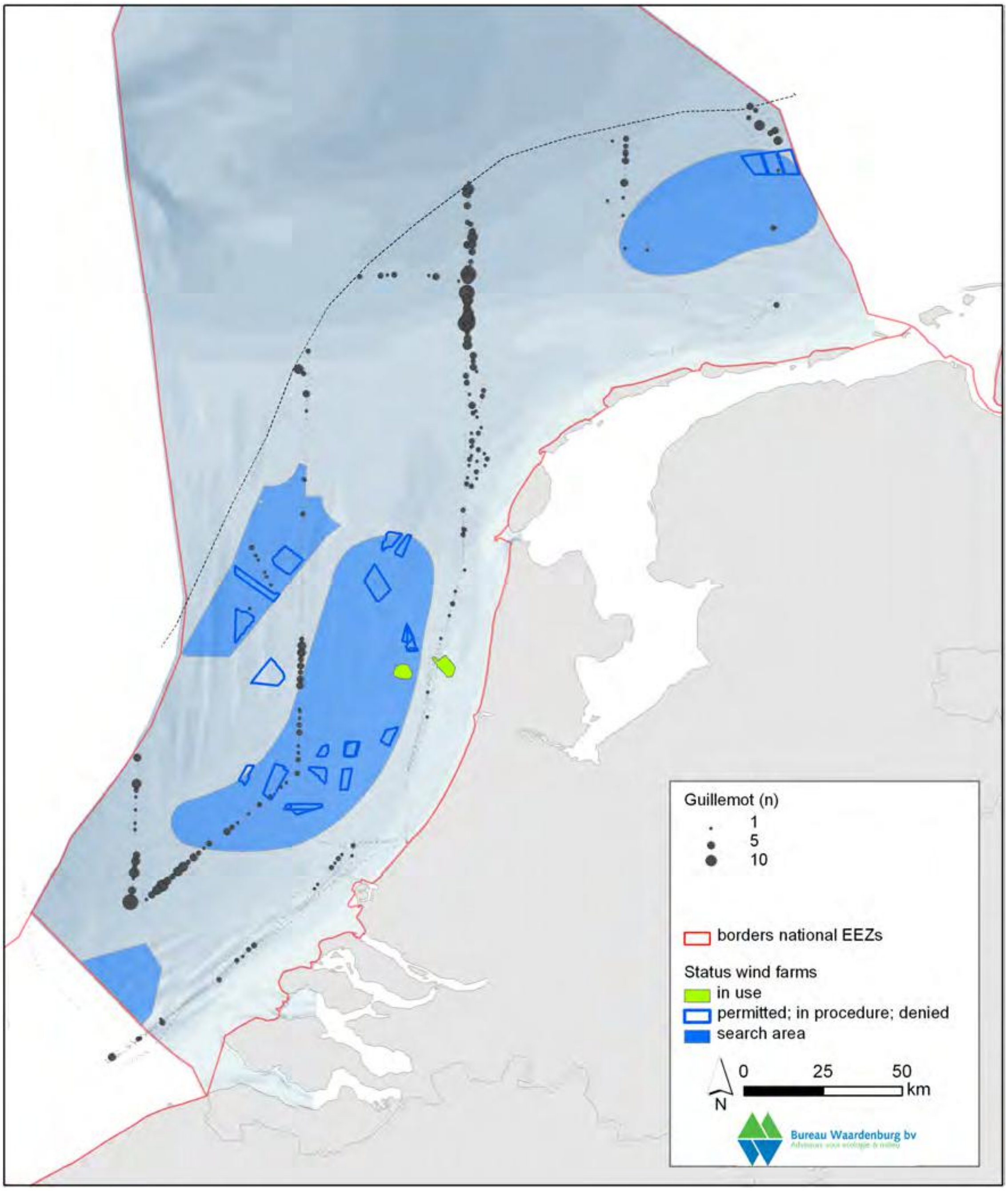


Figure 3.2.17.3 *Cumulative distribution of Guillemot observed during the ship-based survey monitoring Shortlist Masterplan project (nine surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).*

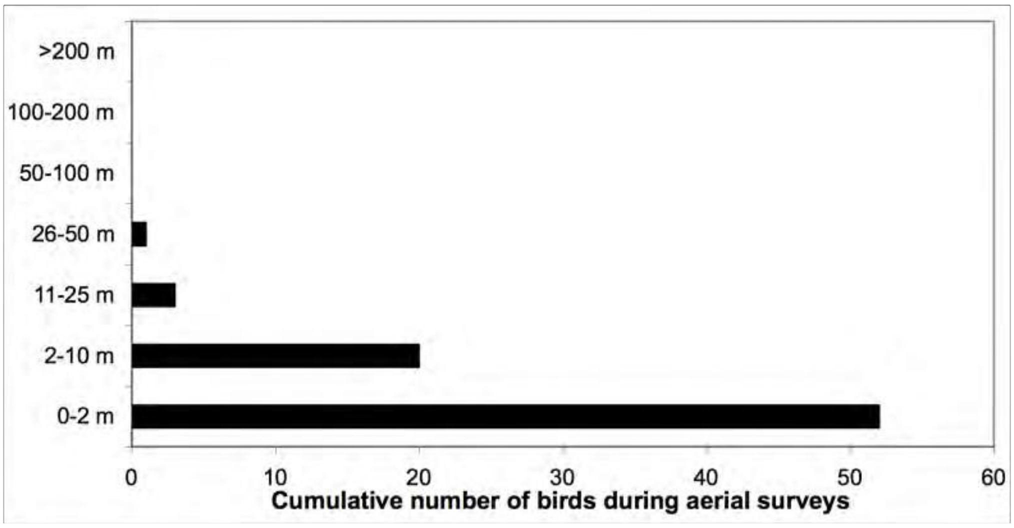


Figure 3.2.17.4 *Cumulative number of Guillemot flying at different altitudes during the aerial-based survey monitoring Shortlist Masterplan project (nine surveys in the period May 2010 – April 2011). Only flying birds are taken into consideration.*

3.2.18 Razorbill

Observations in this study

Compared to the Guillemot the arrival of Razorbills is later in the season and their densities are lower. From May to September almost no birds were observed within the boundaries of the Dutch EEZ, but from October to February numbers steadily increased. The patterns in distribution are less obvious in comparison to the Guillemot, which is probably due to the smaller numbers recorded. Almost all birds were present north of the 30 m depth contour.

The total number of birds and the patterns in observed numbers within a survey are partly the result of differences in observation conditions. Sea state and sun glare during cloud-free days were the most imported factors contributing to detection levels. Poor observation conditions may result in a decrease in the rates of identification to the species level. Under these conditions a shift occurred towards a higher rate of birds that were identified as ‘auks’.

The effects of disturbance from the aeroplane were observed. On several occasions, birds were observed taking off in front of the aeroplane. Furthermore, in situations with tailwinds differences in the numbers of birds on each side of the aeroplane were recorded. This further indicates that fleeing behaviour in certain situations may result in smaller quantities of remaining birds and therefore a lower observation rate. In general, birds remained on the water surface. It is therefore plausible that the majority of Razorbills were not affected by the aeroplane.

Associations with other species, fronts or human activities
Both Kittiwakes and Little Gulls have been seen to associate with Razorbills. As an aeroplane flies over very quickly the observations of associations between Razorbills and these two gull species are underestimated. Most recorded associations apply to gulls flying closely above or sitting next to recently surfaced Razorbills. In cases where Razorbills are still foraging under the water, the association is missed and only the flying or foraging gull is recorded.

Flight altitude
The majority of Razorbills were recorded on the water surface, with only 49 birds observed flying. All flying birds were below 10 metres above sea level (Figure 3.2.18.4). This corresponds with the results of the ship-based surveys.

Comparison with ship-based data
Most observations of Razorbills are related to birds sitting on water. Sea state and sun glare have large influences on the level of detection in ship-based surveys. However, compared to aerial surveys the ship-based surveys have a great advantage, as due to relative slow traveling speed the observation times are much longer. In a diving species this means that in a ship-based survey there is a much higher chance that the bird will be above water to be detected. Therefore in ship-based surveys the detection levels are higher, even in situations with less than ideal circumstances.

The identification of auk species during the Shortlist Masterplan aerial surveys is well in accordance with the identification during ship-based surveys (see further paragraph 4.1). The relatively low flight altitude compared to the MWTL aerial program explains this. Overall the proportion of Razorbills was even slightly higher than the ship-based dataset. This is partly explained by the fact that a certain amount (16%) of auks could not be identified to the species level from the aeroplane as these birds were recorded as ‘Guillemot / Razorbill’.

The ship-based data gives limited insight in the overall distribution of Razorbills throughout the research area due to the restricted survey design.

Comparison with MWTL-data
Due to the higher flight altitudes of the aeroplane the distinction between Razorbills and Guillemots is difficult. Therefore, the MWTL monitoring scheme makes no distinction between these species (see further the text on auks).

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea

The nearest breeding colonies of Razorbills are in Northeast England and Helgoland in Germany, however, many birds from breeding colonies in Western Britain are also known to winter in the Dutch North Sea (Camphuysen & Leopold 1994), although in smaller numbers (Wenham *et al.* 2002). It is estimated that around 44,000 Razorbills are present within Dutch North Sea waters during the winter, mostly between February and March (Camphuysen & Leopold 1994). Most birds can be found offshore but higher densities occur to the northwest of the Wadden Islands. Unlike Guillemots, few young are seen in Dutch waters (Camphuysen & Leopold 1994).

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms

This study provides information about the distribution of Razorbills throughout the study area, although, observations are, to a high degree, related to good observation conditions. The ship-based survey data have a higher rate of Razorbill observations, however, there is limited coverage of the entire research area. The MWLT data makes no distinction between Guillemots and Razorbills. Therefore, no concrete information about the Razorbill distribution can be obtained from this study. In general, the combined studies give a strong indication of the distribution patterns of Razorbills.

Based on these studies the distribution of Razorbills in search areas for new offshore wind farms is relatively low. Only during short periods relative small numbers are present in the search areas for new offshore wind farms. This applies to the northern part of 'Hollandse kust' and the centre part of 'IJmuiden'. Razorbills were present in relatively low numbers or were even absent in the search areas for new offshore wind farms of south of 'Hollandse kust', the 'Waddensea' and 'Borselle'. In general, the search areas for wind farms are not of particular importance for Razorbills (see Figure 3.2.18.1 – 3.2.18.3).

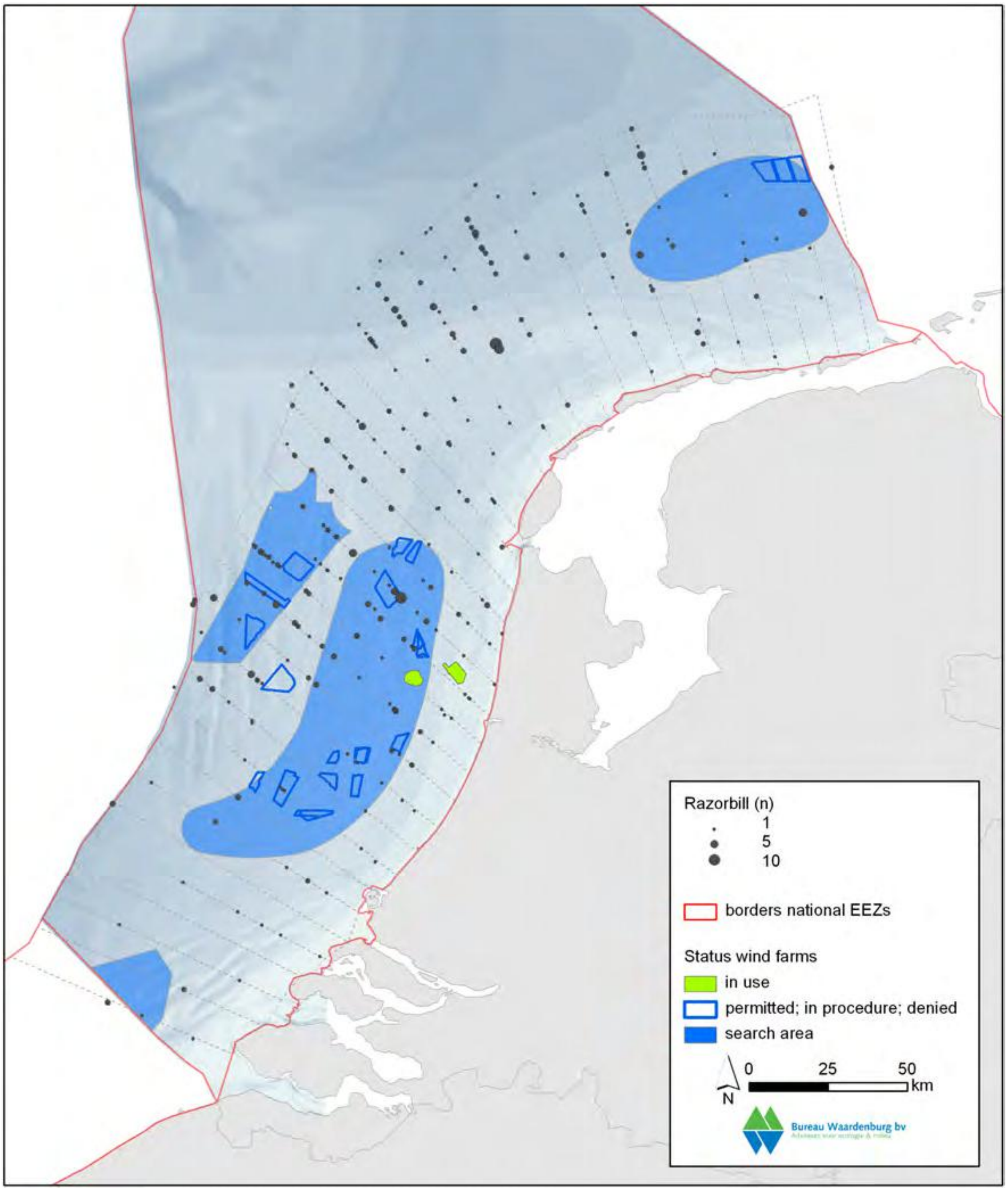


Figure 3.2.18.1 *Cumulative distribution of Razorbill observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).*

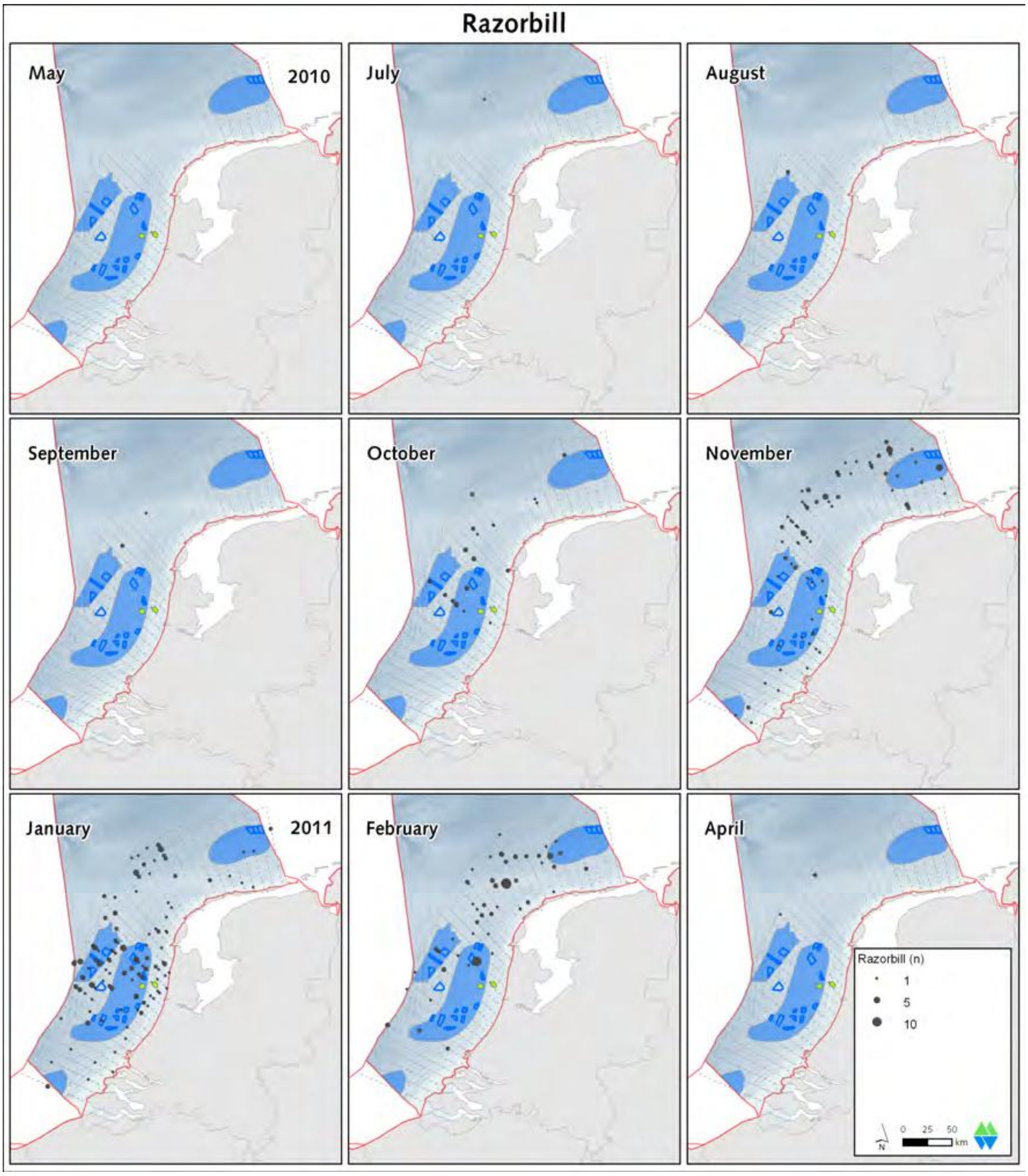


Figure 3.2.18.2 *Distribution of Razorbill observed during the aerial-based survey monitoring Shortlist Masterplan project per month (nine surveys in the period May 2010 – April 2011).*

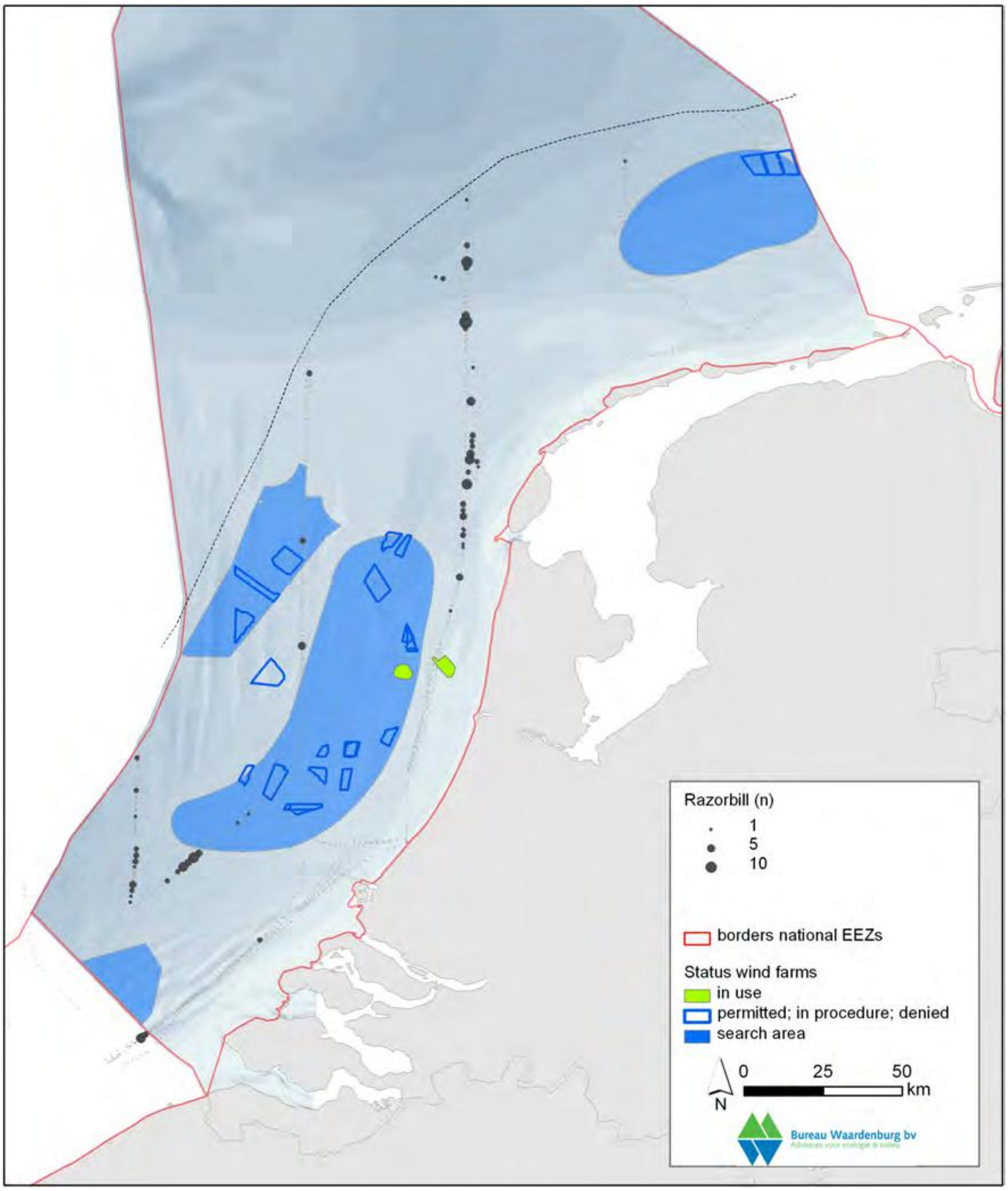


Figure 3.2.18.3 Cumulative distribution of Razorbill observed during the ship-based survey monitoring Shortlist Masterplan project (nine surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).

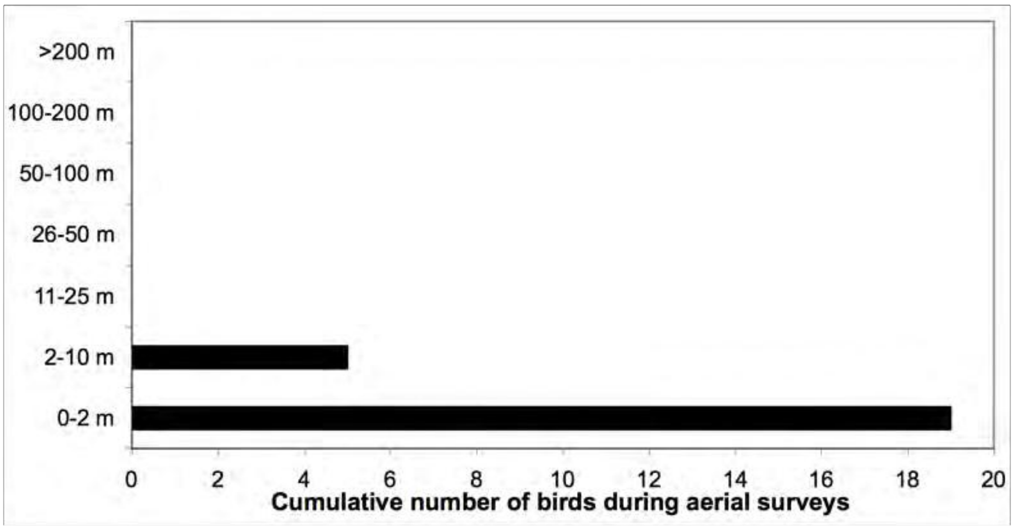


Figure 3.2.18.4 *Cumulative number of Razorbill flying at different altitudes during the aerial-based survey monitoring Shortlist Masterplan project (nine surveys in the period May 2010 – April 2011). Only flying birds are taken into consideration.*

3.2.19 Auks (Guillemot, Razorbill and unidentified auks)

Observations in this study

The cumulative pattern of auk distribution is a composite of different distribution patterns throughout the season. The majority of observations is fairly scattered throughout the study area. Areas with small numbers of observations consisted of the waters near-shore and some of the waters offshore from the coast off South Holland.

The total number of birds and patterns in observed numbers within a survey are partly the result of differences in observation conditions. Sea state and sun glare during cloud-free days were the most important factors contributing to detection levels. Poor observation conditions resulted in a decrease in the rates of identification to the species level. Under these conditions a shift occurred towards a higher rate of birds being recorded as auks.

The effects of disturbance by the aeroplane were observed. Birds were frequently observed taking off in front of the aeroplane. Furthermore, in situations with tailwinds difference in the numbers of birds recorded on each side of the aeroplane were noted. This further indicates that fleeing behaviour in certain situations may result in smaller quantities of remaining birds and therefore a lower observation rate. In general, birds remained on the water surface. It is therefore plausible that the majority of 'auks' were not affected by the aeroplane.

Associations with other species, fronts or human activities
Both Kittiwakes and Little Gulls have been seen associated with Guillemots and Razorbills. As an aeroplane flies over very quickly the observations of associates between Guillemots and these two gull species are underestimated. Most recorded associations apply to gulls flying closely above or sitting next to recently surfaced Guillemots and Razorbills. In cases where Guillemots and Razorbills are still foraging under the water surface, the association is missed and only the flying or foraging gull is recorded.

Flight altitude
The majority of 'auks' were recorded on the water surface. Only 234 birds were recorded in flight. The majority of flying birds were flying below two metres above sea level (Figure 3.2.19.4). Only one bird (0,75%) was flying above 25 metres above sea surface. This distribution pattern corresponds with the results of the ship-based surveys.

Comparison with ship-based data
Compared to aerial surveys in diving species groups like the auks the ship-based surveys have longer observation times. Therefore, detection levels are higher, even in situations with less than ideal circumstances and recorded densities of auks are generally higher for ship-based surveys, see further chapter 4.

The map of 'auks' based on the ship-based survey consists mainly of Guillemot observations and therefore contains many similarities with the Guillemot distribution map. It is clear that due to the survey design the data provided by the Shortlist Masterplan aerial surveys gives a better overview of the spatial distribution of auks throughout the research area. The data give more insight in how and when auks use the study area further offshore.

Comparison with MWTL-data
The MWTL-data makes no distinction between Guillemots and Razorbills. Identification problems at species level are due to the higher flight altitude of the aeroplane (500 feet). Therefore, detailed information at the species level is not or only occasional available. The differences in survey design attributes strongly to the differences found in the results within the same study area. However, the main areas with sightings strongly coincide between the two studies. Several hundreds of kilometres to the Northwest of the Wadden Islands much higher densities of auks are found. This can be mainly attributed to closer proximity to breeding grounds. The main breeding grounds are located in Eastern England and South-eastern Scotland (Camphuysen & Leopold 1994).

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea
The Dutch North Sea is of importance to both Guillemots and other auks breeding mainly in Eastern England and Scotland. Both old (Baptist H.J.M. & Wolf P.A. 1993)

and recent surveys (MWTL) of the entire Dutch Continental Plate (NCP) show that the main areas for auks consist of the most remote parts in the northwest.

Auks do not breed in the Netherlands. Numbers generally build up during late summer as breeding birds arrive with their offspring. Peak numbers occur during October and November (Camphuysen & Leopold 1994). Numbers gradually decrease throughout the winter, although winter storms may drive birds into the Dutch North Sea region again. Most birds occur in the offshore zone with fewer birds nearer to the coast.

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms

This study provides detailed information about the distribution patterns of auk species throughout the entire research area. This is only partially true for the MWLT survey data and the ship-based survey data. The MWLT survey makes no distinction between Guillemots and Razorbills.

Based on these studies the distribution of auks in search areas for new offshore wind farms is relatively low. Only during specific periods relatively high numbers are present in the northern part of 'IJmuiden' and the northern part of 'Hollandse kust'. Smaller numbers were present in the 'Waddensea' and 'Borselle'. The occurrence of auks in the search areas for new offshore wind farms south of 'Hollandse kust' was is relatively low. In general, the search areas for wind farms are not of particular importance for auks (see Figure 3.2.19.1 - 3.2.19.3).

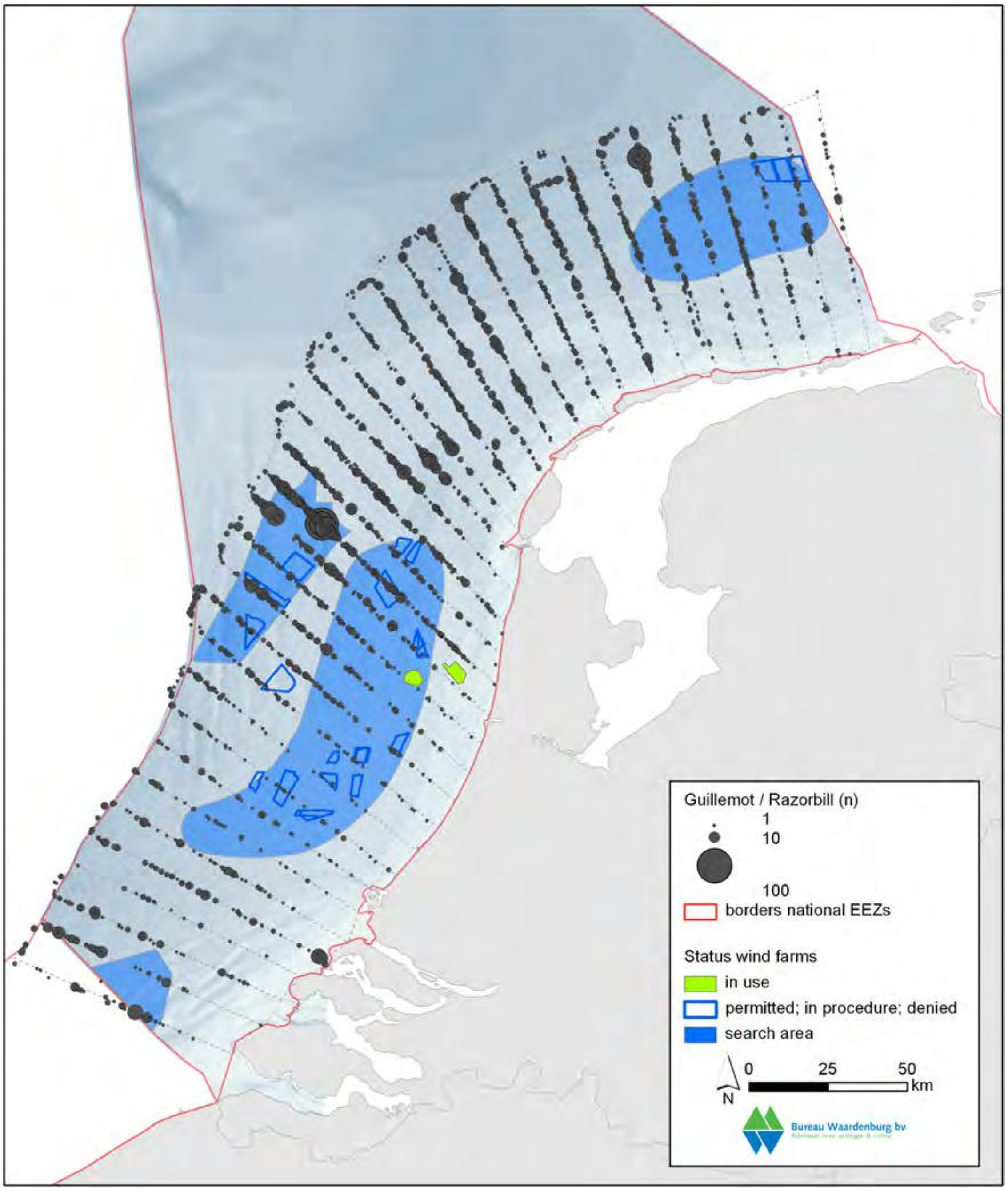


Figure 3.2.19.1 Cumulative distribution of the species group auks observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).

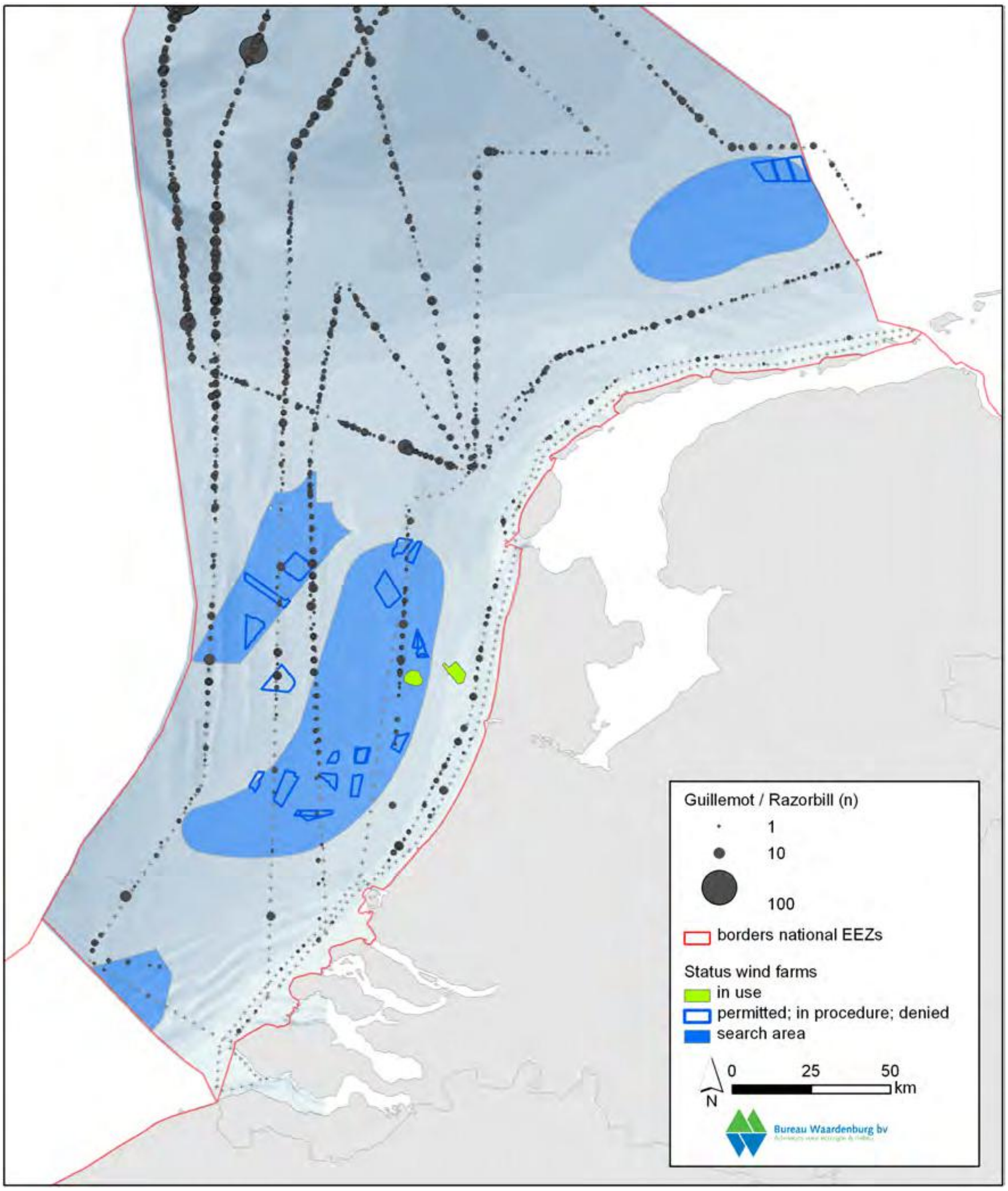


Figure 3.2.19.2 *Cumulative distribution of the species group auks observed during the aerial-based survey MWTL monitoring project April 2010 – March 2011 (six surveys).*

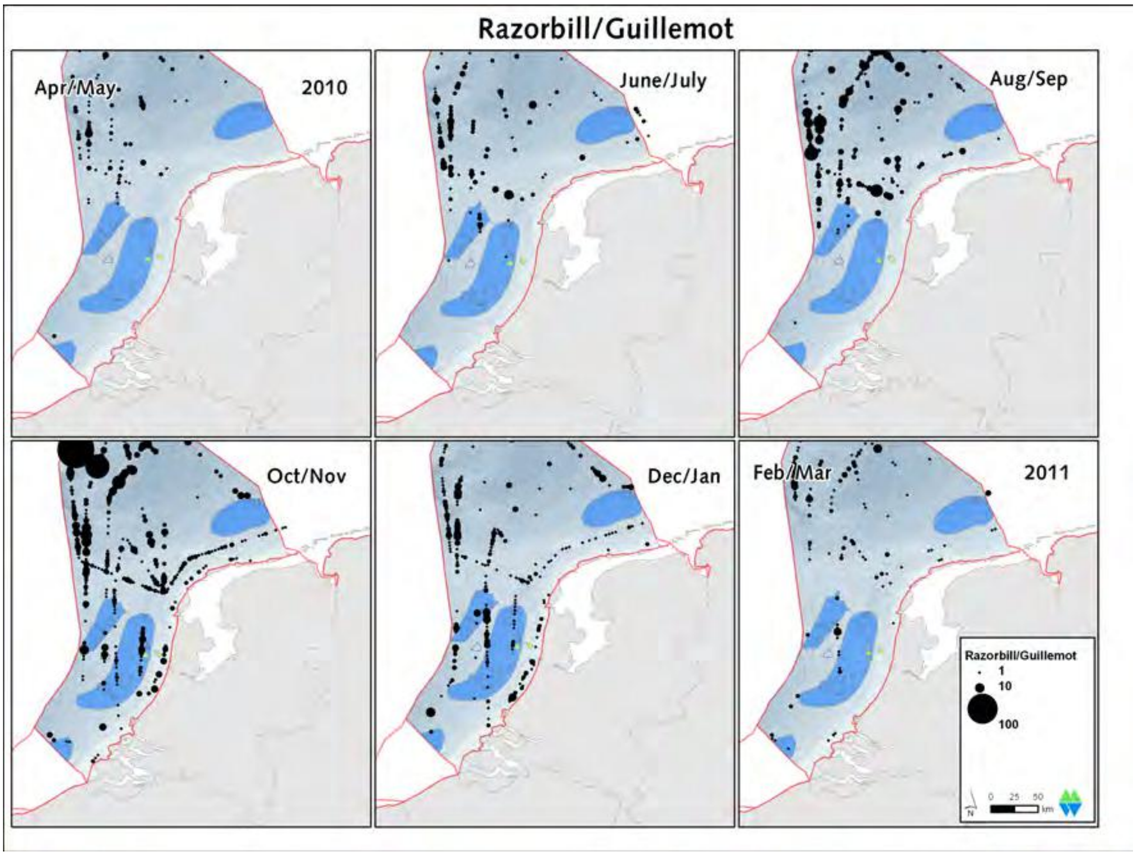


Figure 3.2.19.3 Distribution of the species group auks observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).

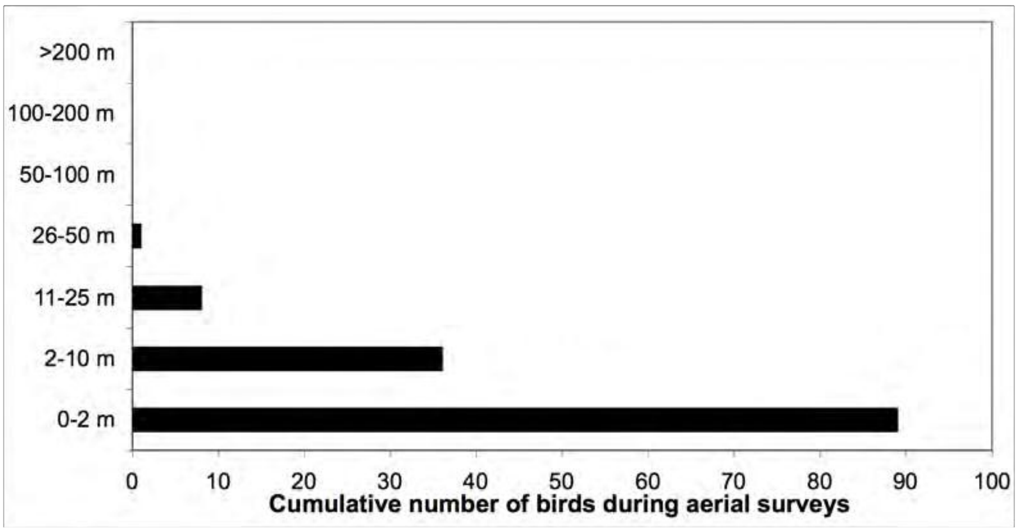


Figure 3.2.19.4 Cumulative number of the species group auks flying at different altitudes during the aerial-based survey monitoring Shortlist Masterplan project (nine surveys in the period May 2010 – April 2011). Only flying birds are taken into consideration.

3.3 Species accounts marine mammals

3.3.1 Harbour Porpoise

Observations in this study

Harbour Porpoises were observed throughout the study area but were less common in the southern and more common in the northern part of the study area (roughly from Egmond aan Zee upwards) (Figure 3.3.1.1). The detection of Harbour Porpoises is highly dependent on weather conditions and sea state. Overcast and low sea states yield much more sightings of Harbour Porpoise than sunny days with slightly higher sea states. This is illustrated in the surveys of September 2010 and April 2011. In particular, in the latter the area with the lowest sea state conditions (see Figure 2.3.2) yielded many more sightings of Harbour Porpoises than the others. Temporal patterns are therefore difficult to describe from figure 3.3.1.2. On the other hand, it is clear that most Harbour Porpoises are seen off the Dutch coast in winter and spring whereas numbers fall over the course of the summer and increase again in the autumn (Figure 3.3.1.4). Disturbance of Harbour Porpoises from the aeroplane is difficult to estimate because the animals dive and are out of sight of the observer, however, disturbance was confirmed by sightings of escaping behaviour involving animals swimming at great speed away from the transect line.

Associations with other species, fronts or human activities

Associations of Harbour Porpoises with birds were observed. These were mainly with Gannets. Due to flight speed of the aeroplane these associations were difficult to assess and probably do occur more often than currently present in the database. Other associative behaviour of Harbour Porpoises has not been recorded.

Comparison with ship-based data

During the ship-based surveys Harbour Porpoises were recorded throughout the study area (Figure 3.3.1.3). However, due to the limited coverage of the study area no clear patterns could be found in the distribution of the species. In general, a more offshore distribution pattern was found with also fairly substantial numbers of the coast of Zeeland. The detection of Harbour Porpoises is limited, as these animals generally avoid ships and only surface very briefly and with a very small part of the body. On the other hand, in case of low seastates, chances of recording Harbour Porpoises can be greater during ship-based surveys due to the slower speed of the observation platform.

Comparison with MWTL data

Harbour Porpoise were recorded during the MWTL surveys but the observed numbers were small (Figure 3.3.1.2). Harbour Porpoises were distributed throughout the study area (similar to the Masterplan aerial surveys) but due to the more limited coverage of the study area this pattern is difficult to assess. Remarkably, there are relatively large numbers of Harbour Porpoises close to the shore in the MWTL dataset. Some obvious differences between the two aerial surveys do also exist. During the MWTL surveys hardly any porpoises were recorded directly west of Den Helder, one of the main hotspots for Harbour Porpoise during the Shortlist aerial surveys. Another hotspot for Harbour Porpoise, the Frisian Front, was hardly covered during the MWTL surveys, mainly due to the choice to fly around the restricted-fly zone above the eastern Wadden Islands. Flight altitude may also have an influence on the rate of detection. During the MWTL aerial surveys the aeroplane flies at a much higher altitude than during the Shortlist Masterplan Surveys. The latter method may show larger numbers as it 'samples' the animals more by 'surprise' in contrast to a higher flying aeroplane, which is 'visible/audible' at a much greater distance.

The numbers of Harbour Porpoises were small in winter (February to March) (Figure 3.3.1.5) and high in late spring (April to May) and early summer (June to July). This is in contrast to the seasonal patterns known from the literature (e.g. Arts 2010; Geelhoed *et al.* 2011) and the results of the Shortlist Masterplan aerial surveys (Figure 3.3.1.4).

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea

The temporal and spatial patterns of Harbour Porpoise in the Dutch North Sea as found during the Masterplan Aerial Surveys are similar to those found in the literature (Hammond *et al.* 2002; Arts 2010). Following a decrease in autumn, the highest numbers of Harbour Porpoises are found in winter and numbers decrease during spring towards a low in summer.

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms

Harbour Porpoises were found in all four of the search areas and present in substantial numbers during all surveys. In particular, the 'IJmuiden' search area yielded high numbers of Harbour Porpoises.

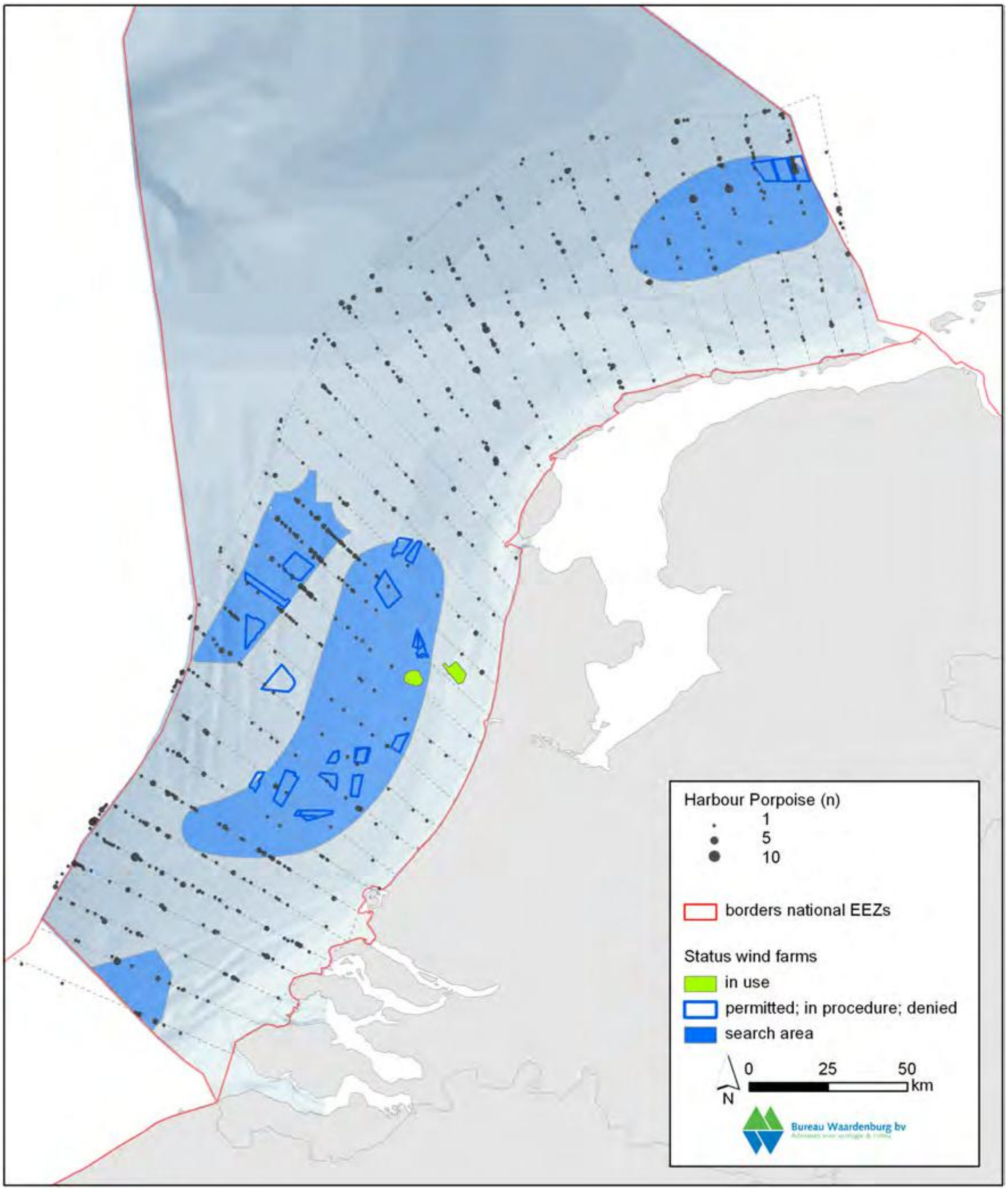


Figure 3.3.1.1 *Cumulative distribution of Harbour Porpoise observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).*

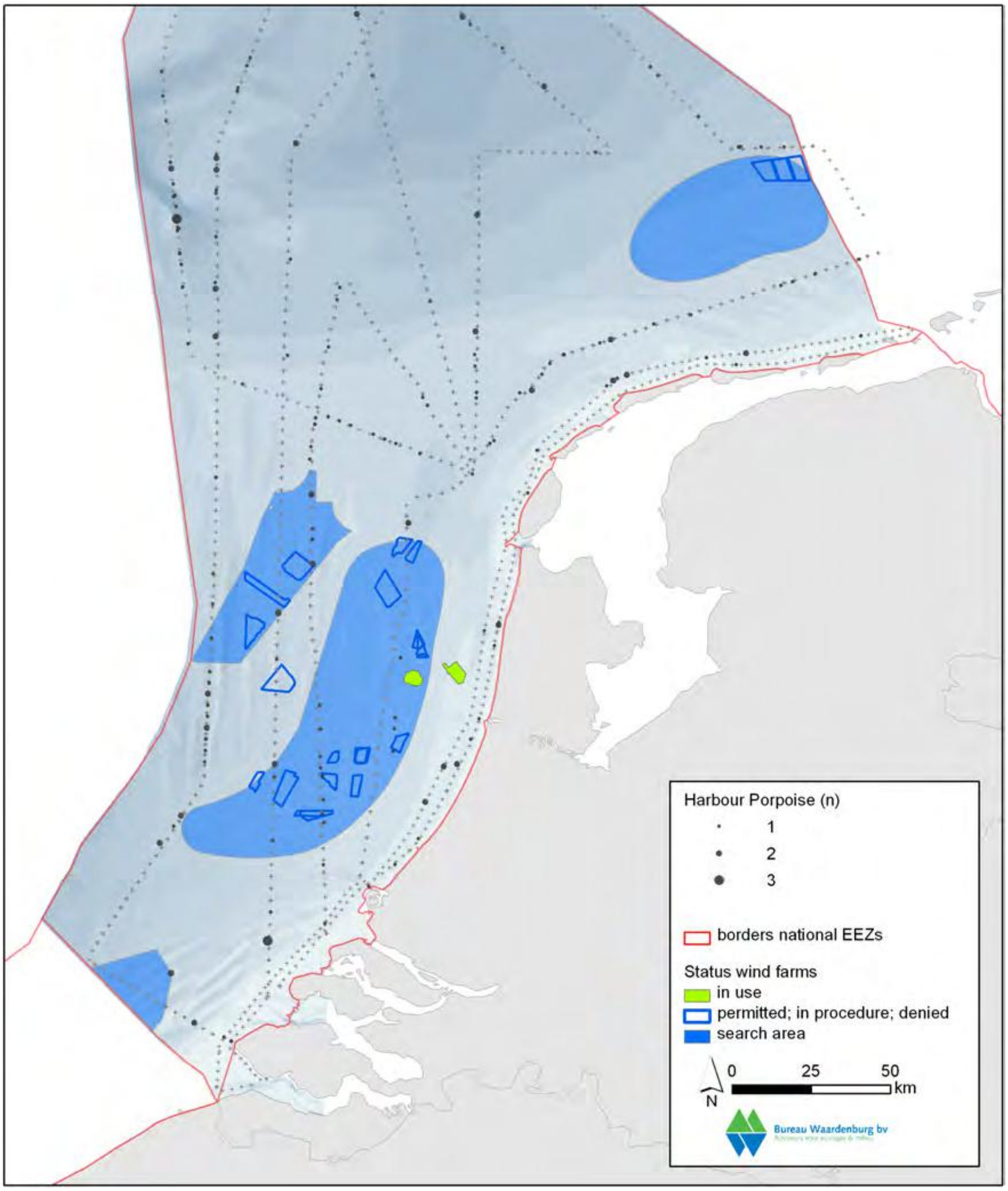


Figure 3.3.1.2 *Cumulative distribution of Harbour Porpoise observed during the aerial-based survey of the MWTL monitoring (six surveys in the period April 2010 – March 2011).*

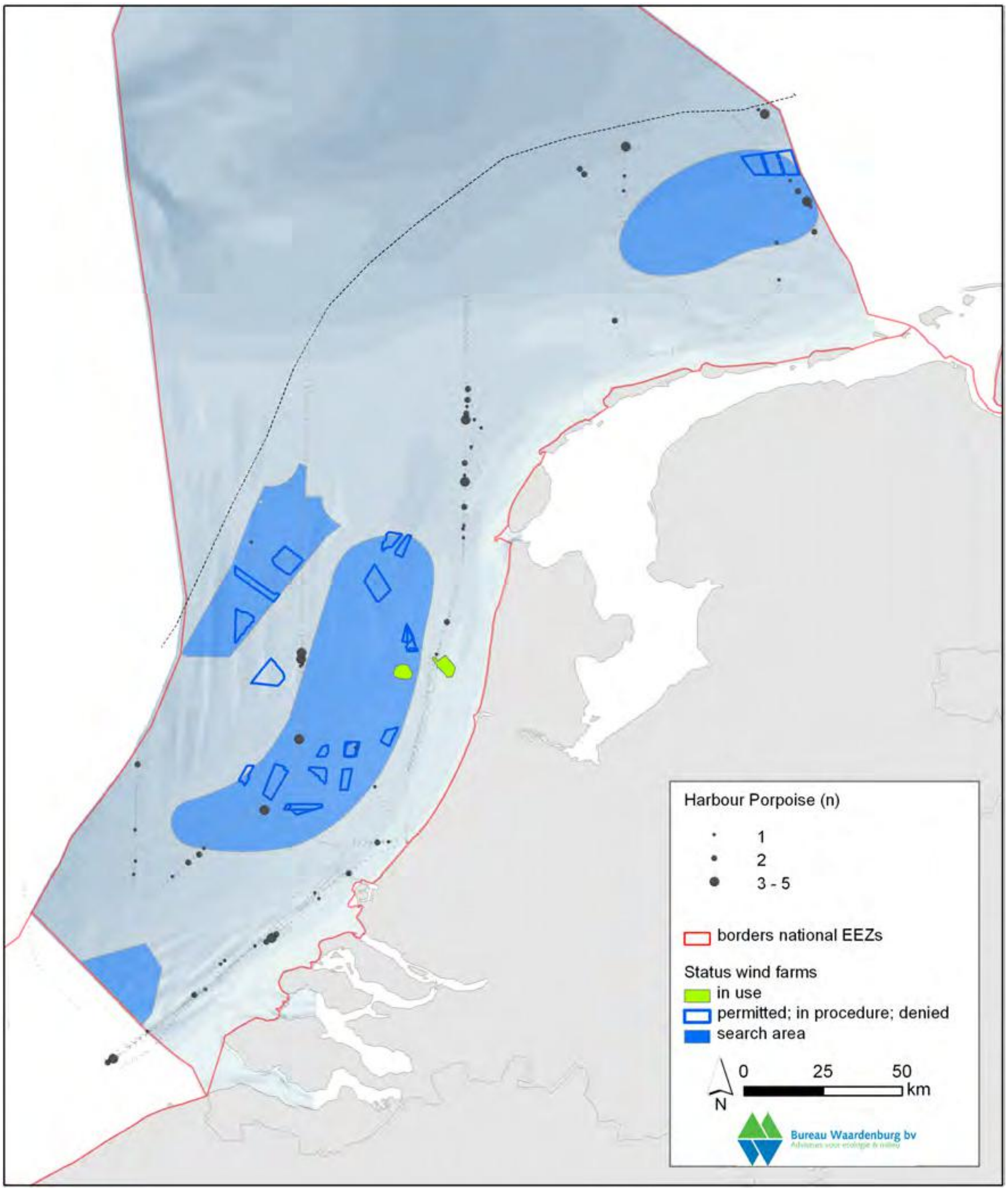


Figure 3.3.1.3 Cumulative distribution of Harbour Porpoise observed during the ship-based survey monitoring Shortlist Masterplan project (surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).

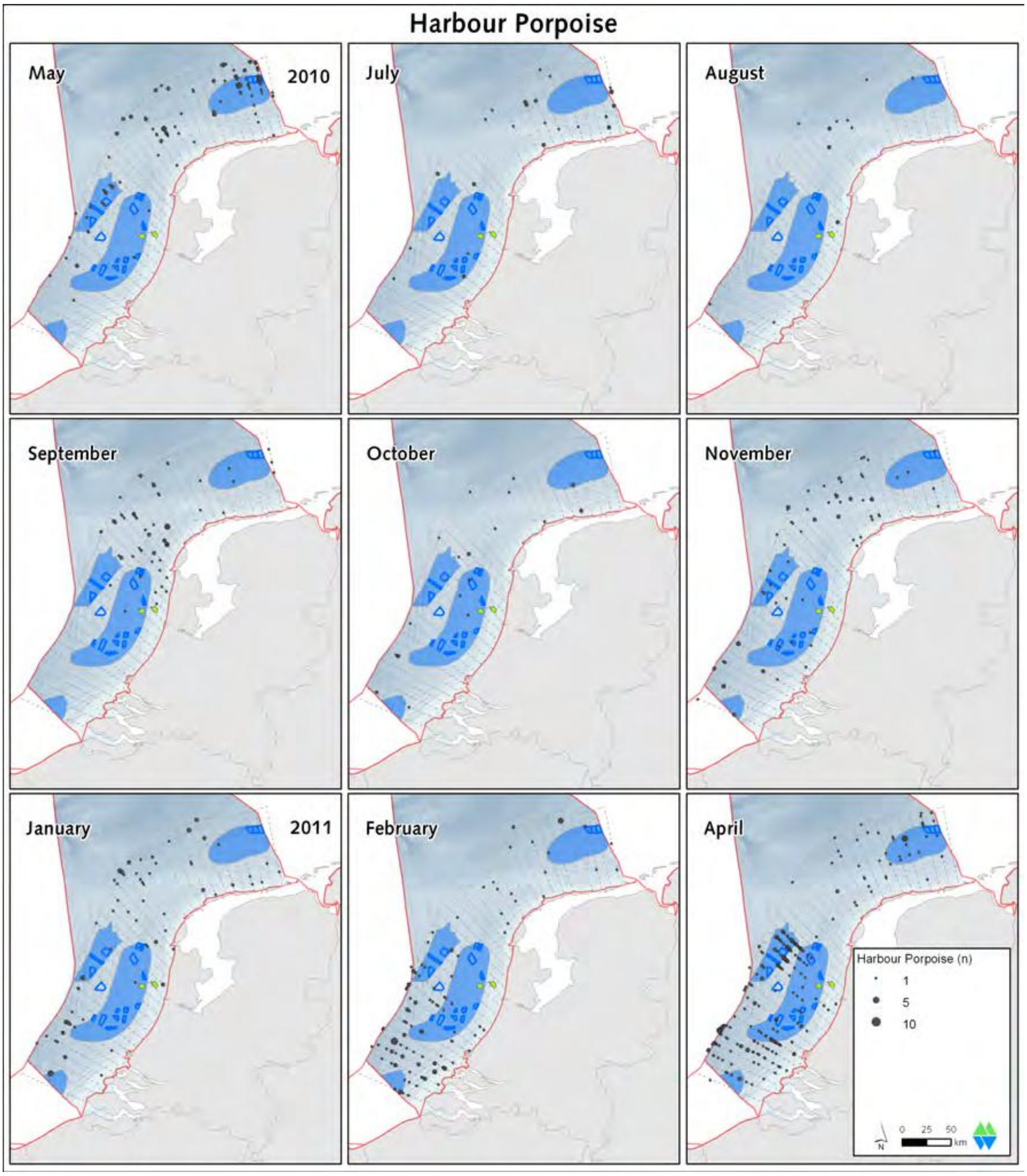


Figure 3.3.1.4 *Distribution of Harbour Porpoise observed during the aerial-based survey monitoring Shortlist Masterplan project per month (nine surveys in the period May 2010 – April 2011).*

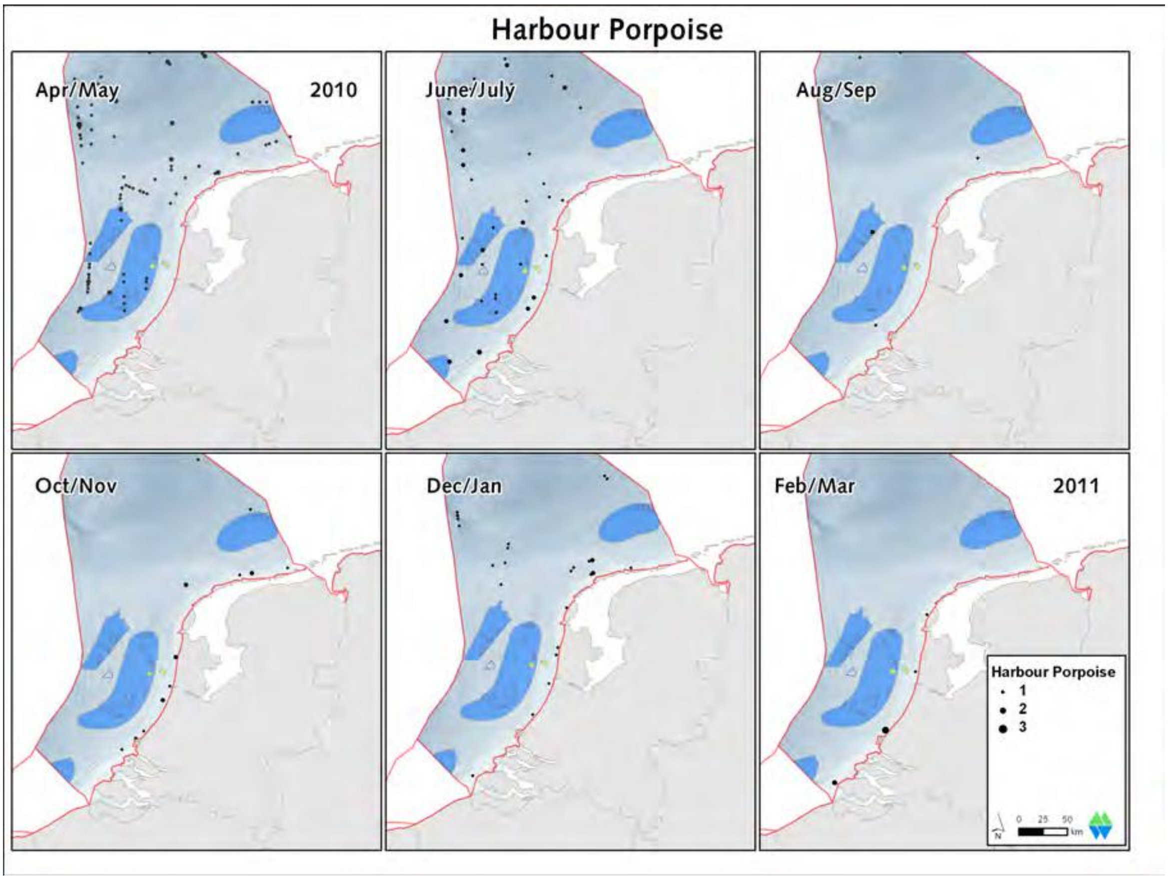


Figure 3.3.1.5 *Distribution of Harbour Porpoise observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).*

3.3.2 Seal spp

Observations in this study

Two species of seals were recorded during the Masterplan Aerial Surveys, Grey Seal and Harbour Seal. Most seals, however, were not identified to species level. The main concentrations of seals were found along the coast on the different haul-out sites. As with Common Scoter, the clustered presence of seal species will give biased results for distribution and density of the species, yet the large number of transects and substantial amount of coast parallel sections of transects provide a good indication of where the hotspots of seal abundance were located. Large numbers of seals were found resting on sandbanks and beaches in the Voordelta (including the newly formed Maasvlakte 2), de Razende Bol, de Richel and het Rif/Engelmansplaat (between Ameland and Schiermonnikoog).

At sea, swimming seals were encountered close to the coast but also far offshore. Most sightings were in the northern part of the study area, but also off the Voordelta seals were seen far offshore.

Associations with other species, fronts or human activities
No associations of seals with other living animals, fronts or human activities were recorded. On one occasion a large male Grey Seal was seen feeding on a large dead fish.

Comparison with ship-based data
Similar to the Shortlist Masterplan aerial surveys the main distribution of seals was in the coastal zone but they were also recorded further offshore in the northern part of the Dutch North Sea. Due to their 'spy-hopping' behaviour seals are easier to detect than Harbour Porpoises from ships. Therefore, the advantage of looking down on an animal (aerial survey) rather than towards an animal (ship-based survey) will be minimal. The detection of seals is therefore expected to be similar between ship-based and aerial surveys. Species identification proved to be easier from a ship. A total of five out of 38 seal sightings could not be assigned to species level during the ship-based surveys, whereas from the aeroplane almost all sightings were recorded as undetermined seal due to the speed of the aeroplane.

Comparison with MWTL data
During the MWTL surveys seals were also recorded. Small numbers of seals were seen in the coastal zone above the Dutch Wadden Isles and some individuals in the Voordelta. Distribution was confined to areas close to the haul-out sites in the Voordelta, Razende Bol, Richel and Engelmansplaat. Small numbers of seals were seen further offshore.

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea
The distribution patterns of seals found in this study are in line with findings in the literature (e.g. Leopold *et al.* 1997, Brasseur *et al*. 2004), which describe concentrations on the coast were found but also foraging trips and migration/dispersal far offshore.

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms
Seals can be encountered in all search areas although during none of the surveys were seals seen in the most southern search area. This area is close to the Voordelta haul-out sites and it is likely that seals swim into this area.

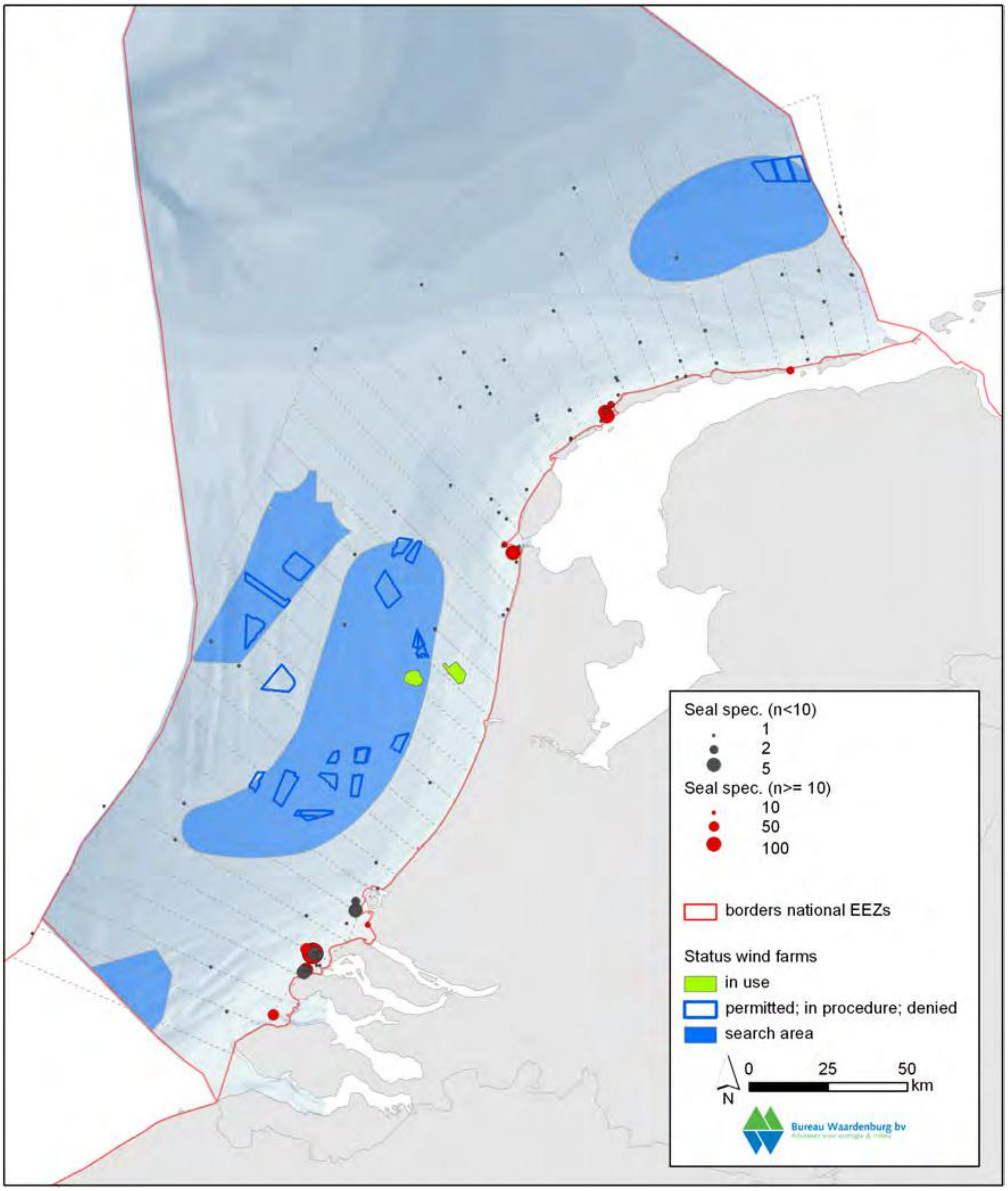


Figure 3.3.2.1 *Cumulative distribution of Seal spp. observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).*

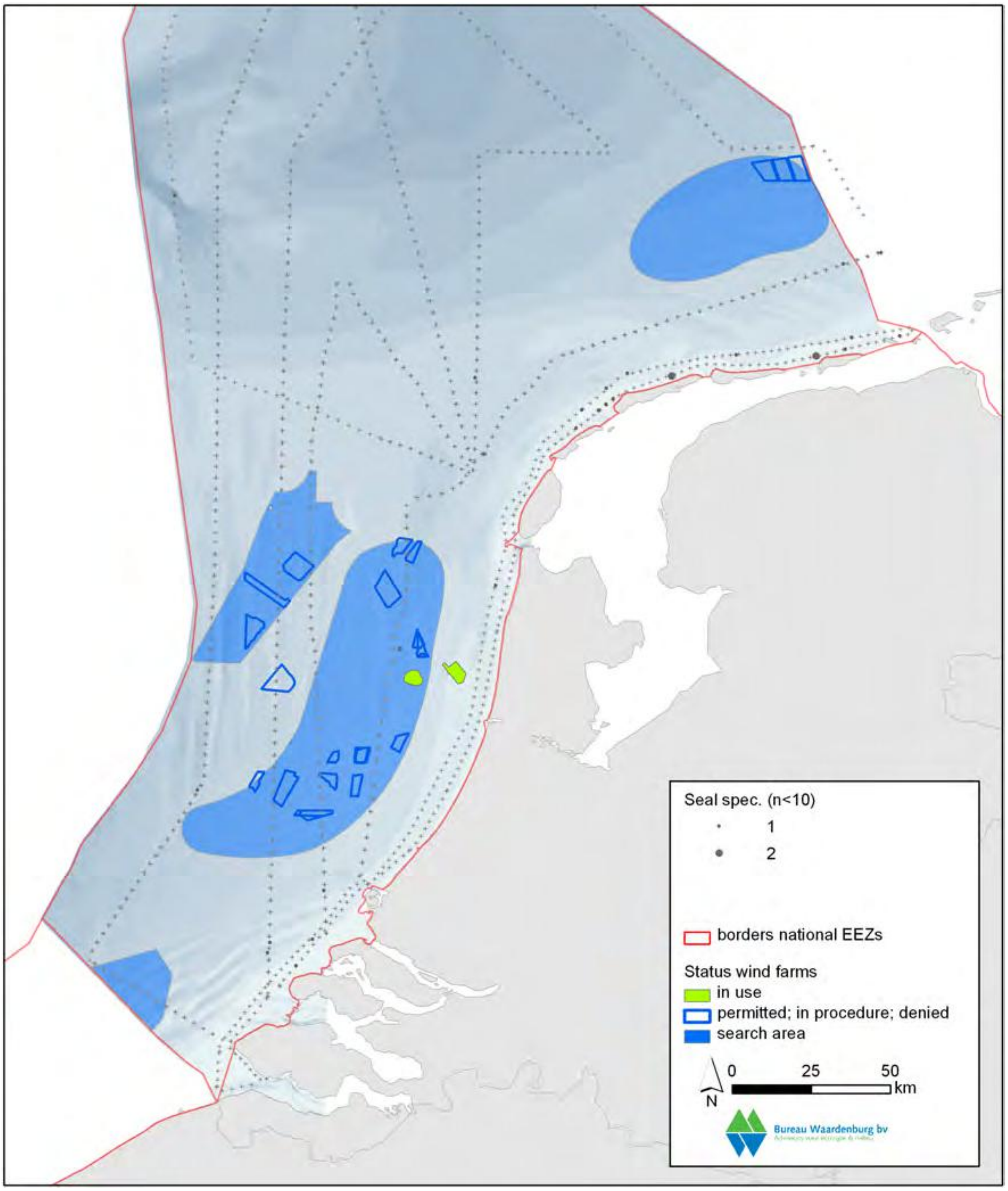


Figure 3.3.2.2 *Distribution of Seal spp. observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).*

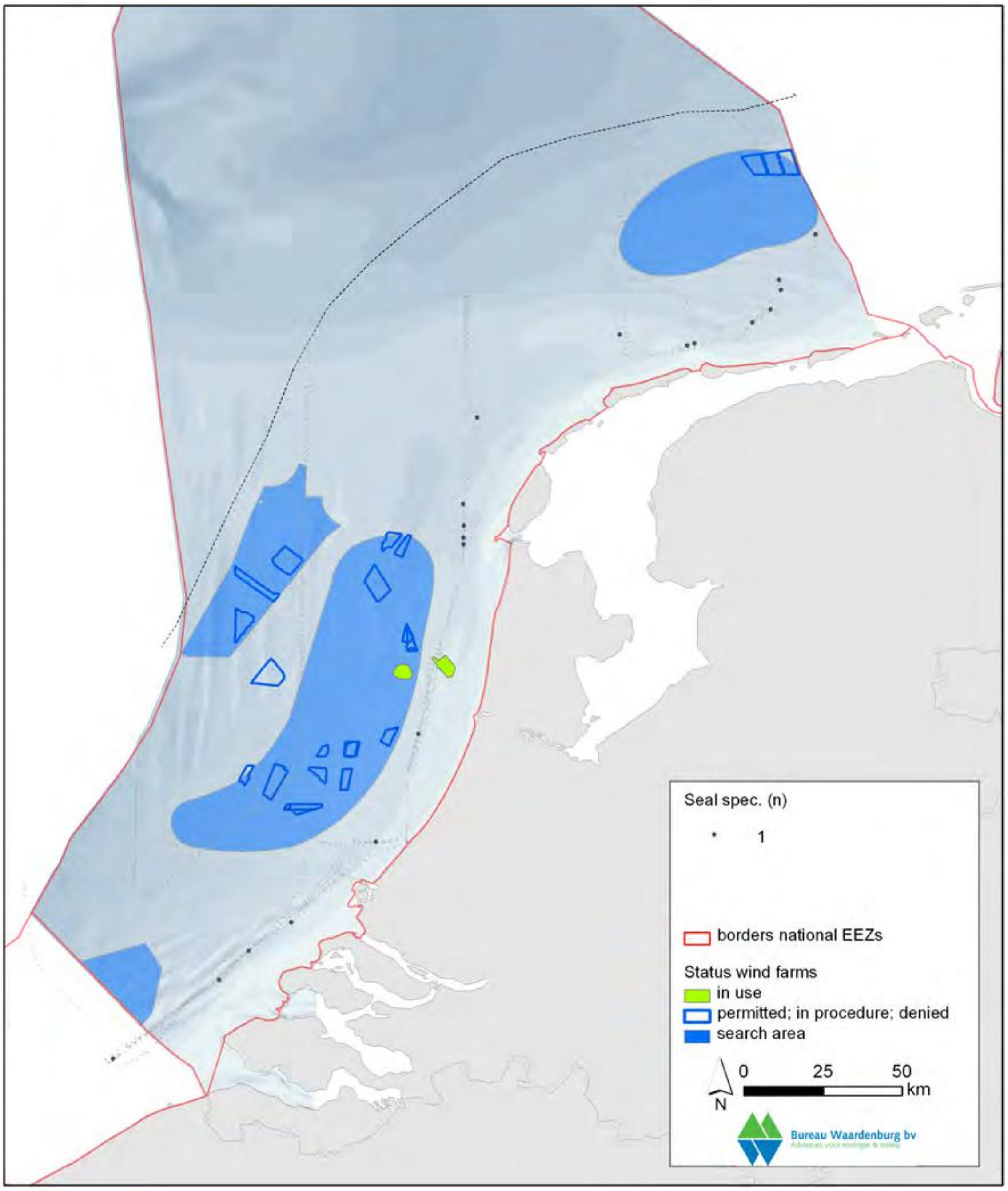


Figure 3.3.2.3 Cumulative distribution of Seal spp. observed during the ship-based survey monitoring Shortlist Masterplan project (surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).

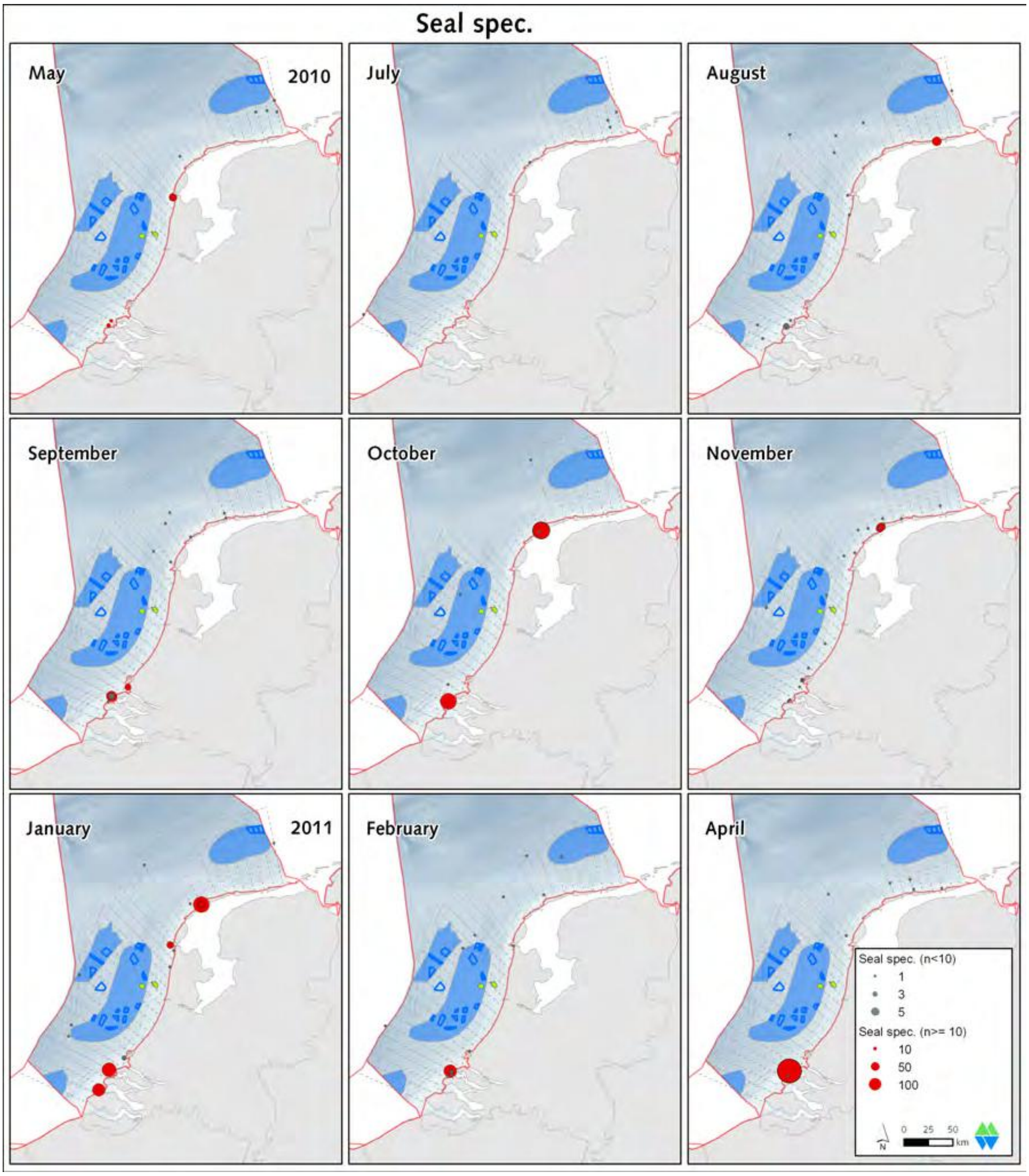


Figure 3.3.2.4 *Distribution of Seal spp. observed during the aerial-based survey monitoring Shortlist Masterplan project per month (nine surveys in the period May 2010 – April 2011).*

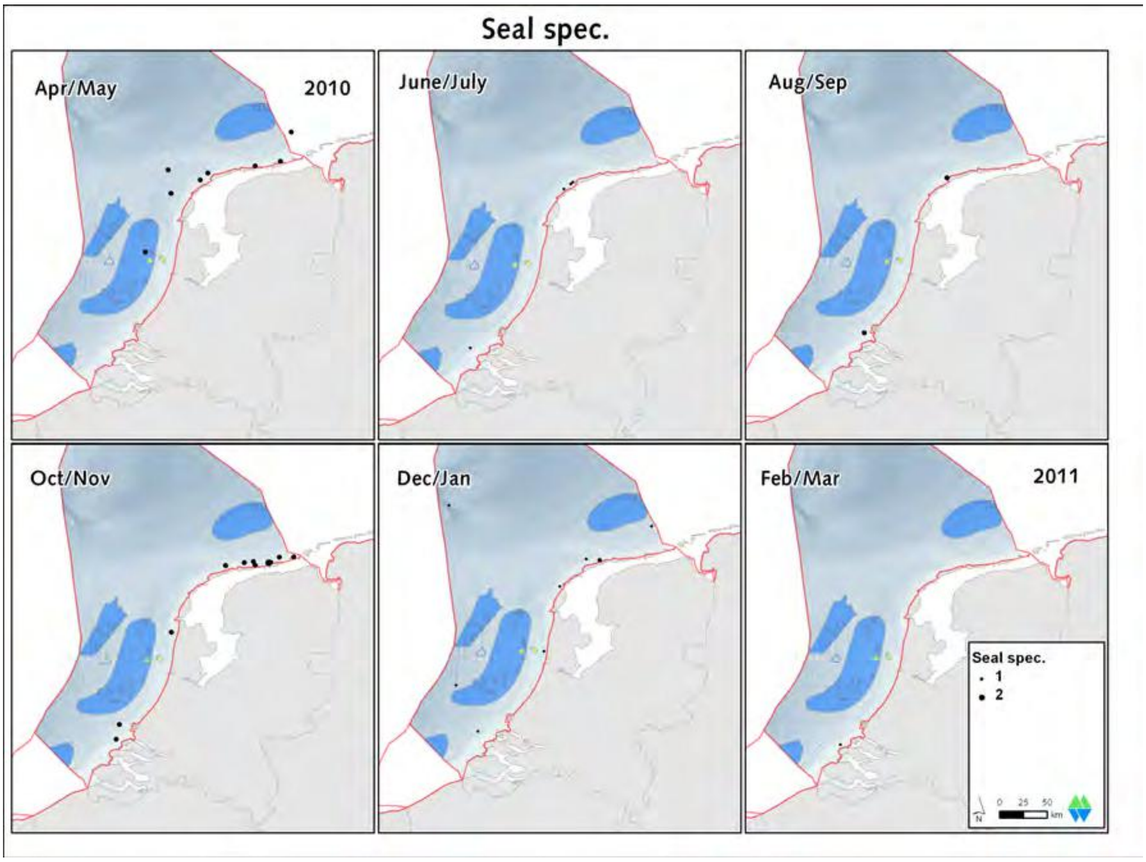


Figure 3.3.2.5 *Distribution of Seal spp. observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).*

3.3.3 Dolphins and whales

Observations in this study

Three other cetacean species have been recorded during the Masterplan Aerial Surveys. Single observations of Bottlenose Dolphins *Tursiops truncatus* and Minke Whale *Balaenoptera acutorostrata* were made north of Texel during the October and July surveys respectively. These species generally occur more northerly in the North Sea but are known to travel great distances and do visit the more central part of the North Sea. Especially Minke Whale is known to be present in substantial numbers in the Doggersbank area during the summer (de Boer, 2010) A total of three observations of White-beaked *Dolphins Lagenorhynchus albirostris* were made during the Masterplan Aerial Surveys, one during May and two during February. Two of these were probably of a resident pod of dolphins living in adjacent Belgian waters, which are encountered frequently during offshore surveys of the Instituut voor Bos- en NatuurOnderzoek (INBO), Brussel (Degraer & Brabant, 2009).

Similar to Harbour Porpoise, other cetacean observations are also limited to periods with good weather conditions (no sun-glare and low sea-state), however, incidences of these species are small and chances of missing animals due to environmental conditions are likely also to be small.

Associations with other species, fronts or human activities
No associations of marine mammals with other phenomena were recorded.

Comparison with ship-based data
Also during the ship-based surveys four other cetacean species were recorded in addition to Harbour Porpoise. All these sightings were outside the area covered during the Shortlist Aerial Surveys. White-beaked Dolphin was the most abundant species, with several pods on the Doggersbank and in the western part of the central Southern North Sea. Short-beaked Common Dolphins were seen off the Belgian coast. Bottlenose Dolphins were seen southeast of the Doggersbank. Minke Whales were seen in May and June, along the flanks of the Doggersbank.

Comparison with MWTL data
No other marine mammals than Harbour Porpoise and seals spp. were recorded during the 2009-2010 MWTL surveys, although sightings outside the surveyed transects do exist.

Discussion of observations in relation to general occurrence in the Dutch part of the North Sea
Other cetacean species than Harbour Porpoise are scarce in the southern and western parts of the Dutch part of the North Sea. Common-, Bottlenose- and especially White-beaked Dolphins are likely to enter the Dutch part of the North Sea from the Channel region in the south. The Northern part of the Dutch North Sea has more resident pods of White-beaked Dolphins and also Minke Whales do regularly occur in spring and summer.

General discussion of occurrence of the species in relation to the search areas for new offshore wind farms
The most southern located search area is closest to the nearest resident White-beaked Dolphins. In the other search areas only incidental visiting cetaceans are expected.

3.4 Accounts miscellaneous – ‘floating matter’

3.4.1 Cargo ships, tankers and other large to medium sized ships

Large to medium ships where recorded across much of the study area. Unsurprisingly the largest numbers were within shipping lanes (shown below in shaded pink) and around ports, particularly off the coasts of Rotterdam, Scheveningen and IJmuiden.

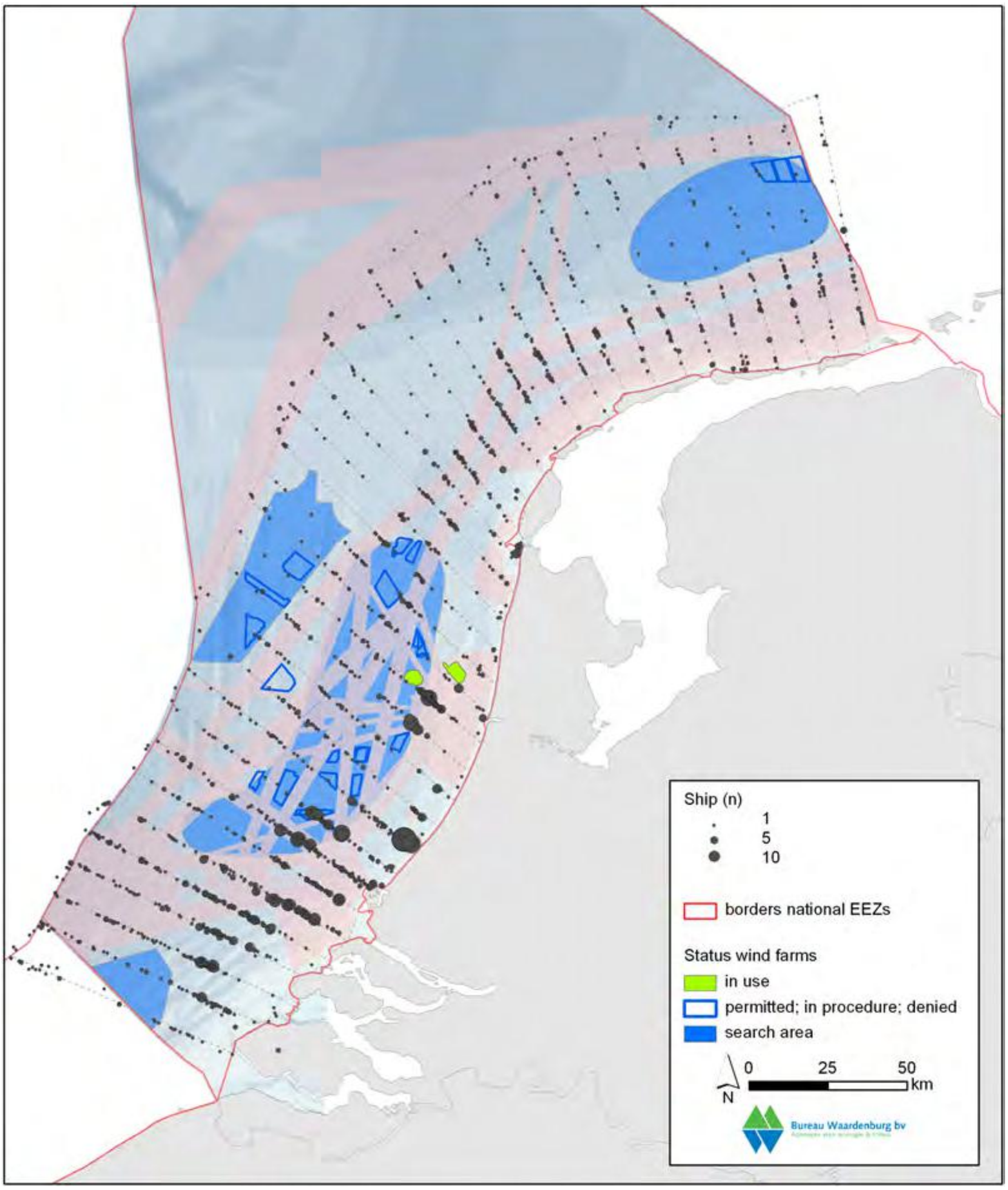


Figure 3.4.1.1 *Cumulative distribution of large to medium sized ships observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).*

3.4.2 Fishing vessels

Fishing vessels were recorded throughout the year and throughout much of the study area. Larger numbers of fishing vessels were recorded close to the coast, particularly around the Wadden Islands. In May, larger numbers were recorded just north of the Waddenzee. In the Texel Reef area (Figure 2.3.6) and in the platform area (Figure 2.3.5) (hardly) no fishing vessels were observed.

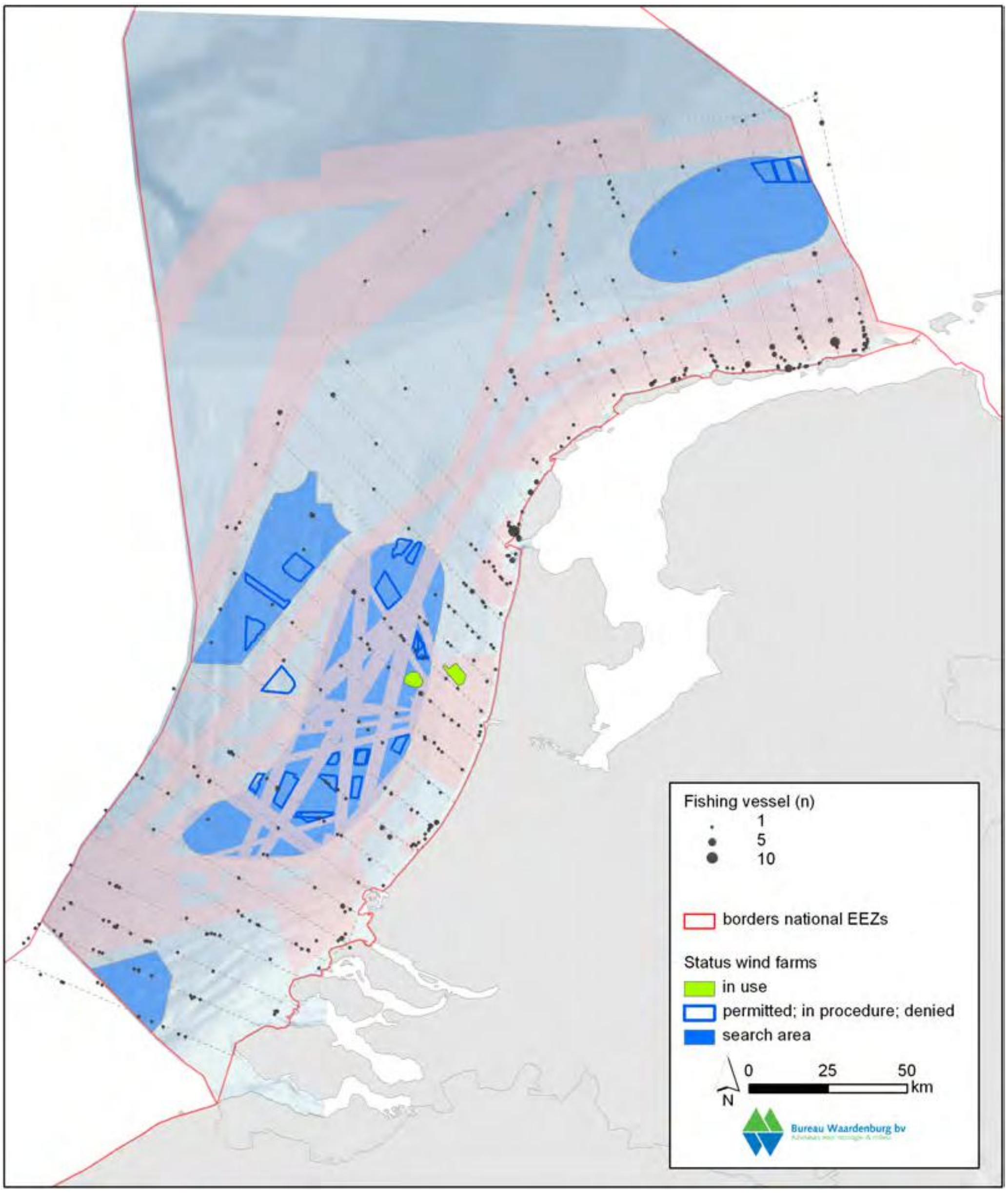


Figure 3.4.2.1 Cumulative distribution of fishing vessels observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).

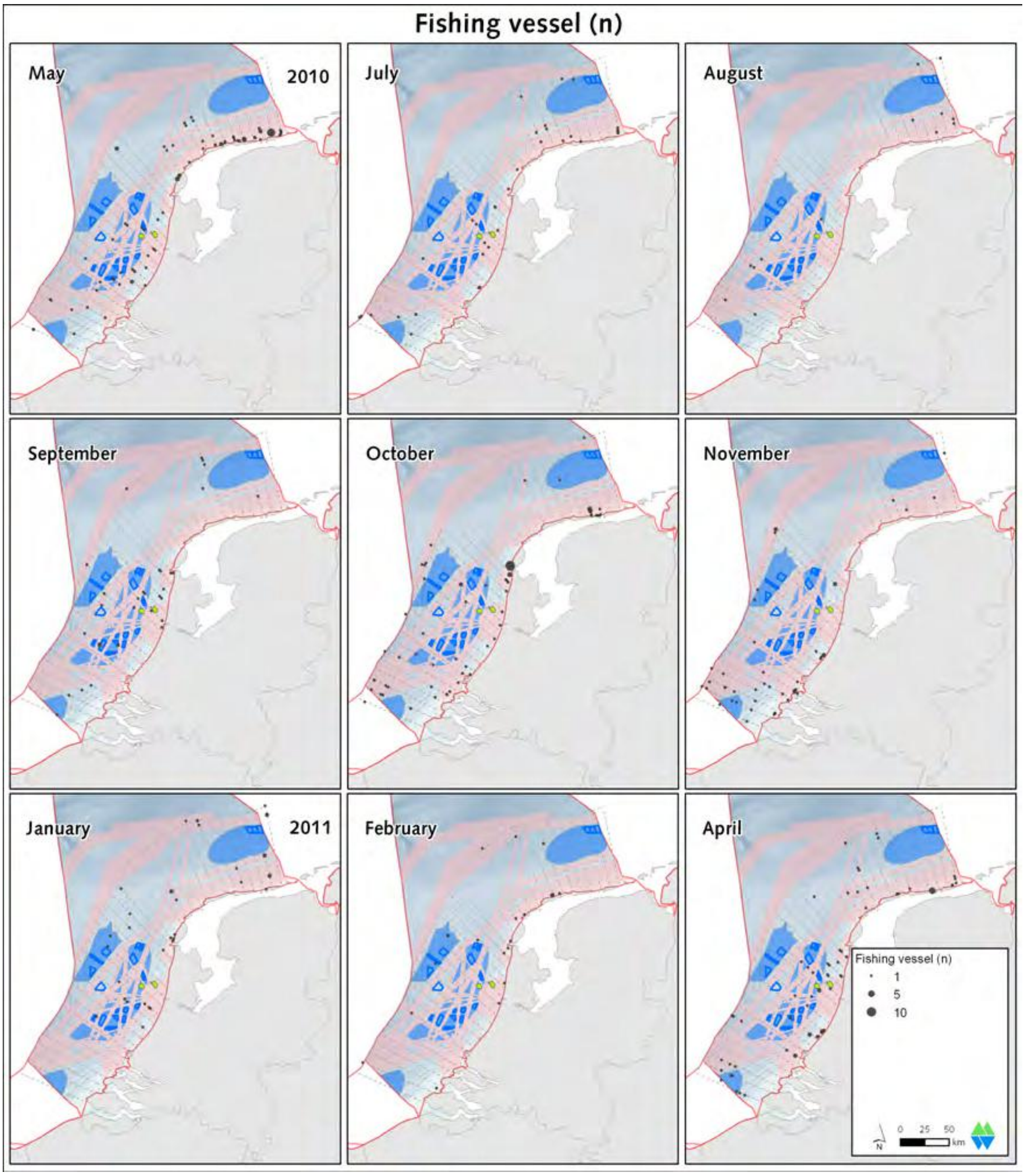


Figure 3.4.2.2 *Distribution of fishing vessels observed during the aerial-based survey of the MWTL monitoring per month (six surveys in the period April 2010 – March 2011).*

3.4.3 Small boats (sail boats, recreational boats, zodiacs, etc.)

Rather unsurprisingly, small boats were concentrated close to the coast, with smaller numbers further offshore. The higher activity off the coast of Noord-Holland is likely to correspond to boats from the harbours of Den Helder and IJmuiden, the latter possibly boats associated with the two wind farms in this area.

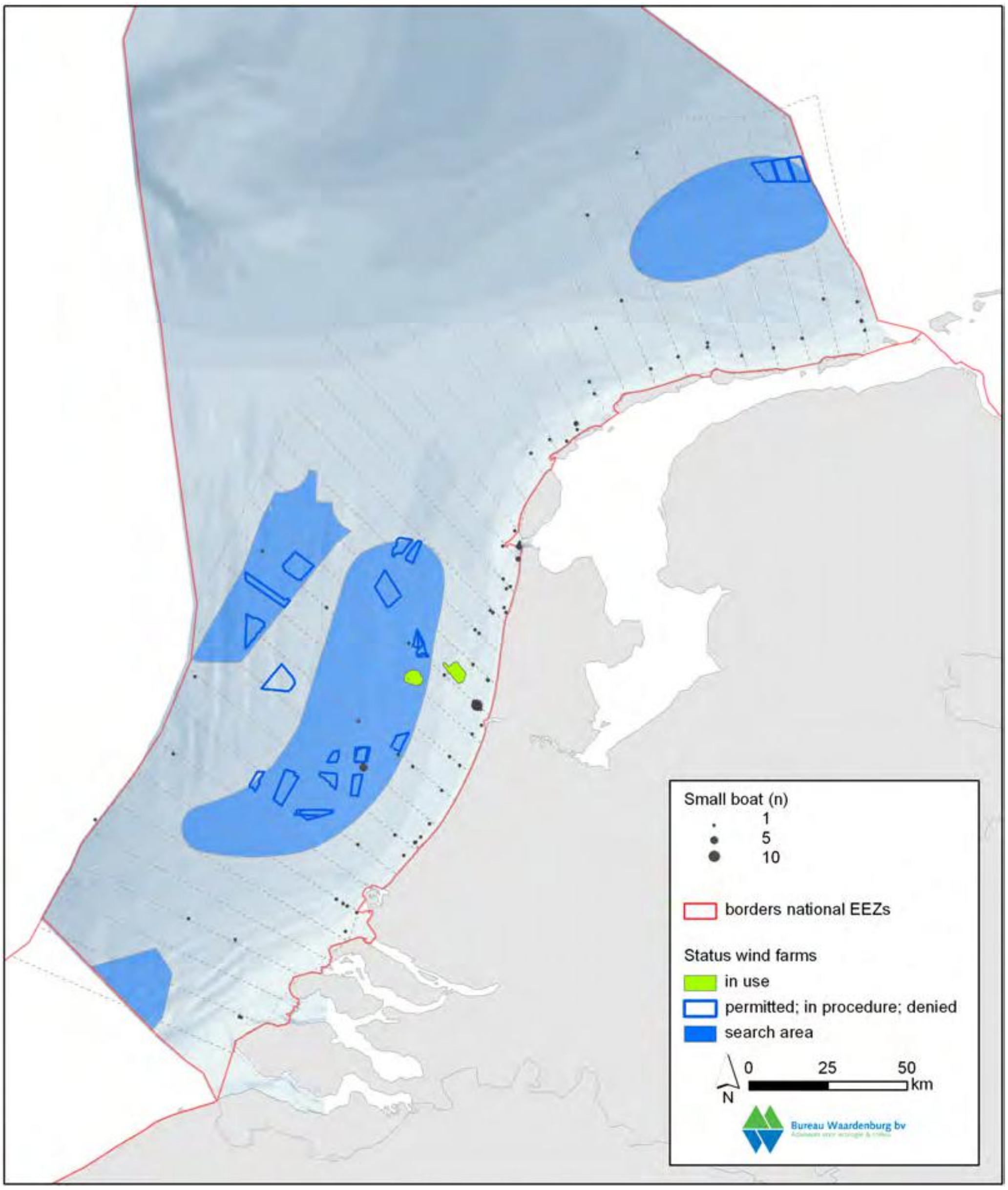


Figure 3.4.3.1 Cumulative distribution of small boats observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).

3.4.4 Debris (large pieces of plastics, parts of floating fishing nets, large pieces of wood, etc.)

Debris was recorded throughout the study area. No clear patterns were evident, although less debris was recorded close to the coast, perhaps relating to the currents.

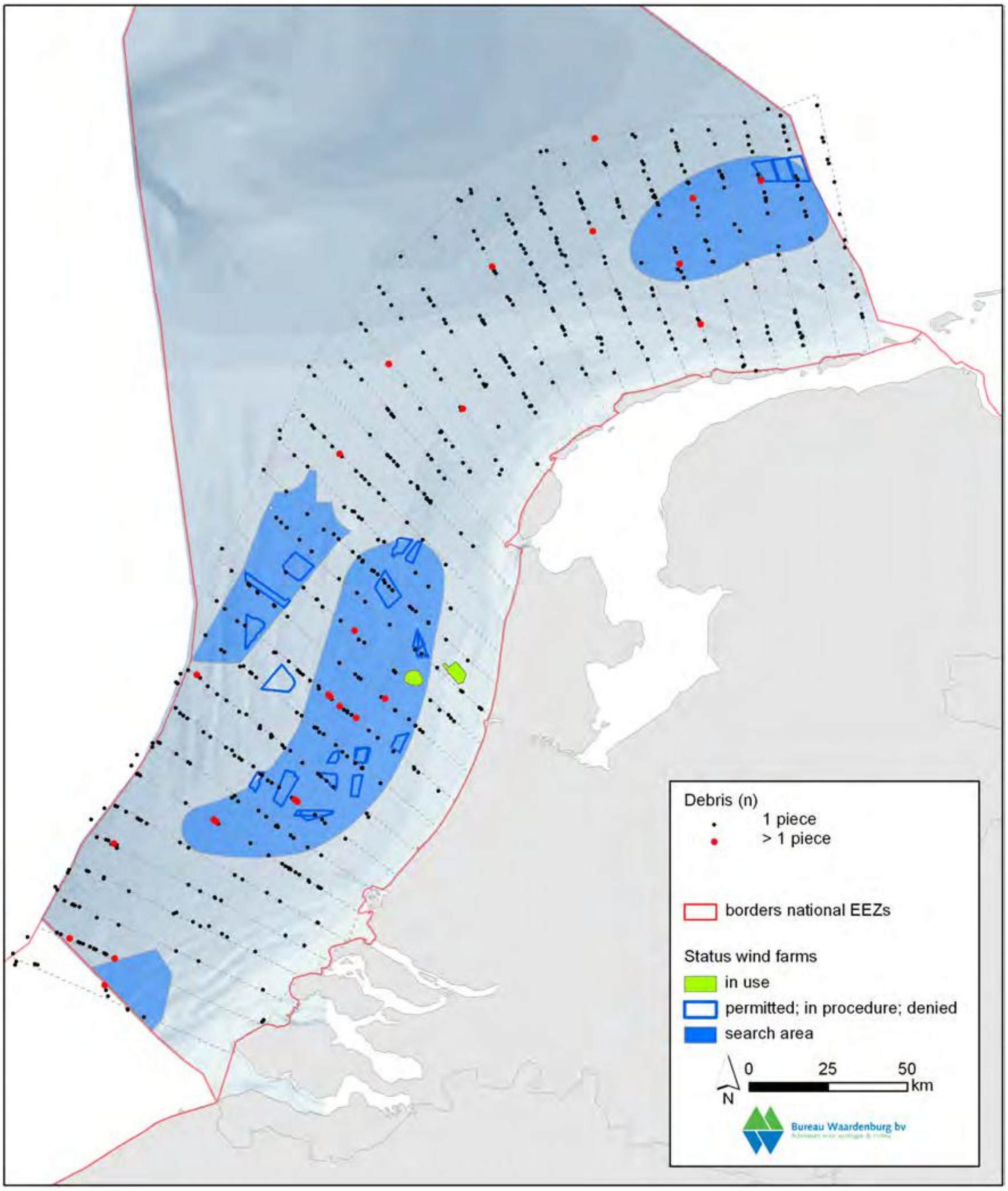


Figure 3.4.4.1 Cumulative distribution of debris observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).

3.4.5 Balloons

Balloons (party balloons) floating on the water were recorded across much of the study area, although in low numbers. At times multiple balloons tied together were recorded.

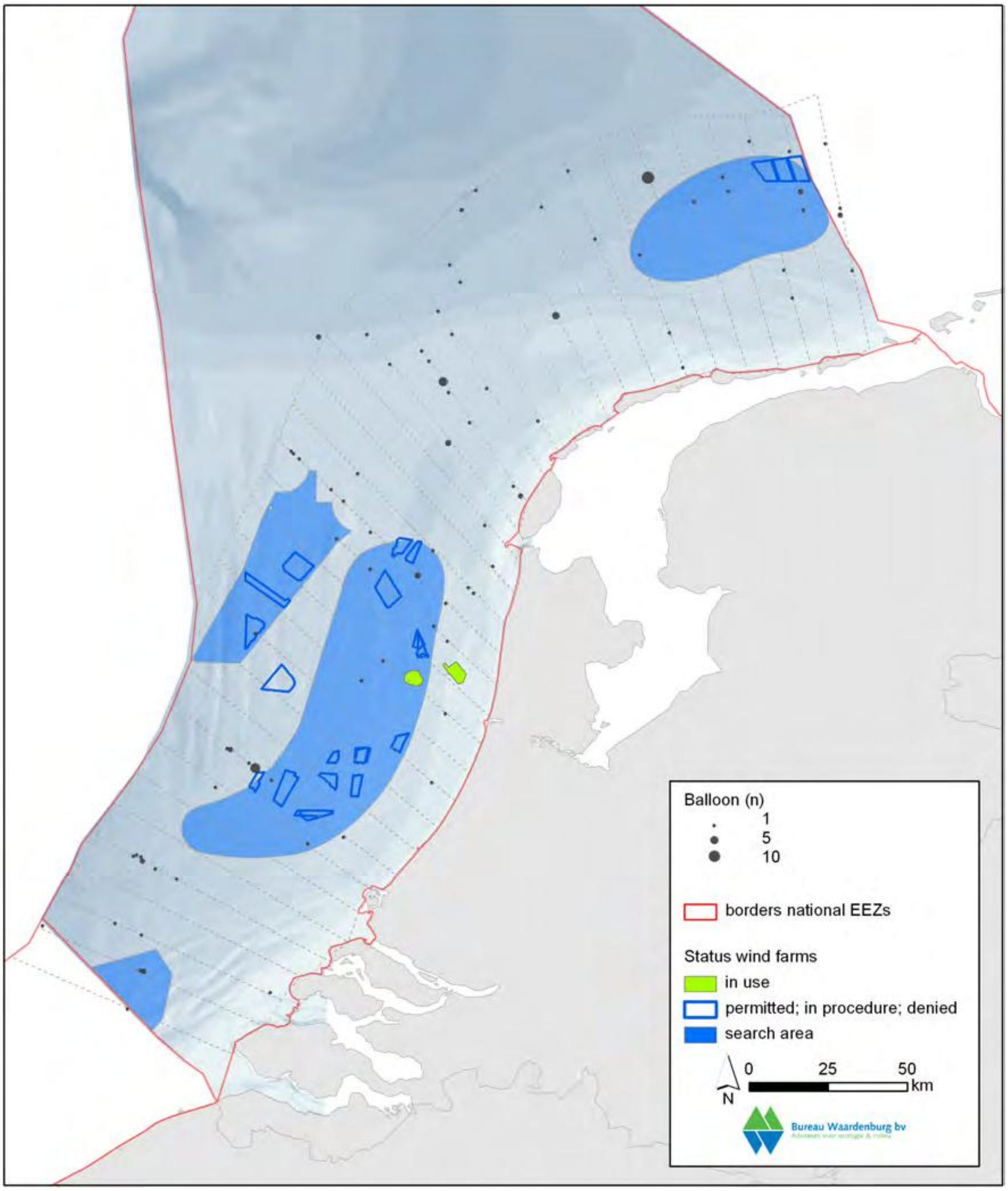


Figure 3.4.5.1 Cumulative distribution of ballons observed during the aerial-based survey monitoring Shortlist Masterplan project May 2010 – April 2011 (nine surveys).

4 Comparison of the Shortlist Masterplan aerial surveys with ship-based observations and the aerial program MWTL

4.1 Species identification in the Shortlist Masterplan aerial survey program compared with ship-based observations

In this section the proportions of identified species (and unidentified) recorded in the Shortlist Masterplan aerial surveys are compared with those of the ship-based surveys. Also it should be emphasized here that the comparisons made are to verify whether there are indications that large differences in species identification occur due to the differences in methodology and/or survey platform used. One should bear in mind that many differences described below can alternatively be the result of the differences in distribution of the evaluated species or species groups and the differential coverage both in time and space of the aerial surveys and ship-based surveys.

The accuracy of the data first of all depends on the correct identification of the species concerned. In section two several identification issues have already been addressed for certain species and species groups. Calibration of these species identification issues is possible by comparing the data obtained during ship-based surveys and aerial-based surveys. (Figures 4.1.1 to 4.1.6).

Skuas
The identification of Skua species during aerial surveys is well in accordance with the identification during ship-based surveys (Figure 4.1.1). The proportion of different species is comparable in all months. During both surveys Parasitic Skuas are only observed in summer, Long-tailed Skuas only in autumn and Great Skuas approximately in all months. During the aerial surveys two observations of Skua (10%) could not be identified to the species level (these were either Parasitic Skua or Long-tailed Skua).

Terns and Little Gull
The proportion of different tern species differs between aerial-based surveys and ship-based surveys. The proportion of small terns (Common Terns, Arctic Terns and Black Terns) is considerably higher in the ship-based survey dataset (Figure 4.1.2). On the contrary, the proportion of Sandwich Terns is higher in the aerial-based dataset. Although a large number of small terns could not be identified to the species level during aerial surveys this does not explain the difference in the proportion of terns. Nor is this likely due to differences in the timing of the surveys. The difference is more likely due to the survey design with relatively more transect length near the coast during ship-based surveys. As Common Terns and Sandwich Terns are more abundant near the coast this may explain why the proportion of Common Terns is

relative high during the ship-based surveys. The lower number of Sandiwch Terns on ship-based surveys might be due to flying birds, which may be relatively high, being overlooked. The proportion of Little Gull during aerial surveys is well in accordance with the identification during ship-based surveys.

Auks

The identification of auk species during aerial surveys is well in accordance with the identification during ship-based surveys (Figure 4.1.3). Overall the proportion of Razorbills was slightly higher than in the ship-based dataset. This can be explained by the fact that a certain amount (16%) of auks could not be identified to the species level from the aeroplane. These birds were recorded as 'Guillemot / Razorbill'.

Small gulls

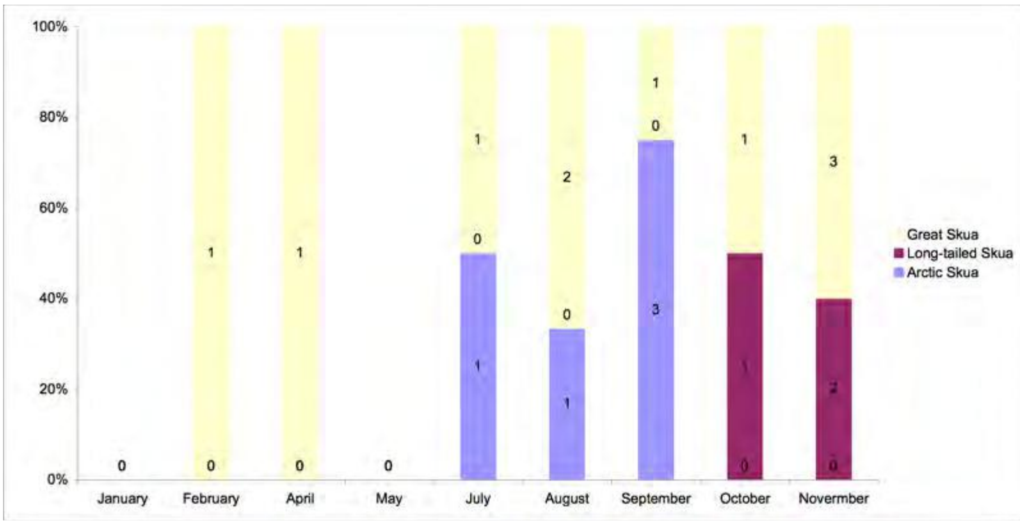
Overall the identification of small gull species during aerial surveys is well in accordance with the identification during ship-based surveys, although some differences appear between months (Figure 4.1.4). First of all this is due the fact that a certain amount (overall 19%) could not be identified to the species level from the aeroplane. These birds were recorded as 'unidentified small gulls'. Moreover, differences between both datasets can be explained from the behaviour of the species concerned. The occurrence of Kittiwakes and Common Gulls may differ day to day due to the presence or absence of fishing vessels, which may in turn affect the proportion of different small gull species.

Large gulls

Overall the identification of large gull species during aerial surveys is well in accordance with the identification during ship-based surveys, although some differences appear between months (Figure 4.1.5). First of all this is due the fact that a certain amount (overall 23%) could not be identified to the species level from the aeroplane. These birds are recorded as 'unidentified large gulls'. Moreover, differences between both datasets can be explained from the behaviour of concerned species. The occurrence of Herring Gulls may differ day to day due to the presence or absence of fishing vessels and weather conditions, which may in turn affect the proportion of different Large gull species.

Divers

During the ship-based surveys within the study area no diver species other than Red-throated Divers were recorded (Figure 4.1.6). This is in concordance with the fact that in the Dutch North Sea the Red-throated Diver is by far the most abundant species. During the aerial surveys almost 90% of the observed divers could be identified (mostly as Red-throated Divers), this was largely due to the low flight altitude.



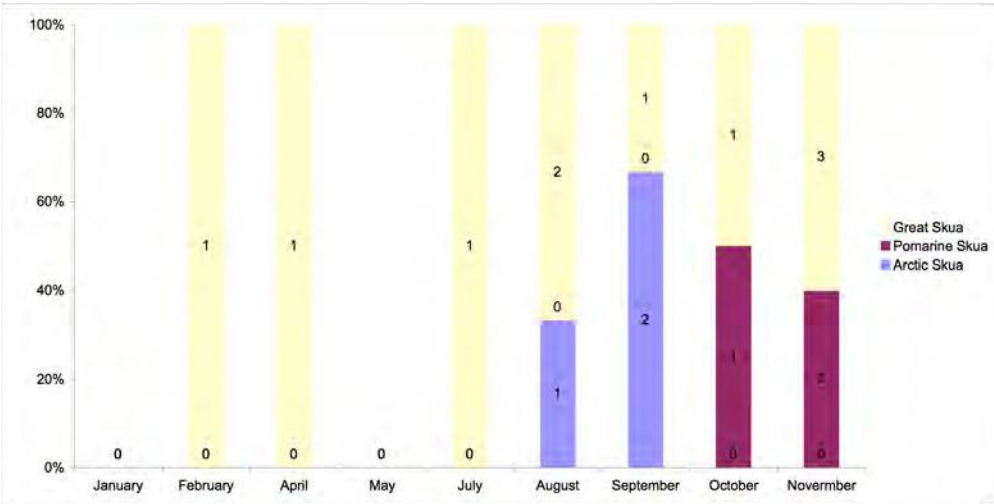
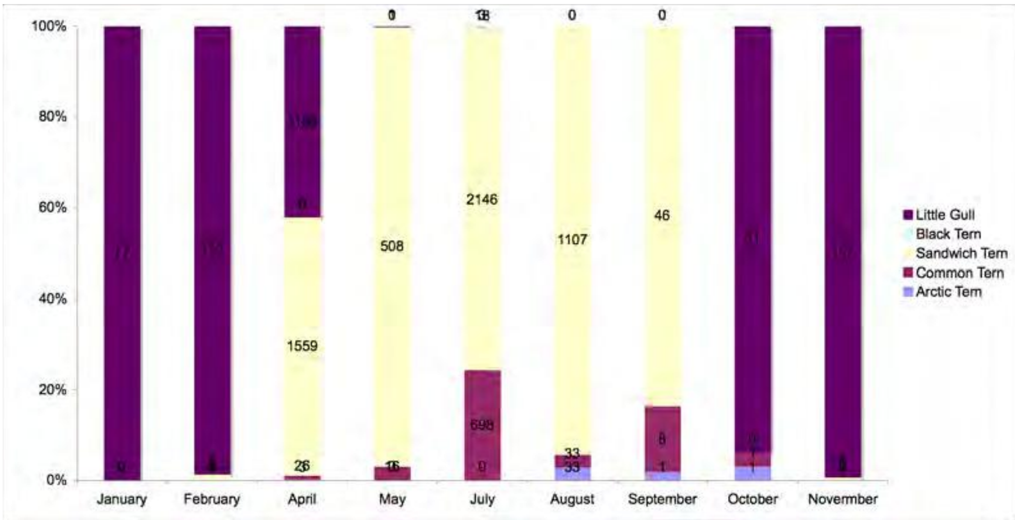


Figure 4.1.1 *Proportion of different Skua species recorded during aerial surveys (above) and ship-based surveys (below) (both surveys of Shortlist Masterplan project, nine ship surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).*



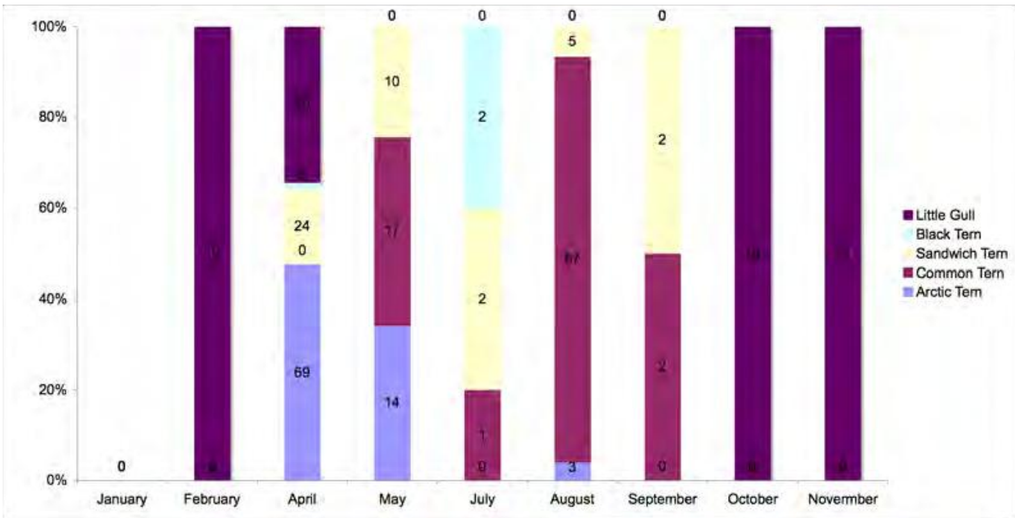
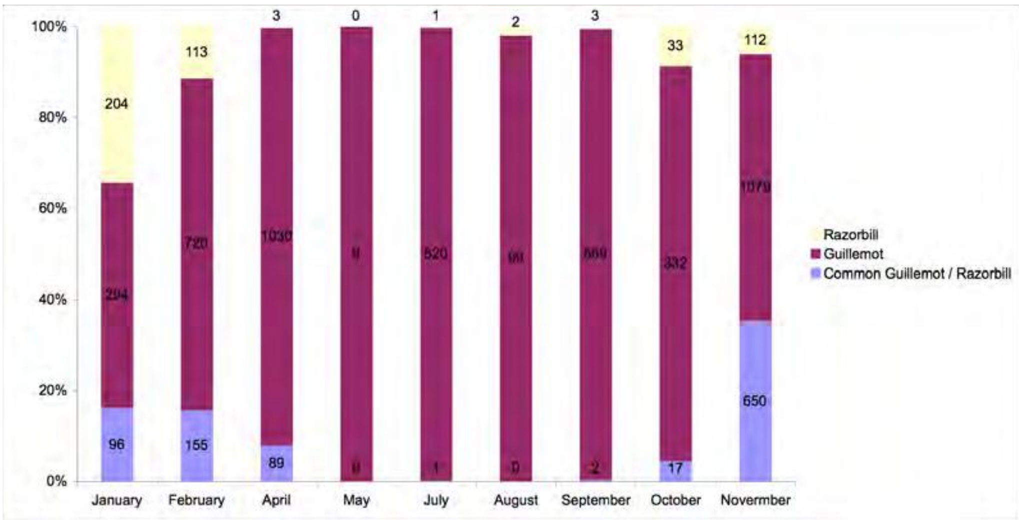


Figure 4.1.2 Proportion of different Tern species and Little Gull recorded during aerial surveys (above) and ship-based surveys (below) (both surveys of Shortlist Masterplan project, nine ship surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).



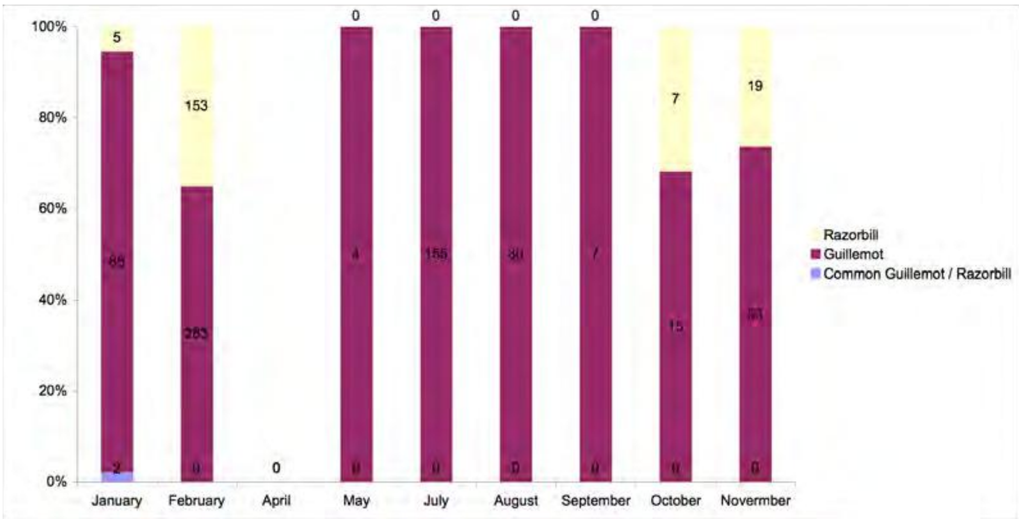


Figure 4.1.3 Proportion of different Auk species recorded during aerial surveys (above) and ship-based surveys (below) (both surveys of Shortlist Masterplan project, nine ship surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).

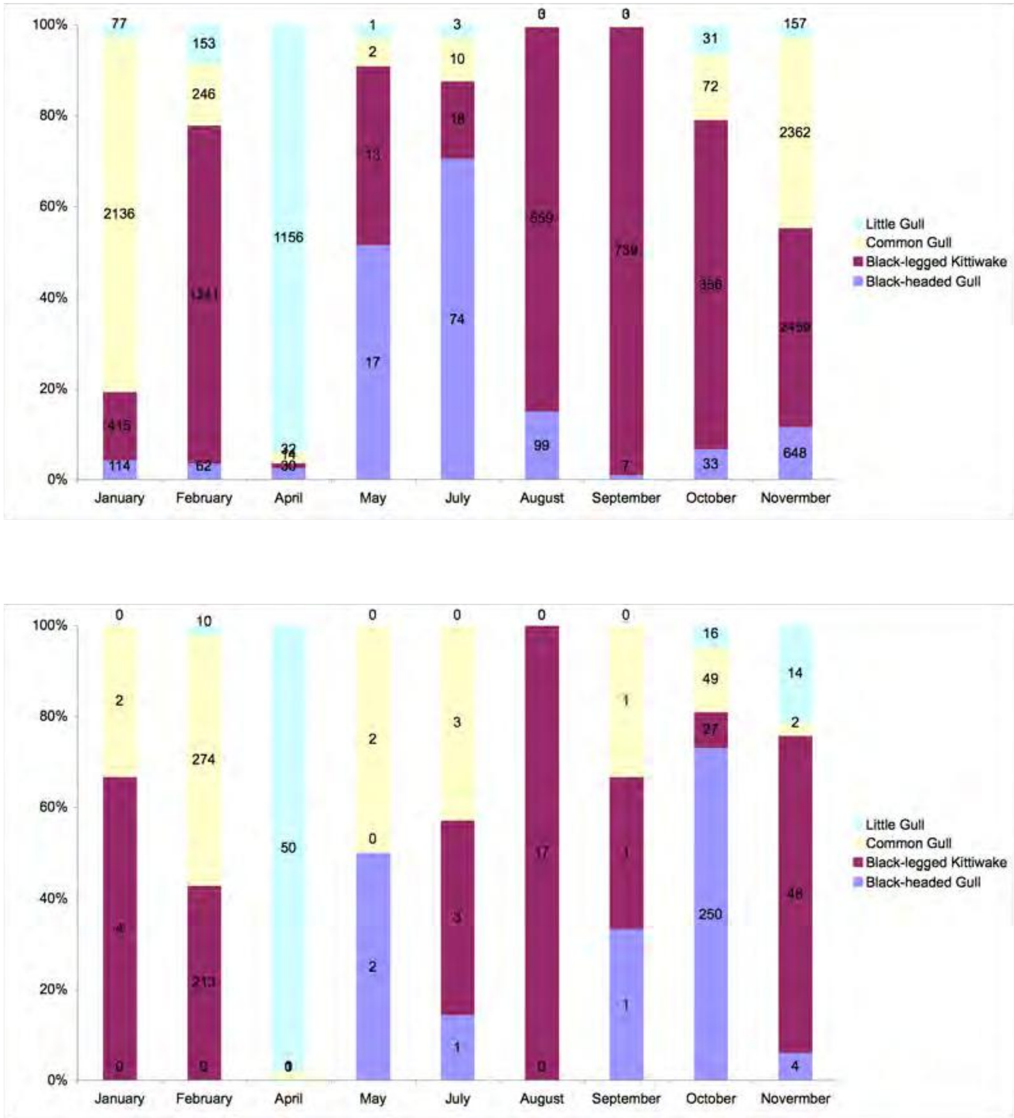
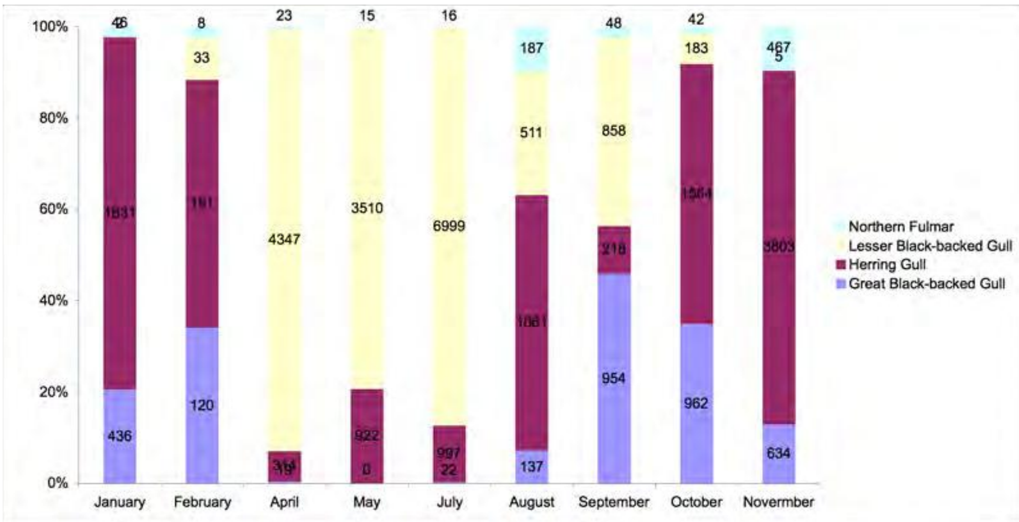


Figure 4.1.4 Proportion of different small Gull species recorded during aerial surveys (above) and ship-based surveys (below) (both surveys of Shortlist Masterplan project, nine ship survey selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).



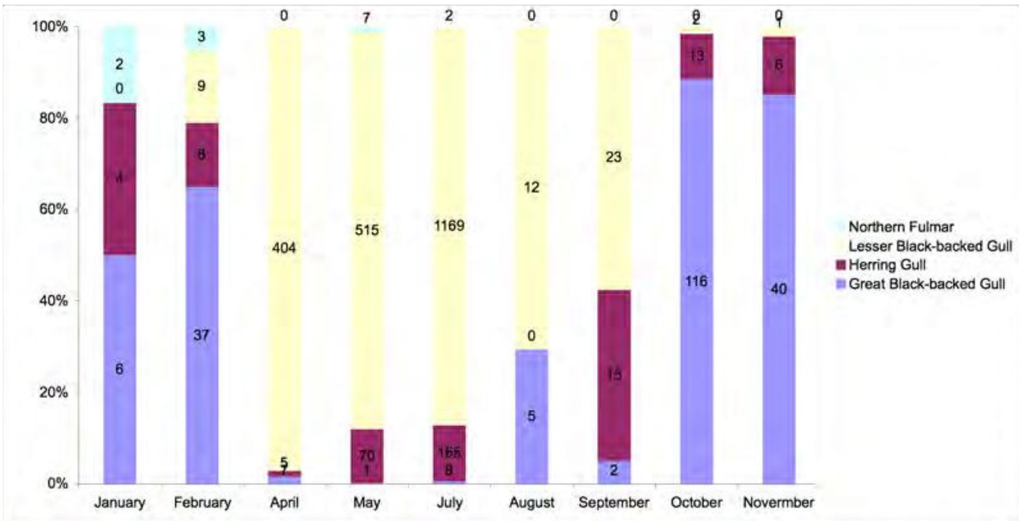
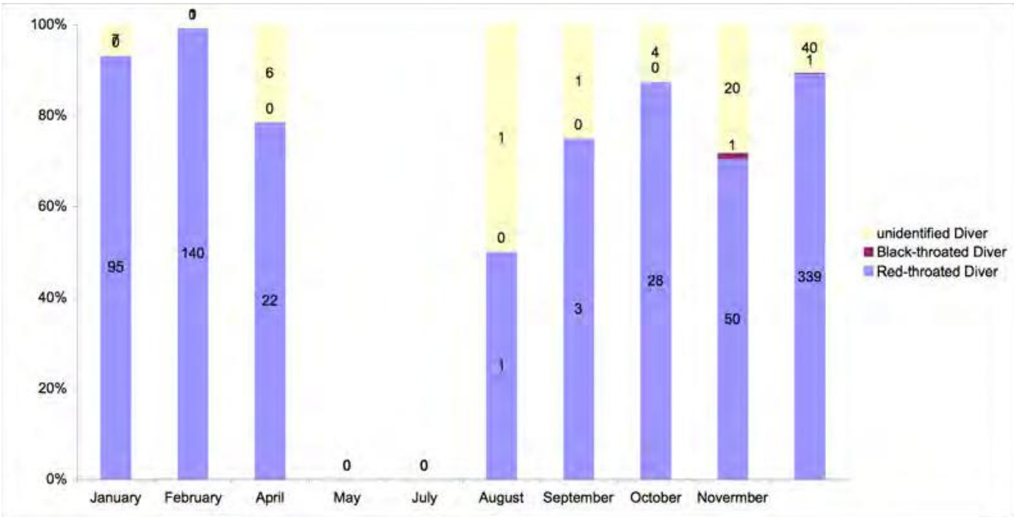


*Figure 4.1.5 Proportion of different large Gull species recorded during aerial surveys (**above**) and ship-based surveys (**below**) (both surveys of Shortlist Masterplan project, nine ship surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).*



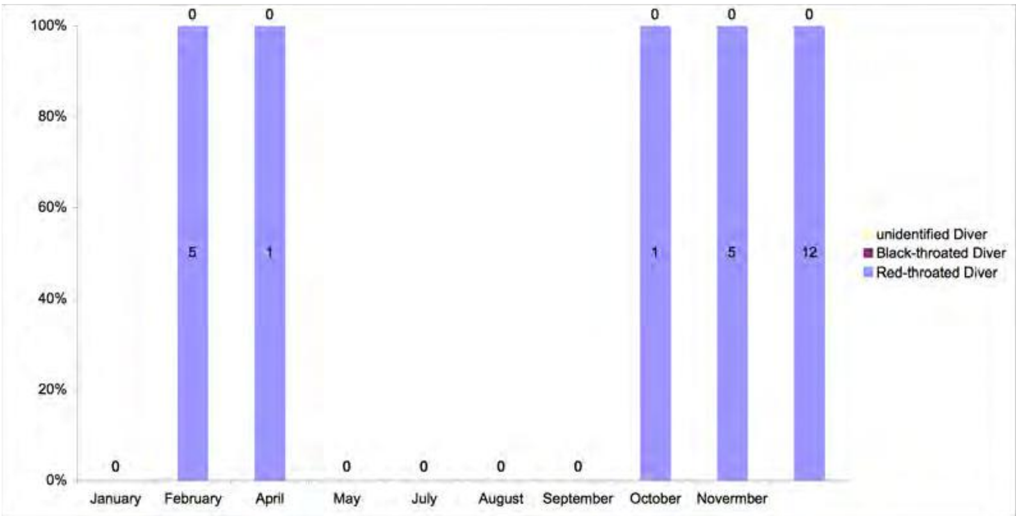


*Figure 4.1.6 Proportion of different Diver species recorded during aerial surveys (**above**) and ship-based surveys (**below**) (both surveys of Shortlist Masterplan project, nine ship surveys selected in the same months as the aerial-based surveys in the period May 2010 – April 2011).*

4.2 An initial comparison of calculated densities from different types of surveys

The following comparisons must be regarded as a first exercise. The number of surveys compared are of such a low number that it is clear, even before hand, that no firm conclusions can be drawn. At most, indications for future analyses with much more data can be achieved. Furthermore, it should be realised that differences in densities can be the result of a number of factors. First of all, because the huge variability in occurrence of seabirds both spatial as well temporal, differences can be due just that the surveys hardly have any overlap on a daily basis. Within a week, let alone within the same month large differences in the presence of seabirds can occur. Furthermore, the Shortlist Masterplan aerial survey in April was conducted in another year (2011) than the MWTL aerial survey and ship-based survey (2010). For an explanation of the calculation of densities from the different survey data see sections 2.4 and 2.5.

Comparison of densities from aerial and ship-based surveys
Ship-based surveys are thought to provide better density estimates for certain species than aerial surveys and vice versa. However, species that spend much of the time in flight are generally under-recorded during ship-based surveys (Poot *et al.* 2010). The same is true for species that are frequently considered to be associated with ships and which are subsequently removed from density calculations. Aerial surveys, therefore, are expected to yield higher densities of those species that are frequently recorded in flight, such as terns, and those species that associate with ships, such as Kittiwake. Finally, species that are highly sensitive to disturbance, such as divers, often take flight at great distances (often more than 1 km) and are also easily missed by ship-based surveys.

The species groups that are generally recorded in higher densities by ship-based surveys than aerial surveys includes species that undertake foraging dives such as auks. These species have more chance of being underwater for the entire duration of the pass of the aeroplane than for that slower moving ship, meaning that more individuals will be missed by the aerial survey. Furthermore, species with countershading plumages are more difficult to detect from the air, as their lighter undersides are less visible than from a ship. It is possible that the longer search time per area from a ship may also play a role in the number of auks detected. As with ships, disturbance from the aeroplane can also have an influence on certain species. The numbers of Northern Gannets recorded during aerial surveys can be lower as birds fly out of the path of the aeroplane before being counted. In general, gull species are considered to be counted better by ship-based surveys, especially when large concentrations are present. The limited time to count such flocks from a fast moving aeroplane may have an influence on count accuracy and species determination, meaning that a greater proportion of the birds are classed simply as 'gull' or 'large gull'. Aerial surveys using strip-band methodology, such as the MWTL surveys, do not count the proportion of the flock that is outside of the survey strip.

The calculated densities recorded for seabird species in the overlapping study areas of the Shortlist Masterplan differ between the different surveys methods (Table 4.2.1). As discussed above, aerial surveys provide higher density estimates for species commonly recorded in flight, such as Sandwich Tern, and those often recorded as associated with ships, such as Kittiwake and European Herring Gull. Interestingly, the densities of Northern Gannets calculated from the Shortlist Masterplan aerial surveys seems slightly higher or comparable to those from the MWTL and ship-based surveys, suggesting that disturbing birds out of the transect is little of an issue. Differences between the densities of Guillemots from the Shortlist Masterplan aerial surveys and ship-based surveys are apparent in some of the survey months. Higher densities from the Shortlist Masterplan aerial surveys are likely to be due to the transect routes covering more of the key areas for this species compared to the ship-based surveys, in particular the Frisian Front and area to the northwest of Texel.

Comparison of densities from aerial surveys between the Shortlist Masterplan and MWTL

Key differences between the densities from the Shortlist Masterplan aerial surveys and MWTL surveys involve the identification of species. Due to the altitude of the MWTL surveys some birds are not recorded to the species level, in particular divers, auks and small terns. This limits the use of densities for individual species within these groups. However, when roughly comparing the densities of Guillemot and Razorbill taken together with the densities of auks in MWTL, the densities are in the same order of magnitude. It should be taken into account that surveys were rarely carried out in the same week. In January 2011, this was actually the case and the densities of auks, and several other species were very similar densities between the surveys. Furthermore, in some months the densities of European Herring Gull from the MWTL surveys are notably higher than those of both the Shortlist Masterplan aerial surveys and ship-based surveys, likely reflecting the coastal route of the MWTL surveys (see paragraph 4.3 below). Despite the fact that in MWTL the ship associated birds are not used in calculating densities, the MWTL densities in most species/period combinations, for those species in which ship associations occur, are higher than recorded in the Shortlist Masterplan aerial program as well as in the ship-based program. It is clear that these differences at the moment cannot be properly evaluated because of the very limited number of surveys to be compared. More years of data collection, including more ship-based data, are needed.

Table 4.2.1 Densities of seabird species derived from the Shortlist Matserplan aerial surveys, MWTL aerial surveys and ship-based surveys. For each month, with the exception of the group 'Common/Arctic Tern', densities are only shown for those species for which densities from more than one survey are available. '-' indicates that densities are not available.

		Density km^2		
Month	**Species**	**Masterplan aerial**	**MWTL aerial surveys**	**Ship-based**
Jan	diver spec.	-	0.318	<0.001
Jan	Northern Fulmar	0.066	0.093	0.063
Jan	Northern Gannet	0.026	0.145	<0.001
Jan	Great Cormorant	0.079	0.012	<0.001
Jan	Common Gull	3.122	0.696	0.056
Jan	European Herring Gull	2.374	1.234	0.104
Jan	Great Black-backed Gull	0.467	0.780	0.156
Jan	Kittiwake	0.538	0.933	0.100
Jan	Lesser Black-backed Gull	0.004	0.006	<0.001
Jan	Little Gull	0.110	0.045	<0.001
Jan	Guillemot	0.628	-	2.595
Jan	Razorbill	0.527	0.018	0.147
Jan	Razorbill/Guillemot	-	1.253	0.048
Feb	diver spec.	-	0.142	<0.001
Feb	Northern Fulmar	0.010	0.058	0.027
Feb	Northern Gannet	0.102	0.311	0.252
Feb	Great Cormorant	0.008	0.064	<0.001
Feb	Common Gull	0.470	0.375	2.858
Feb	European Herring Gull	0.300	0.959	0.065
Feb	Great Black-backed Gull	0.216	0.137	0.320
Feb	Kittiwake	1.917	0.850	1.834
Feb	Lesser Black-backed Gull	0.057	0.478	0.065
Feb	Little Gull	0.323	0.075	0.092
Feb	Sandwich Tern	0.006	<0.001	<0.001
Feb	Guillemot	1.358	-	2.391
Feb	Razorbill	0.310	<0.001	1.322
Feb	Razorbill/Guillemot	-	0.781	<0.001
Apr	diver spec.	-	0.009	<0.001
Apr	Northern Fulmar	0.028	0.013	<0.001
Apr	Northern Gannet	0.027	0.091	0.028
Apr	Great Cormorant	0.056	0.222	<0.001
Apr	Common Gull	0.011	0.074	0.013
Apr	European Herring Gull	0.287	1.457	0.069
Apr	Great Black-backed Gull	0.026	0.073	0.100
Apr	Kittiwake	0.003	1.956	<0.001
Apr	Lesser Black-backed Gull	8.448	2.781	5.524
Apr	Little Gull	2.505	3.669	0.696
Apr	Common/Arctic Tern	-	1.186	-
Apr	Sandwich Tern	1.818	0.855	0.350
Apr	Razorbill	0.010	<0.001	<0.001
Apr	Razorbill/Guillemot	-	0.101	<0.001
May	Northern Fulmar	0.027	-	0.049
May	Northern Gannet	0.020	-	0.030
May	Great Cormorant	0.402	-	0.031
May	Common Gull	0.004	-	0.015
May	European Herring Gull	1.672	-	0.505
May	Lesser Black-backed Gull	4.219	-	3.922
May	Common Tern	0.031	-	0.199
May	Sandwich Tern	0.568	-	0.077
May	Guillemot	0.011	-	0.030

Month	Species	Density km² Masterplan aerial	MWTL aerial surveys	Ship-based
Jun	diver spec.	-	<0.001	<0.001
Jun	Northern Fulmar	-	0.050	0.235
Jun	Northern Gannet	-	0.068	0.089
Jun	Great Cormorant	-	0.349	1.888
Jun	Common Gull	-	0.040	<0.001
Jun	European Herring Gull	-	0.735	0.044
Jun	Great Black-backed Gull	-	0.151	0.065
Jun	Kittiwake	-	0.022	<0.001
Jun	Lesser Black-backed Gull	-	7.391	2.097
Jun	Little Gull	-	<0.001	<0.001
Jun	Common/Arctic Tern	-	0.143	-
Jun	Sandwich Tern	-	0.783	0.077
Jun	Razorbill	-	<0.001	0.006
Jun	Razorbill/Guillemot	-	0.311	<0.001
Jul	Northern Fulmar	0.017	-	0.015
Jul	Northern Gannet	0.150	-	0.030
Jul	Great Cormorant	1.959	-	0.071
Jul	Common Gull	0.009	-	0.021
Jul	European Herring Gull	3.285	-	0.922
Jul	Great Black-backed Gull	0.020	-	0.049
Jul	Kittiwake	0.030	-	0.017
Jul	Lesser Black-backed Gull	14.483	-	9.150
Jul	Common Tern	0.033	-	0.007
Jul	Sandwich Tern	0.908	-	0.013
Jul	Guillemot	0.790	-	1.286
Aug	diver spec.	-	<0.001	<0.001
Aug	Northern Fulmar	0.218	0.050	<0.001
Aug	Northern Gannet	0.248	0.202	0.106
Aug	Great Cormorant	0.021	0.179	<0.001
Aug	Great Skua	0.006	-	0.020
Aug	Common Gull	0.004	0.004	<0.001
Aug	European Herring Gull	0.097	0.225	<0.001
Aug	Great Black-backed Gull	0.237	0.056	0.050
Aug	Kittiwake	0.940	0.357	0.179
Aug	Lesser Black-backed Gull	0.393	2.012	0.131
Aug	Common Tern	0.054	-	0.732
Aug	Common/Arctic Tern	-	0.841	-
Aug	Sandwich Tern	0.961	0.876	0.057
Aug	Guillemot	0.217	-	0.311
Aug	Razorbill	0.010	<0.001	<0.001
Aug	Razorbill/Guillemot	-	0.415	<0.001
Sep	Northern Gannet	0.189	-	0.128
Sep	Great Cormorant	0.104	-	0.055
Sep	Great Skua	0.038	-	0.021
Sep	Common Gull	0.006	-	0.013
Sep	European Herring Gull	0.412	-	0.384
Sep	Great Black-backed Gull	1.714	-	0.036
Sep	Kittiwake	0.986	-	0.021
Sep	Lesser Black-backed Gull	1.103	-	0.413
Sep	Common Tern	0.006	-	0.036
Sep	Sandwich Tern	0.031	-	0.026
Sep	Guillemot	1.344	-	0.146
Oct	diver spec.	-	0.132	<0.001
Oct	Northern Fulmar	0.059	0.039	<0.001
Oct	Northern Gannet	0.442	0.511	0.271
Oct	Great Cormorant	0.077	0.102	<0.001
Oct	Great Skua	0.007	-	0.041
Oct	Common Gull	0.041	0.331	0.362
Oct	European Herring Gull	2.253	1.468	0.096

Month	Species	Density km^2 Masterplan aerial	MWTL aerial surveys	Ship-based
Oct	Great Black-backed Gull	0.757	1.439	0.895
Oct	Kittiwake	0.206	1.257	0.224
Oct	Lesser Black-backed Gull	0.155	0.234	0.015
Oct	Little Gull	0.062	0.364	0.139
Oct	Common/Arctic Tern	-	<0.001	-
Oct	Guillemot	0.705	-	0.140
Oct	Razorbill	0.086	0.019	0.060
Oct	Razorbill/Guillemot	-	1.811	<0.001
Nov	Northern Gannet	1.110	-	0.279
Nov	Great Skua	0.013	-	0.051
Nov	Common Gull	1.664	-	0.028
Nov	European Herring Gull	3.396	-	0.096
Nov	Great Black-backed Gull	0.989	-	0.630
Nov	Kittiwake	4.522	-	0.727
Nov	Lesser Black-backed Gull	0.007	-	0.017
Nov	Little Gull	0.220	-	0.238
Nov	Guillemot	1.958	-	0.816
Nov	Razorbill	0.300	-	0.315

4.3 Comparing distribution outside and inside study area with MWTL

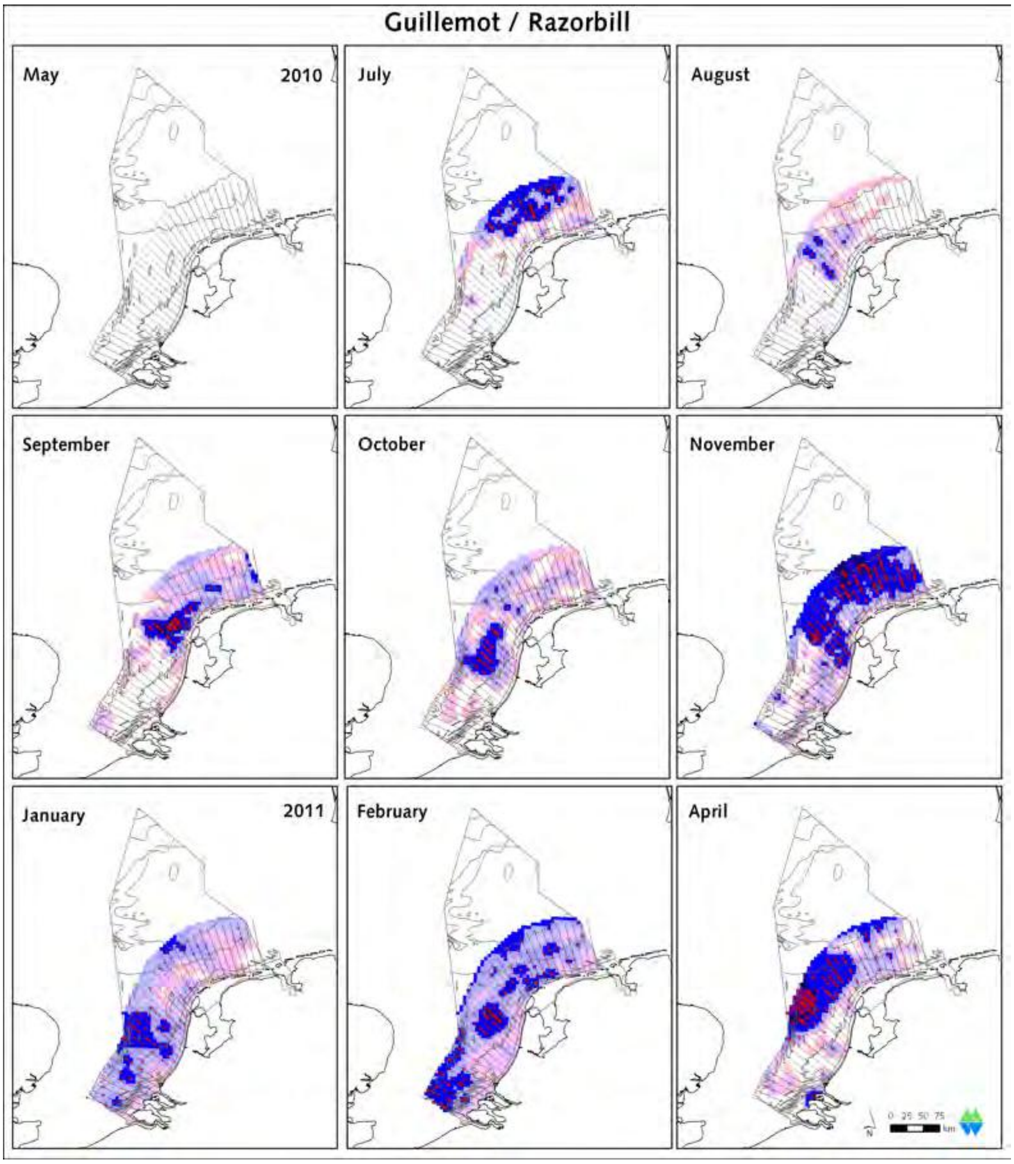
Introduction

The MWTL monitoring data complement the Shortlist Masterplan aerial-based survey project outside the study area, with coverage of the far offshore areas in the northern part of the Dutch North Sea. In relation to possible developments in the future, the question is how the densities in the Shortlist Masterplan study area relate to the areas far offshore in the northern part of the Dutch North Sea. Furthermore, it is interesting whether similar distribution patterns are found in the results of MWTL in the overlapping Shortlist Masterplan study area.

In this section the distribution maps of different species based on the interpolated densities of the two aerial programs are compared. The same modelling technique has been used to interpolate the recorded densities for both the Shortlist Masterplan and MWTL in order to make the distribution patterns more comparable. In this way for a part corrections are made for the differences in spatial effort and survey design between the two aerial survey programs.

Differences between the two programs are that the MWTL covers completely the coast with parallel transect lines, whereas the Shortlist Masterplan aerial surveys, only irregular short transect lines parallel to the coast were flown, giving incomplete coverage of the coast. Furthermore, the short coastal sections between transects were not always routinely surveyed under ideal conditions and therefore were not used for interpolation. Because in the MWTL ship associated birds are not included in the analyses, for this exercise also for the Shortlist Masterplan the large ship associated flocks have been excluded (see for the methods further in paragraph 2.5 and 2.6).

4.3.1 Species group Guillemot/Razorbill ('Razormot')



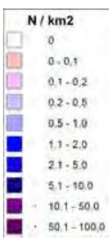


Figure 4.3.1.1 Interpolated densities of Razorbill/Guillemot (including unidentified auks) from the Shortlist Masterplan aerial survey data on the Dutch Continental Shelf. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density. In May, too few observations were available to conduct a reliable interpolation of the data.

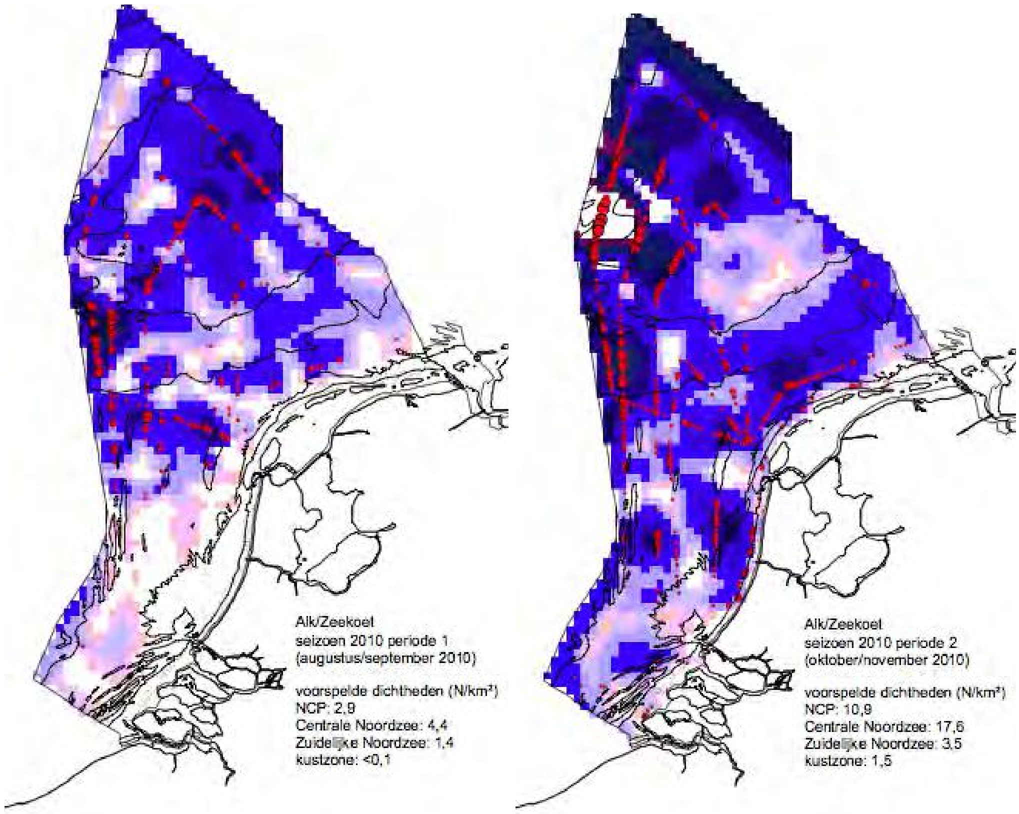


Figure 4.3.1.2 Interpolated densities of Razorbill/Guillemot from the MWTL aerial survey data on the Dutch Continental Shelf. The red dots show the measured bird density of that poskey and the colour gradient from purple to blue indicates the interpolated bird density.

In two periods of the year, the interpolation of survey results of overlapping Shortlist Masterplan and MWTL surveys was possible for the species group Guillemot/Razorbill (Fig. 4.3.1.1 and Fig. 4.3.1.2). The MWTL surveys show that from August to November the highest concentrations of auks were present outside the Shortlist study area, on the Cleaverbank, Doggersbank and Central Oystergrounds. During the course of autumn, an increasing southerly distribution is found for auks. This is generally in line with the finding of the Shortlist surveys, although in October only relatively few Guillemots were recorded. Remarkably, during both surveys a hotspot for auks was found in September west of Texel and in November a little more south of the coast of Noord-Holland.

The aerial surveys within the Shortlist Masterplan project had the advantage of a dense grid of transect lines, which enabled a detailed recording of small-scale spatial distribution patterns of bird species. Therefore small-scale hotspots are more easily identified. This level of coverage provided more detailed information on the spatial distribution of birds in the first 80 km of the Dutch coast. In doing so, several hotspots of Guillemots/Razorbills were found closer in the study area in September. Because of the lower flight altitude of the surveys it has been possible to identify most ‘Razormots’ up to species level (Guillemot in Fig. 4.3.1.3 and Razorbill in Fig. 4.3.1.4).

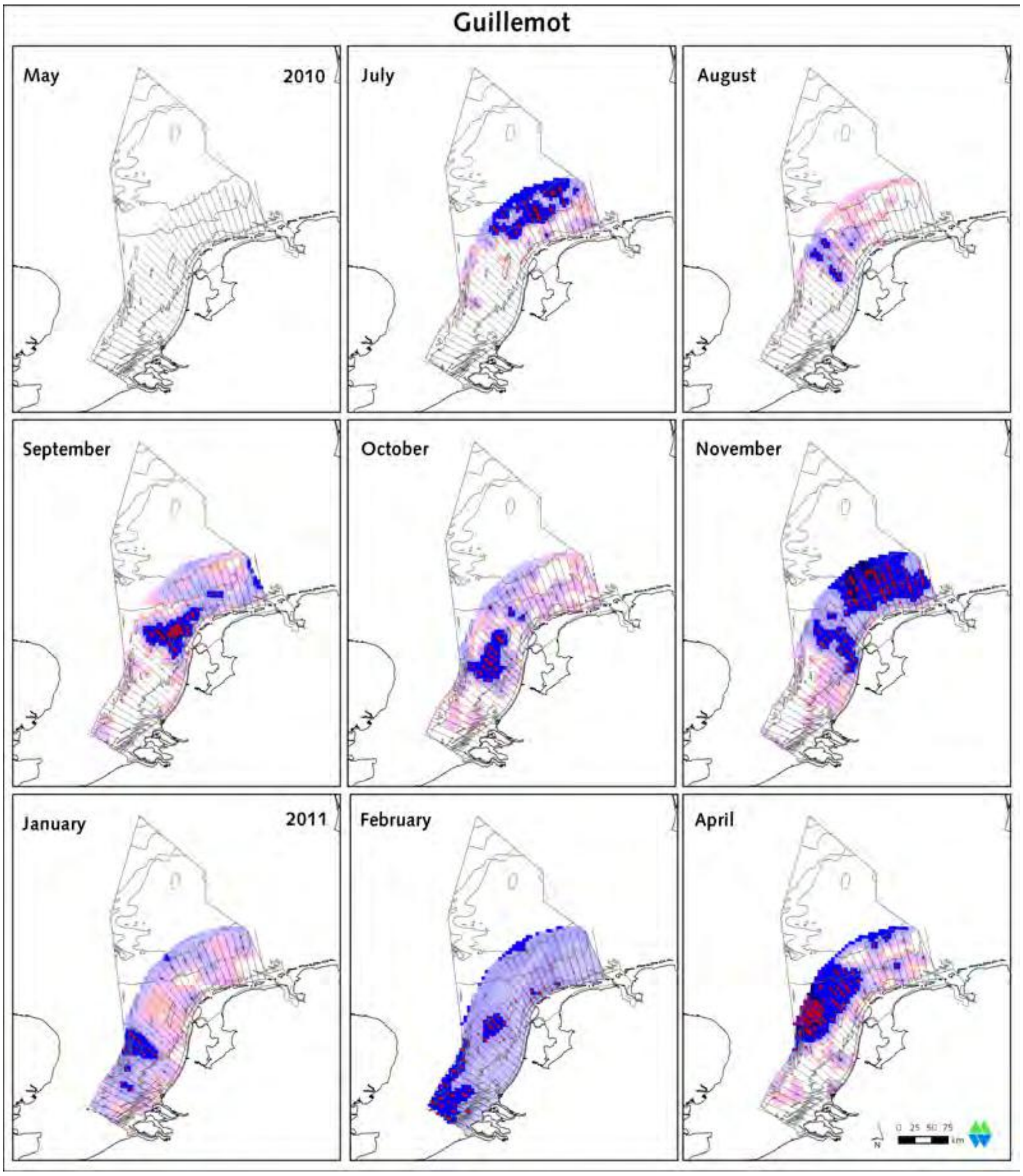


Figure 4.3.1.3 Interpolated densities of identified Guillemots from the Shortlist Masterplan aerial survey data on the Dutch Continental Shelf. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density In May, too few observations were available to conduct a reliable interpolation of the data.

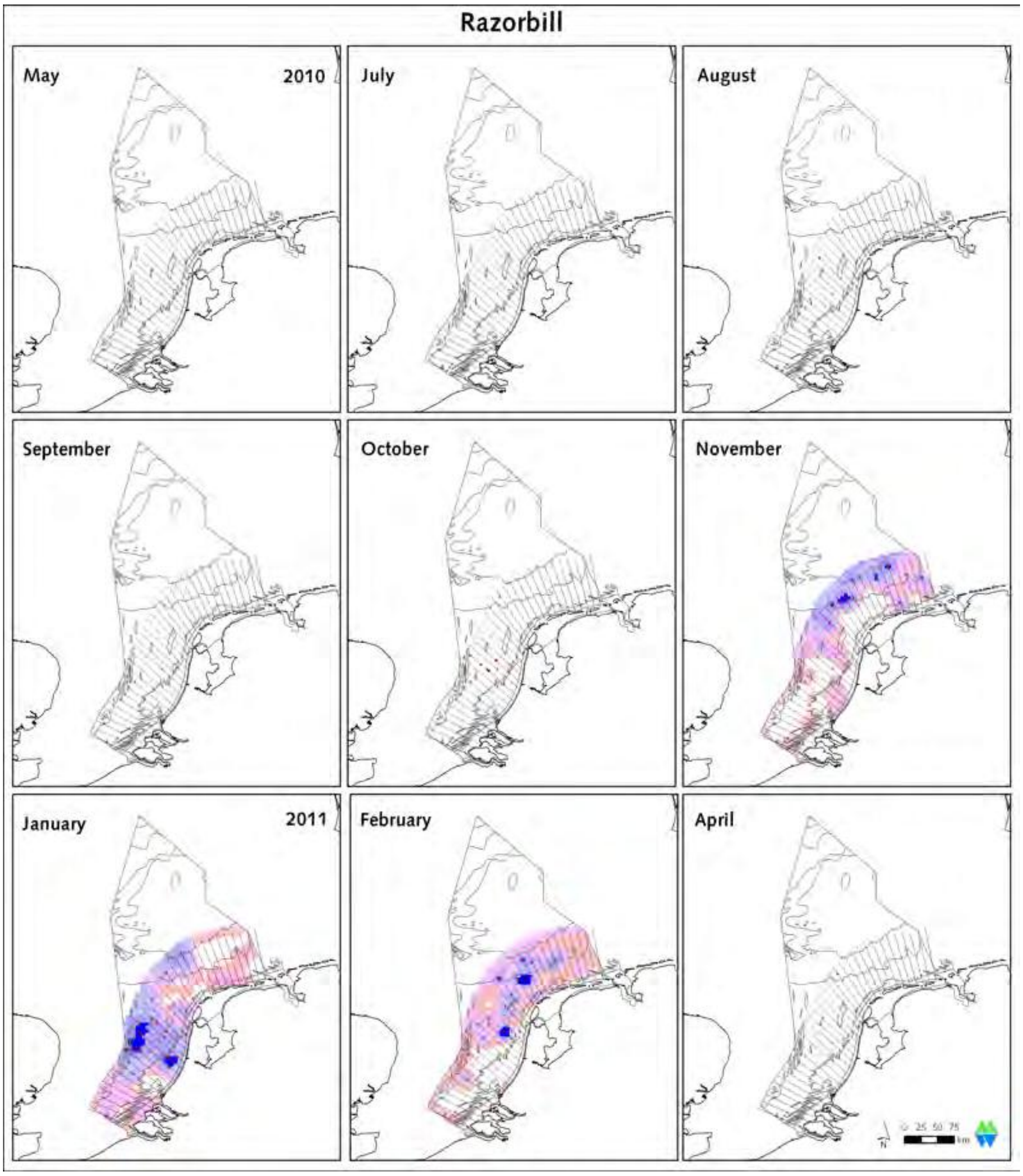


Figure 4.3.1.4 Interpolated densities of identified Razorbills from the Shortlist Masterplan aerial survey data on the Dutch Continental Shelf. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density. Between May and October and in April, too few observations were available to conduct a reliable interpolation of the data.

4.3.2 Kittiwake

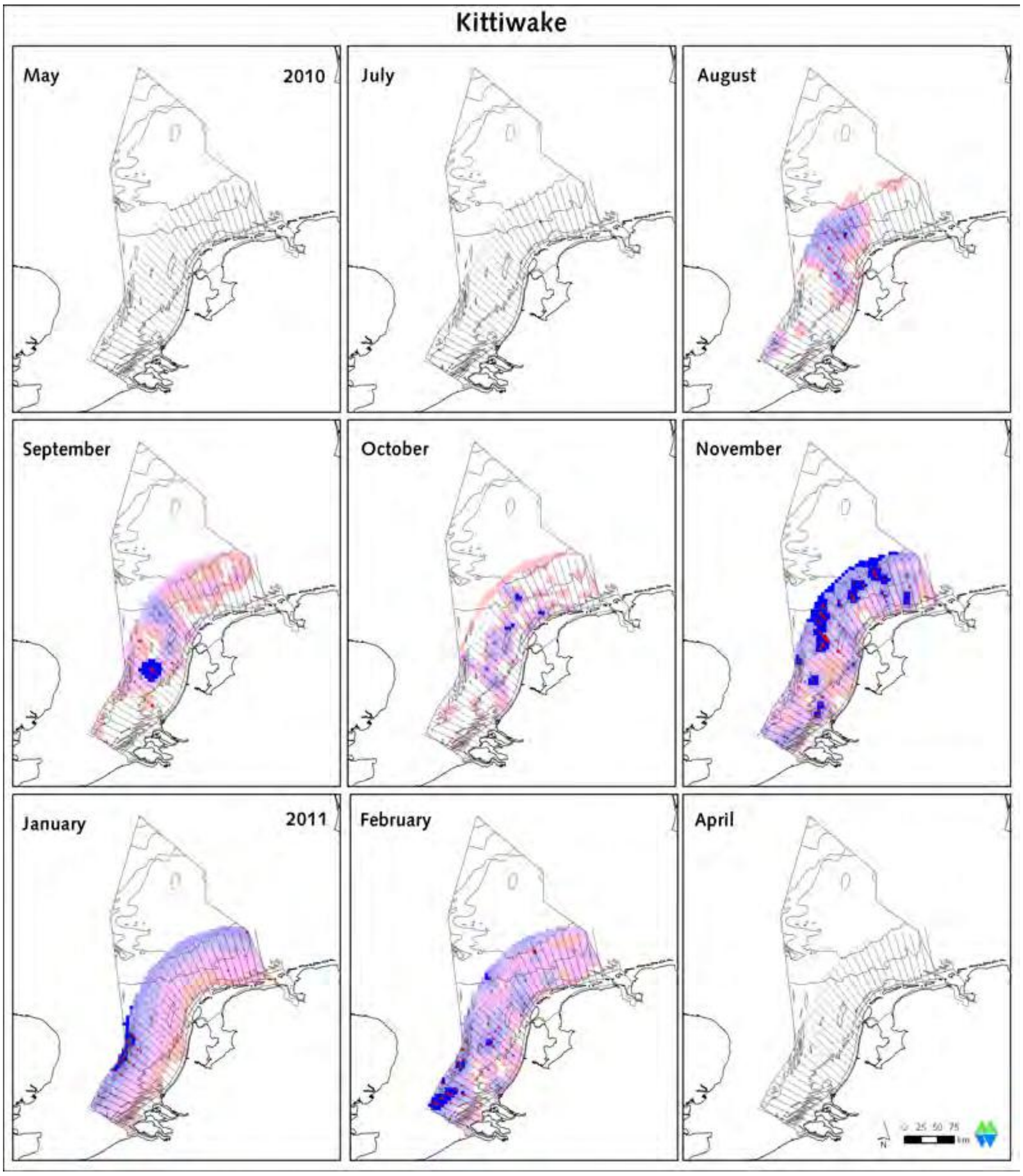
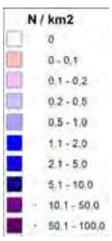


Figure 4.3.2.1 *Interpolated monthly densities of Kittiwake from aerial survey data within the study area. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density. In May, July and April, too few observations were available to conduct a reliable interpolation of the data.*



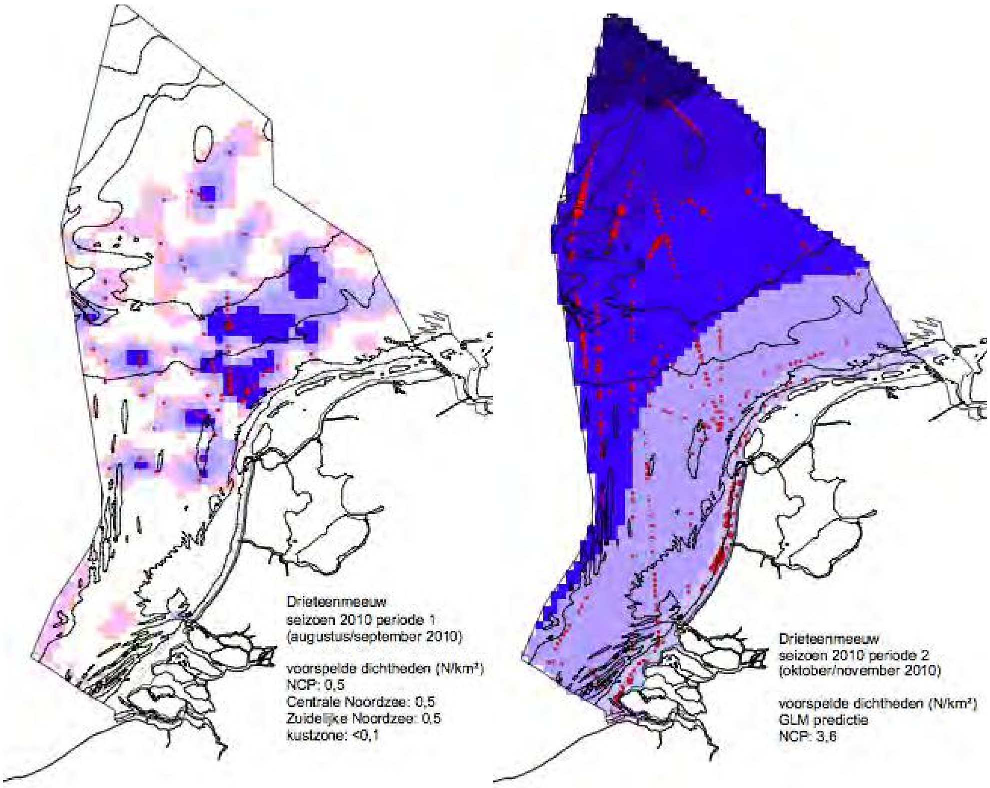


Figure 4.3.2.2 Interpolated densities of Kittiwake from the MWTL aerial survey data on the Dutch Continental Shelf. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density.

In two periods of the year, the interpolation of survey results of both the Shortlist Masterplan and the MWTL surveys was possible. In August/September higher densities were found close to the Frisian Front during the MWTL survey (Fig. 4.3.2.1). A similar pattern was present in the Shortlist surveys (Fig. 4.3.2.2) although the Frisian Front was not surveyed completely. In November, the highest densities of Kittiwakes were found to be outside the Shortlist Study area. This was also found in the Shortlist survey with higher densities on the edges of the northern boundaries of the study area. Due to the higher density of transect lines, small-scale areas of high densities of Kittiwakes could be identified in the Shortlist survey. These hotspots were often large groups of birds associated with platforms or fishing vessels.

4.3.3 Little Gull

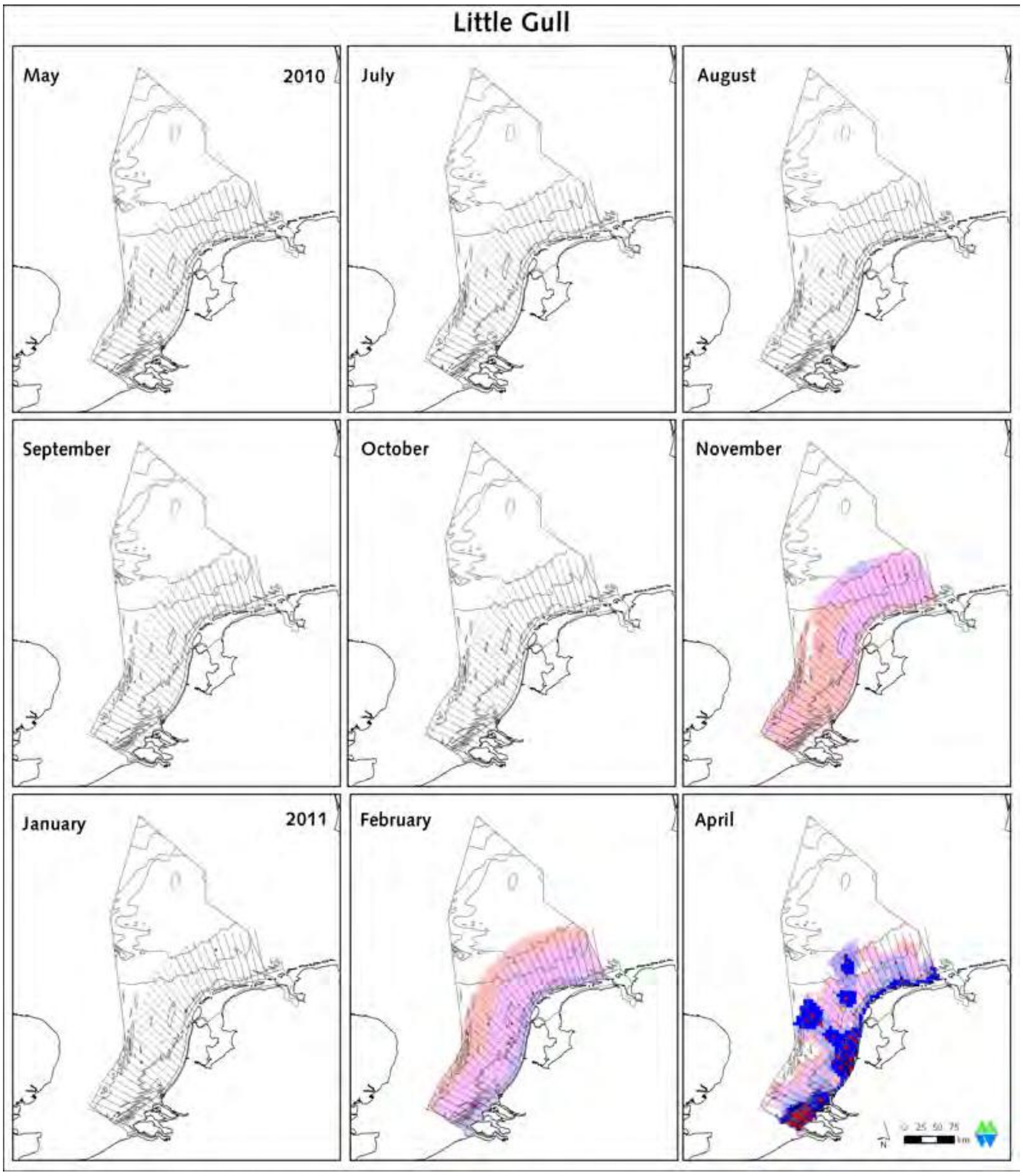
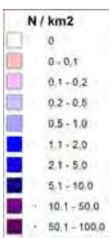


Figure 4.3.3.1 *Interpolated monthly densities of Little Gull from aerial survey data within the study area. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density. Only in November, February and April were enough observations available to conduct a reliable interpolation of the data.*



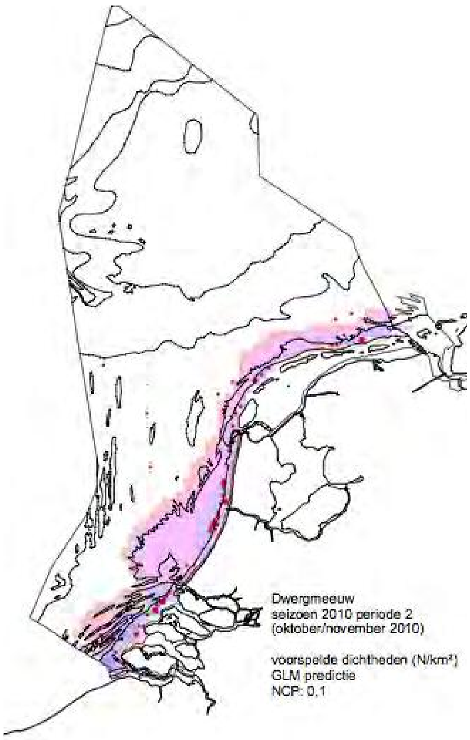


Figure 4.3.3.2 Interpolated densities of Little Gull from the MWTL aerial survey data on the Dutch Continental Shelf. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density.

An overlapping survey of the Shortlist and the MWTL programme occurred in the period October/November (Fig. 4.3.3.1 and Fig. 4.3.3.2). The ‘background density’ during both surveys is similar, however due to the higher density of transect lines a more offshore distribution was found during the Shortlist surveys. The MWTL coastal transect picks up quite a lot of the Little Gulls present in the area but especially north of the Wadden Islands the lack of transect lines during the MWTL surveys causes Little Gulls to be missed offshore.

4.3.4 Sandwich Tern

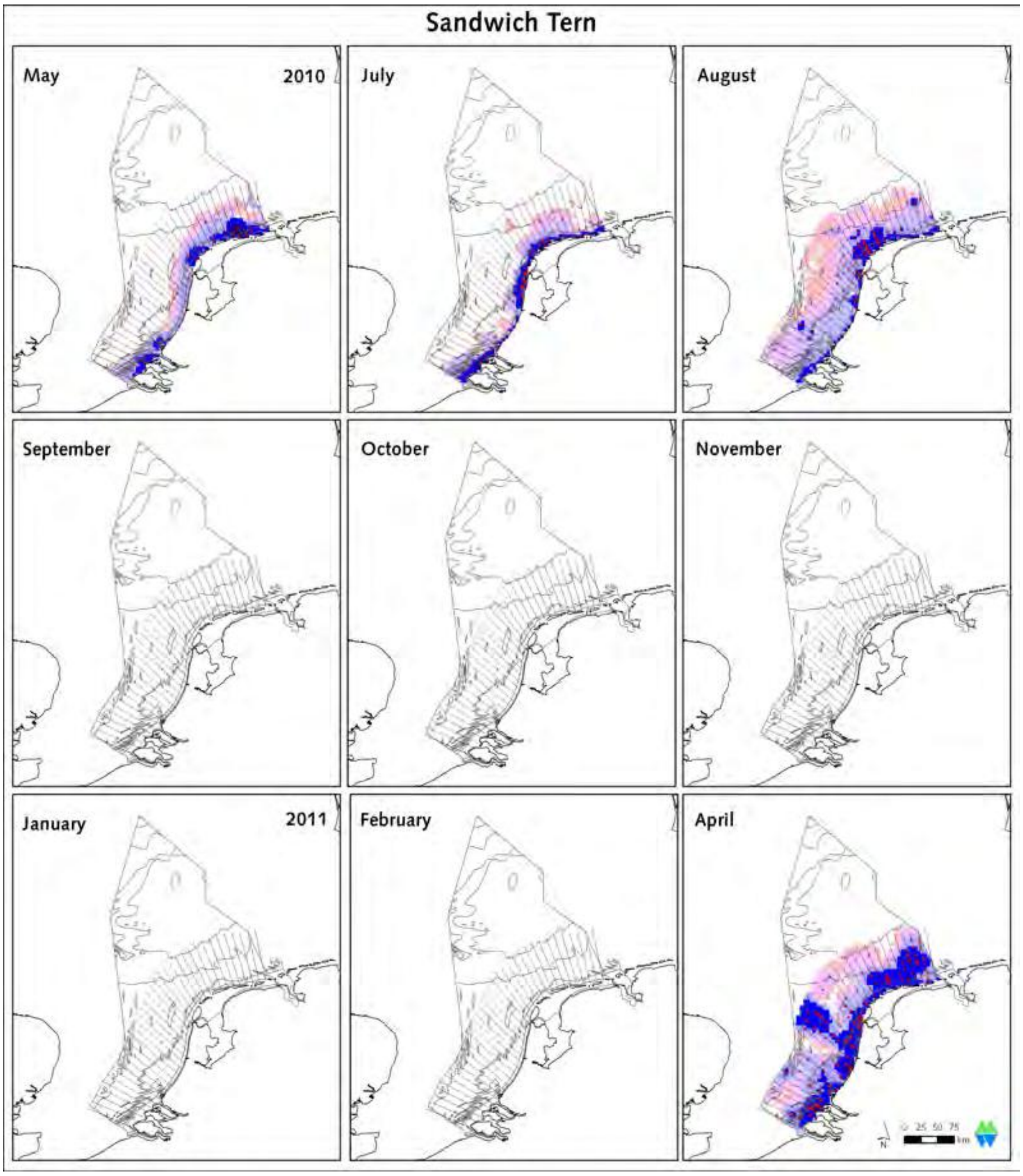
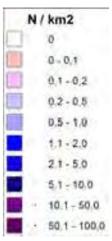


Figure 4.3.4.1 *Interpolated monthly densities of Sandwich Tern from aerial survey data within the study area. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density. From September to February too few observations were available to conduct a reliable interpolation of the data.*



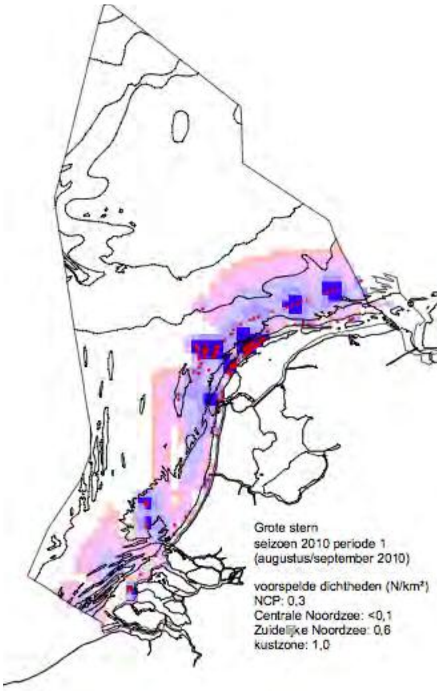


Figure 4.3.4.2 Interpolated densities of Sandwich Tern from the MWTL aerial survey data on the Dutch Continental Shelf. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density.

The interpolated bird density maps of the MWTL and the Shortlist survey in August/September look very similar. The Shortlist survey shows a more spread out distribution into offshore areas but overall a decreasing gradient from the coast with hotspots in the vicinity of the major colonies was found in both surveys.

4.3.5 Northern Gannet

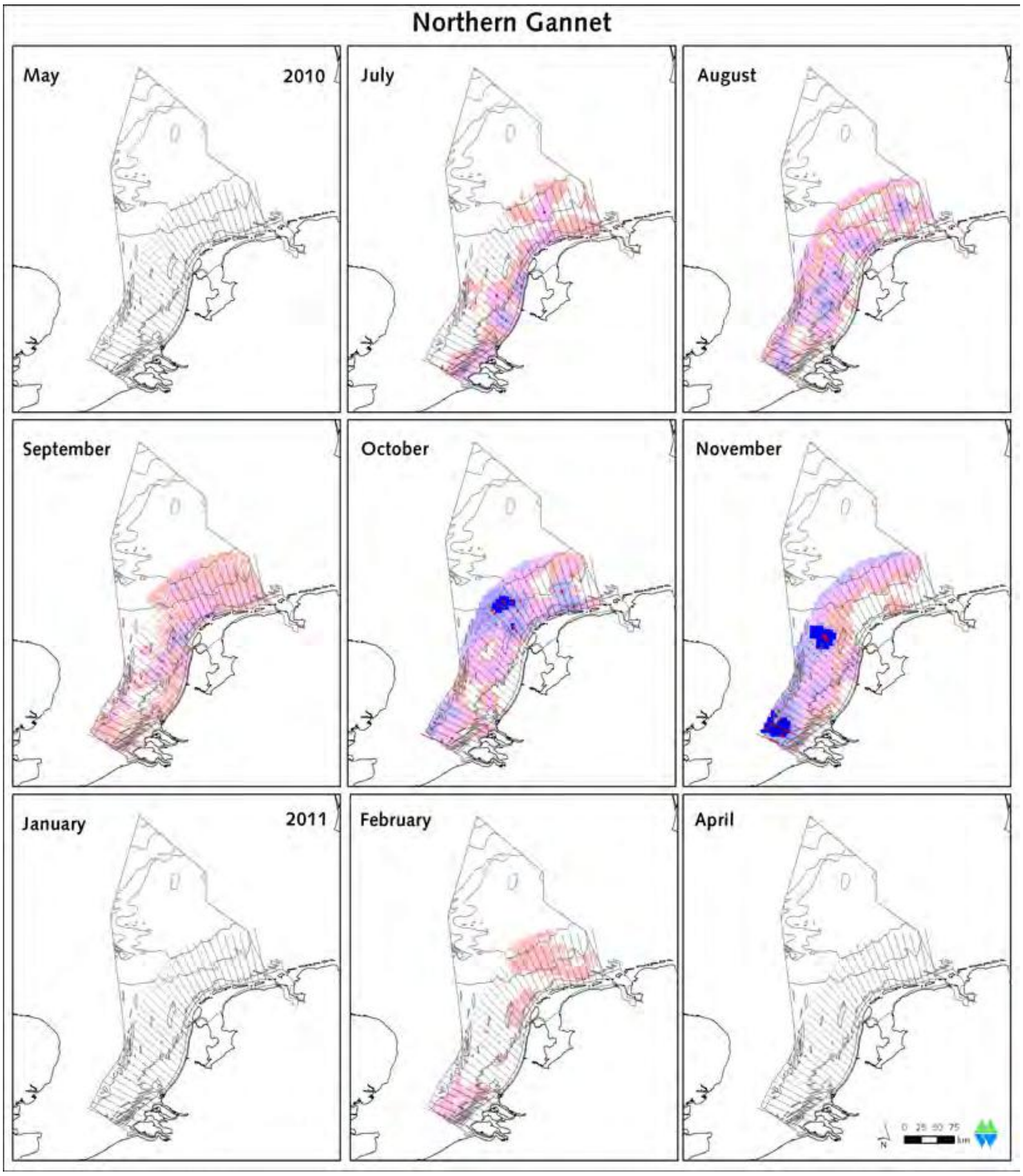
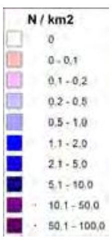


Figure 4.3.5.1 *Interpolated monthly densities of Northern Gannet from aerial survey data within the study area. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density. In May, January and too few observations were available to conduct a reliable interpolation of the data.*



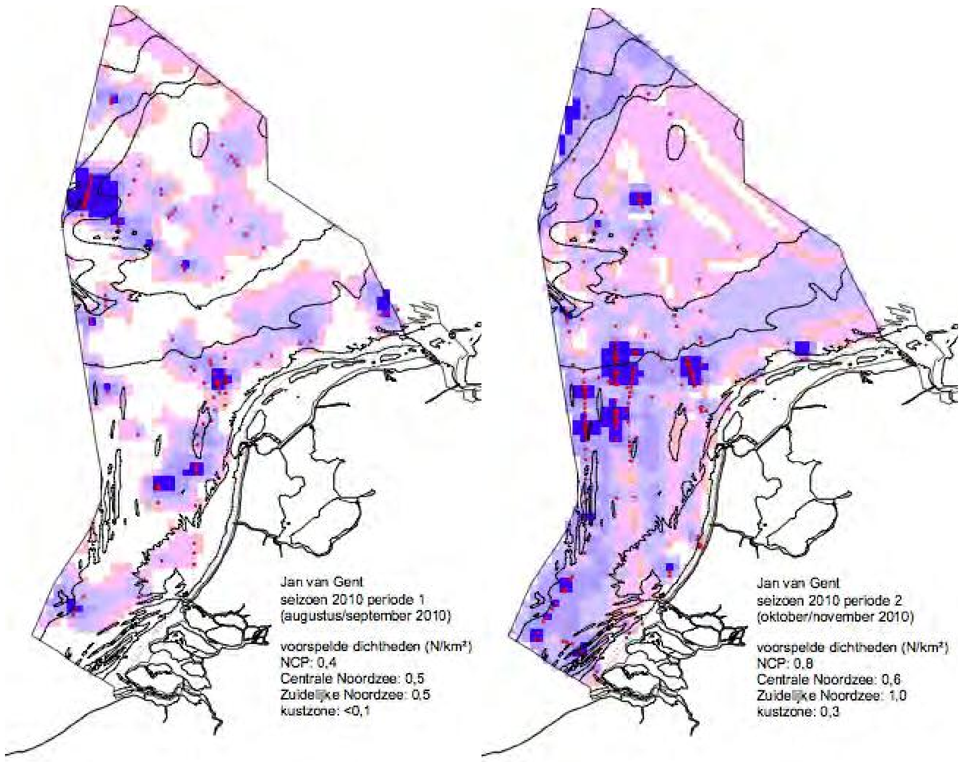


Figure 4.3.5.2 Interpolated densities of Northern Gannet from the MWTL aerial survey data on the Dutch Continental Shelf. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density.

In two overlapping survey periods similar orders of magnitudes of 'background densities' of Northern Gannets were found during both surveys. This fairly uniform density of Northern Gannets extends over the entire Dutch Continental Shelf with some hotspots visible on the Cleaver Bank, Oystergrounds and Frisian Front.

4.3.6 Lesser Black-backed Gull

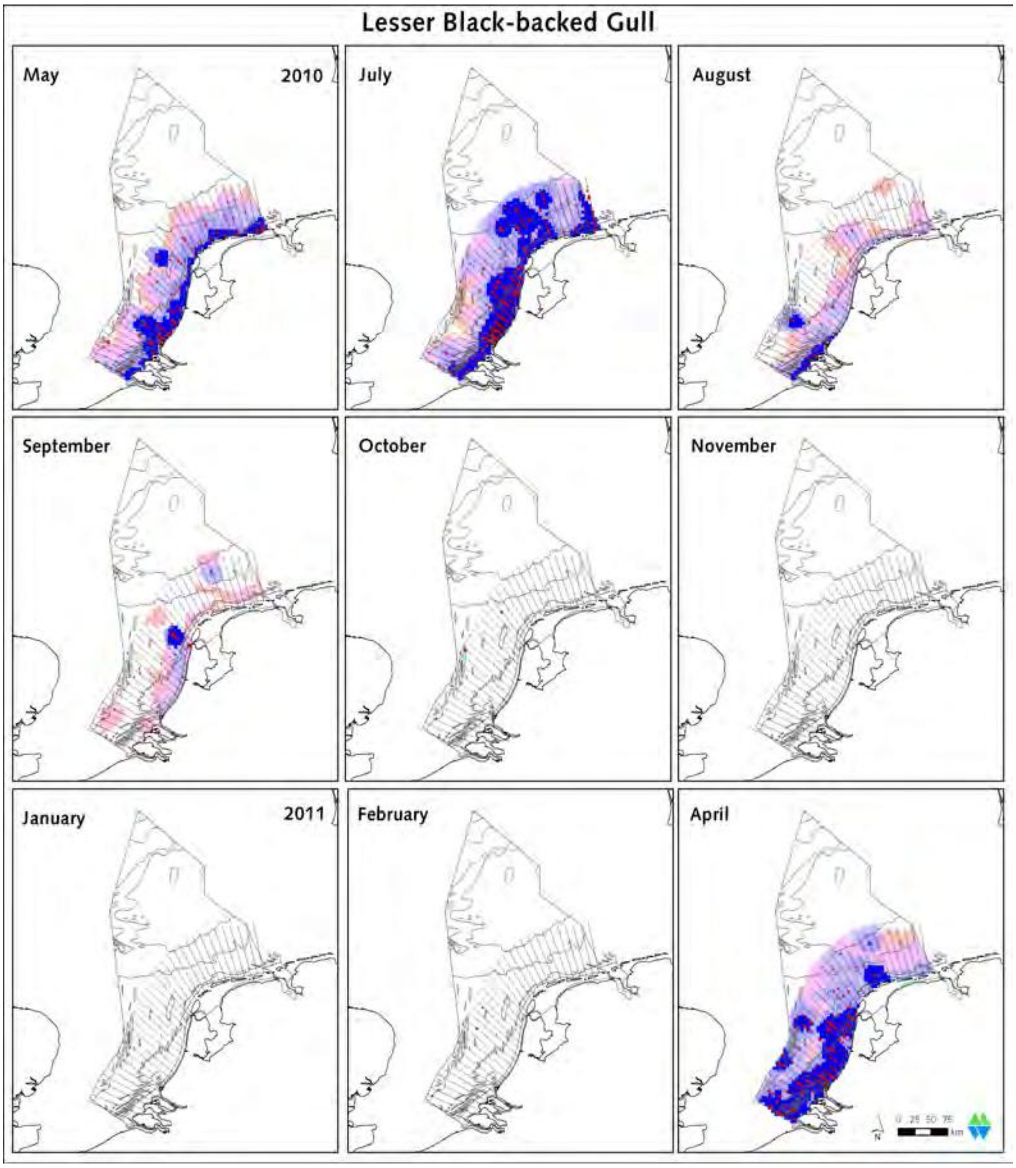
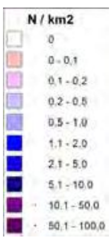


Figure 4.3.6.1 Interpolated monthly densities of Lesser Black-backed Gull from aerial survey data within the study area. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density. From October to February too few observations were available to conduct a reliable interpolation of the data.



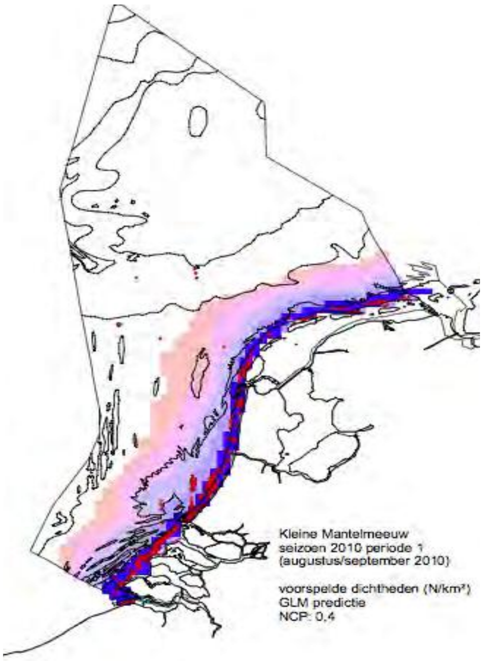


Figure 4.3.6.2 Interpolated densities of Lesser Black-backed Gull from the MWTL aerial survey data on the Dutch Continental Shelf. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density.

The MWTL programme has a transect line parallel to the coast, which implies that for Lesser Black-backed Gulls the highest densities of birds were found on the coast. As during the Shortlist surveys, the transect lines were perpendicular to the coast a much more offshore distribution was found for this species. Also the patchy occurrence of this species offshore, closely related to the occurrence of platforms and fishing vessels, is well identified by the higher density of transects of the Shortlist surveys and less defined by the MWTL surveys.

4.3.7 Great Black-backed Gull

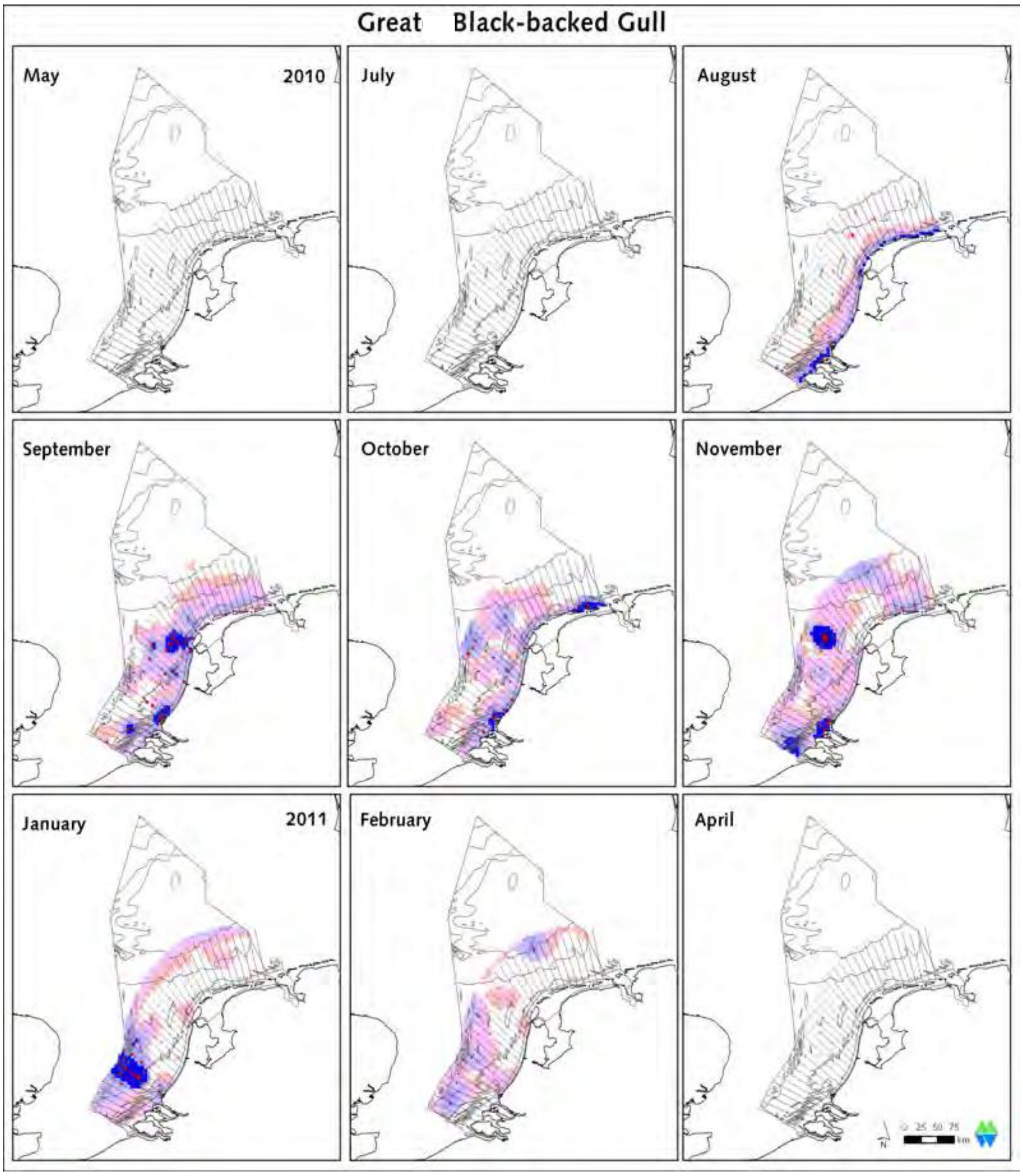
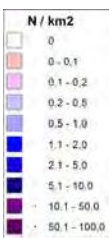


Figure 4.3.7.1 *Interpolated monthly densities of Great Black-backed Gull from aerial survey data within the study area. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density. In May, July and April too few observations were made to be able to conduct a reliable interpolation of the data.*



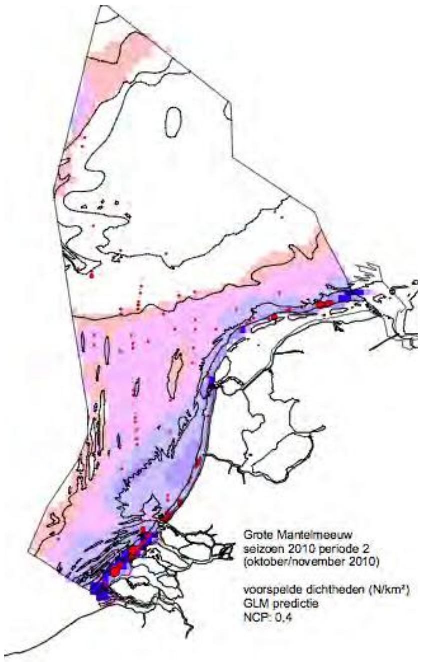


Figure 4.3.7.2 Interpolated densities of Great Black-backed Gull from the MWTL aerial survey data on the Dutch Continental Shelf. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density.

The distribution patterns of Great Black-backed Gulls were fairly similar between the MWTL survey of October/November and the overlapping Shortlist surveys. The areas outside the Shortlist study area do not seem to be of major importance for Great Black-backed Gulls in that time of year. Due to the higher density of transect lines small scale areas of high densities of Great Black-backed Gulls could be identified in the Shortlist survey. These hotspots were often groups of birds associated with platforms or fishing vessels.

4.3.8 Northern Fulmar

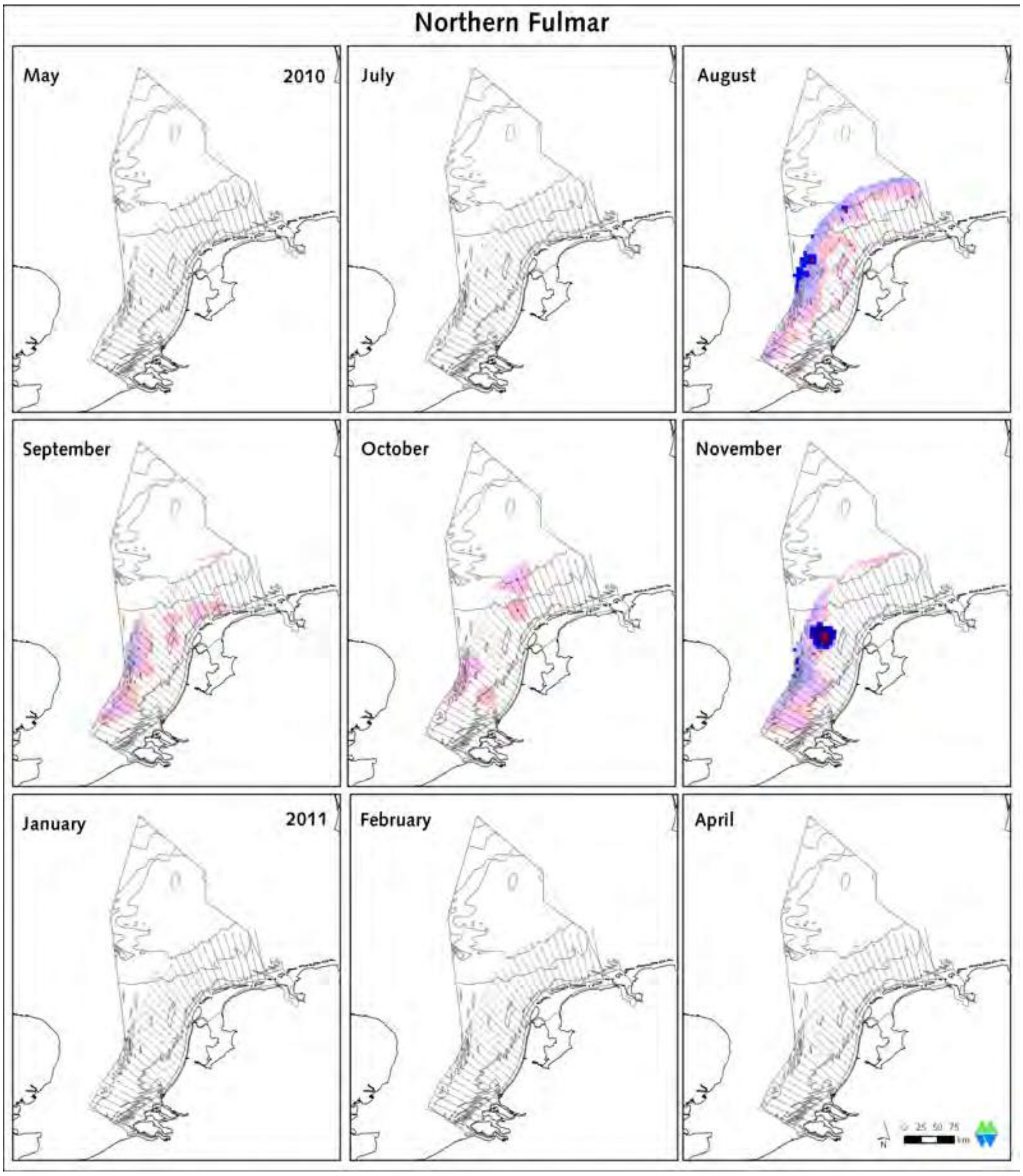
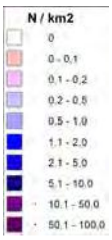


Figure 4.3.8.1 *Interpolated monthly densities of Northern Fulmar from aerial survey data within the study area. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density. Only from August to November were enough observations available to conduct a reliable interpolation of the data.*



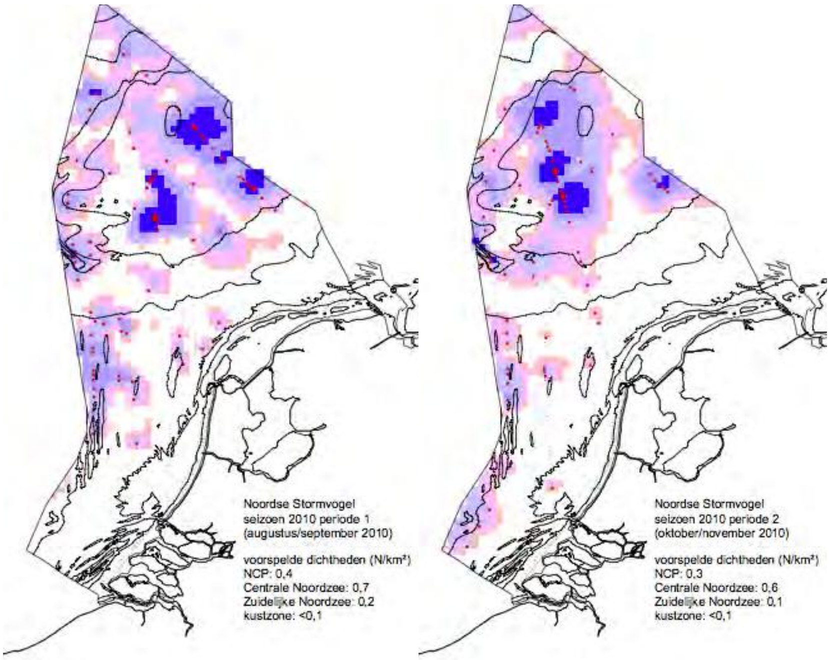


Figure 4.3.8.2 Interpolated densities of Northern Fulmar from the MWTL aerial survey data on the Dutch Continental Shelf. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density.

Northern Fulmars are a typical species of the Oystergrounds during August to November, as shown by the data from the MWTL surveys (Fig. 4.3.16). Distribution within the Shortlist study area is of less importance although incidentally high densities of this species were found (Fig. 4.3.15). These were often related to fishing activity. Also during the Shortlist surveys most Fulmars were found on the outermost edges of the study area.

4.3.9 Common Gull

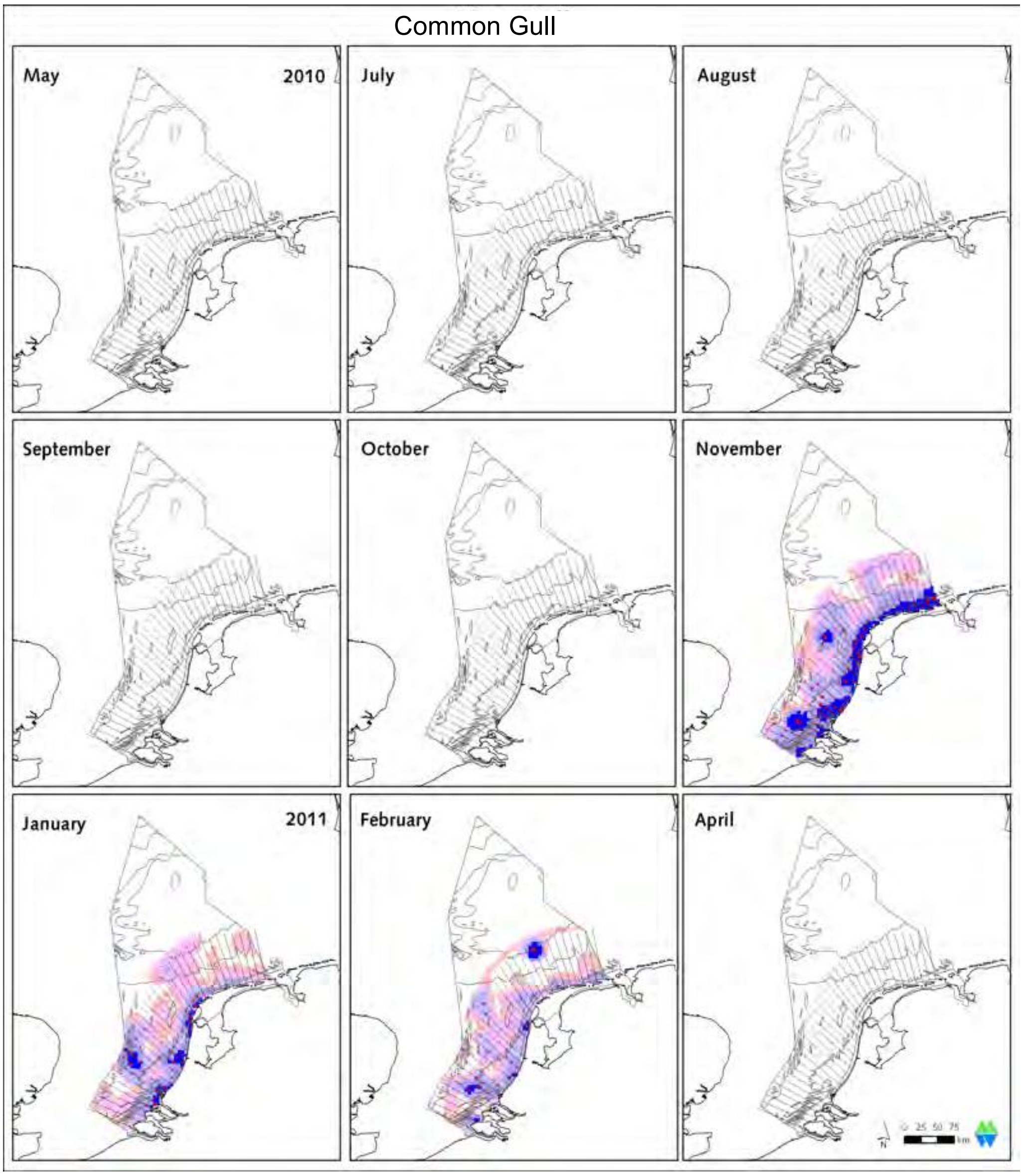
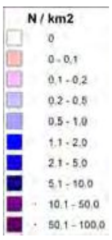


Figure 4.3.9.1 Interpolated monthly densities of Common Gull from aerial survey data within the study area. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density. Only in November, January and February were enough observations available to conduct a reliable interpolation of the data.



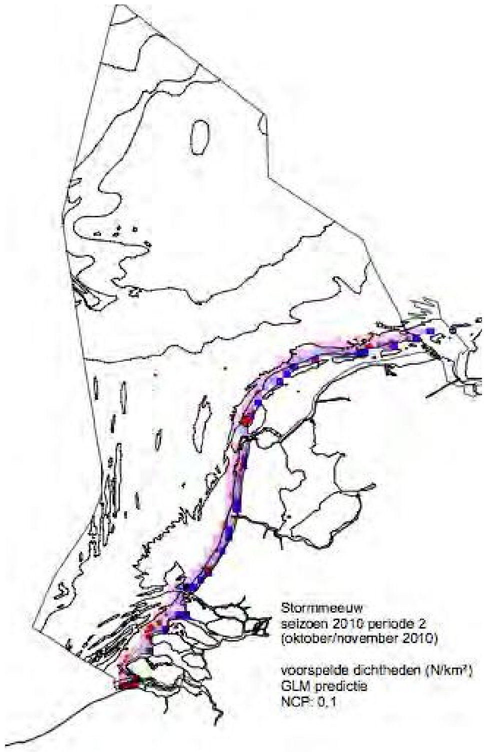


Figure 4.3.9.2 Interpolated densities of Common Gull from the MWTL aerial survey data on the Dutch Continental Shelf. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density.

In winter, Common Gulls have a more offshore distribution and it seems that the MWTL programme does not pick up this distribution (Fig. 4.3.9.1) due to a lack of transect lines perpendicular to the coast. The higher density of transect lines of the Shortlist surveys is better at identifying this offshore distribution (Fig. 4.3.9.2). On the other hand it seems that November is the month that Common Gulls disperse from land to the sea and if the MWTL survey was early November or in October numbers of Common Gulls at sea could have been low anyway.

4.3.10 European Herring Gull

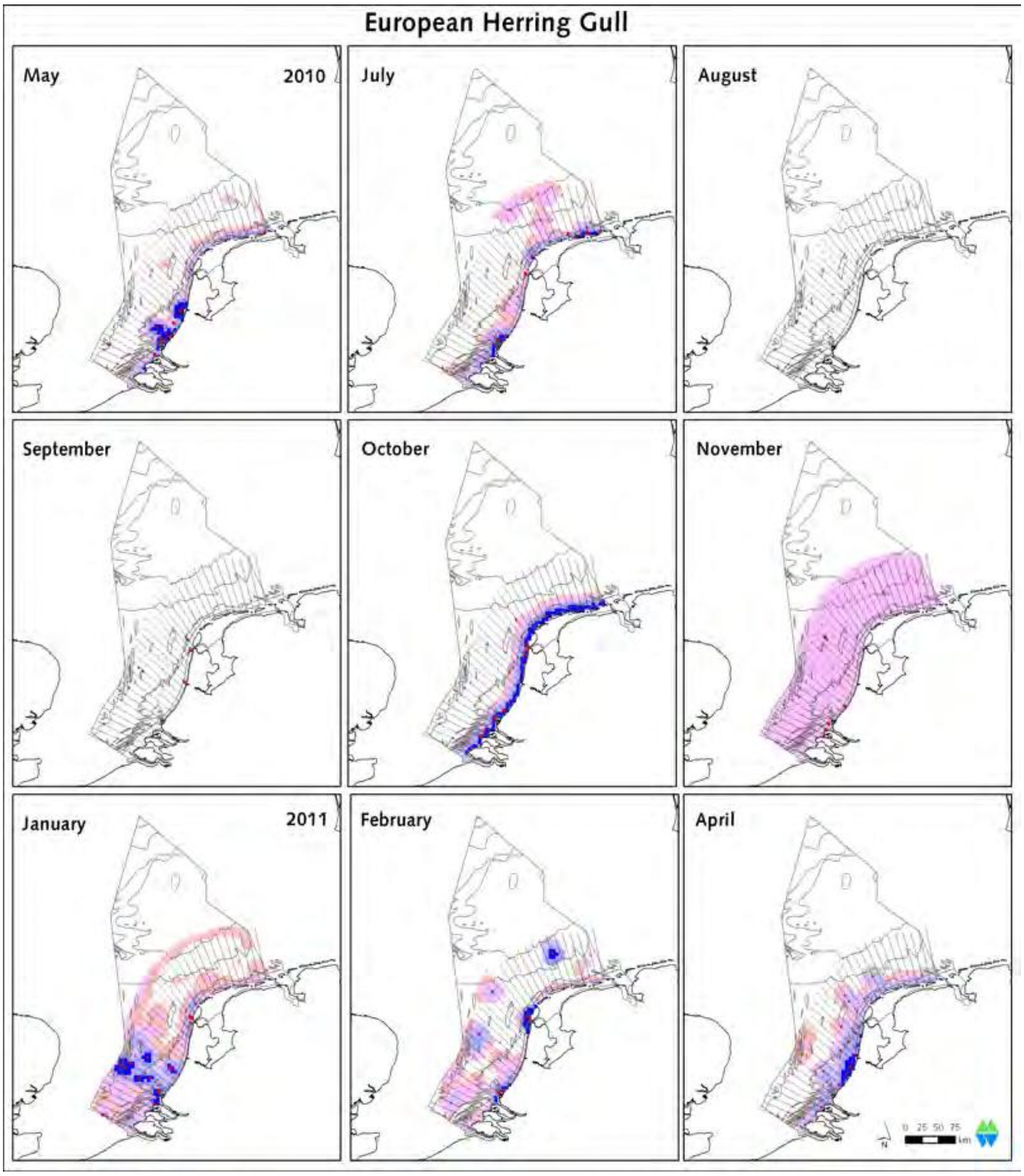


Figure 4.3.10.1 Interpolated monthly densities of European Herring Gull from aerial survey data within the study area. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density. In August and September too few observations were made to be able to conduct a reliable interpolation of the data.

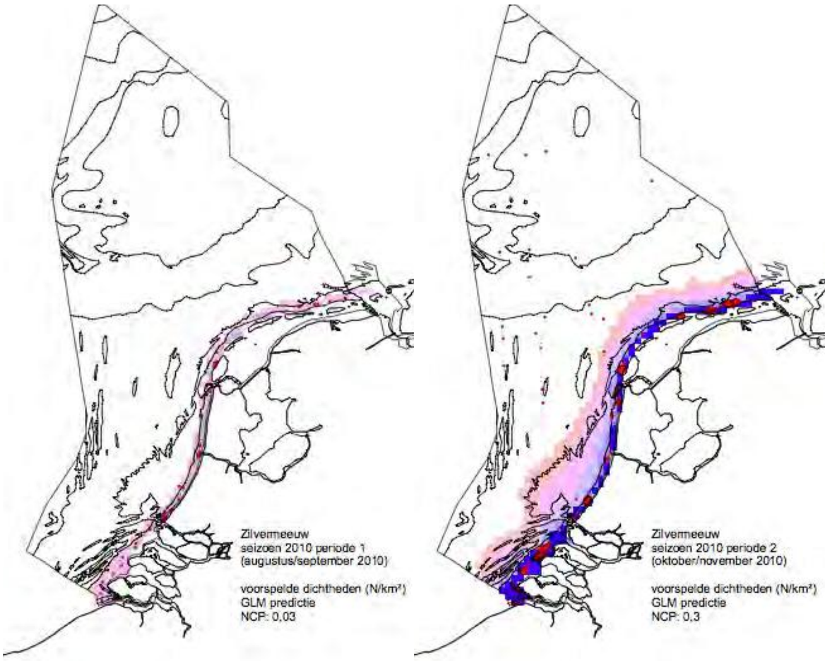


Figure 4.3.10.2 Interpolated densities of European Herring Gull from the MWTL aerial survey data on the Dutch Continental Shelf. The red dots show the measured bird density of that poskey and the colour gradient from pink to blue indicates the interpolated bird density.

The distribution patterns of European Herring Gulls were very similar between the MWTL survey of August to November and the overlapping Shortlist surveys. European Herring Gulls occur close to the coast but due to the higher density of transect lines in the Shortlist surveys, small scale areas of high densities further offshore could be identified. These hotspots were often groups of birds associated with platforms or fishing vessels.

Conclusions

The MWTL monitoring data complement the Shortlist Masterplan aerial-based survey project outside the study area, with coverage of the far offshore areas in the northern part of the Dutch North Sea. The MWTL results show that for several species and in several periods of the year higher densities of birds occur in the far offshore areas in the northern part of the Dutch North Sea (auks, Northern Fulmar, Kittiwake). In the overlapping Shortlist Masterplan study area, the survey design of the Shortlist Masterplan yielded wider offshore distribution patterns of some ‘coastal species’ such as Sandwich Tern, Little Gull and Common Gull. Due to the complete coverage of the coast with parallel survey transect lines in MWTL for some coastal species higher densities very close to the coast were determined (e.g. European Herring Gull).

4.4 Distribution patterns related to platform areas

In the different species accounts the possible relationships with platforms have been discussed. Most of the time associations with platforms are discussed as providing resting places, especially in different gull species and Great Cormorant. For Kittiwakes, platforms can also function as artificial breeding cliffs. The associations of Kittiwakes with platforms have been very apparent in the field. On several occasions this species has been observed rafting in the vicinity of platforms. Also in winter, this phenomenon has been recorded in Common Gulls. These large rafts are likely to be the result of a feeding session from the local kitchen. In a couple of species we also have found potential negative relationships, as discussed in the species accounts based on the basic counting data. However, in some distribution maps the patterns are even stronger, most notably in Guillemot and in Northern Gannet. The holes in the distributions of these species are very apparent. The reason for this unclear and at present it can only be speculated that it could be related to disturbance, but perhaps other reasons like food abundance plays a role here. In the case of the Great Black-backed Gull, an alternative explanation could be found in the behaviour of the birds, namely an uneven distribution due to the birds aggregating on top of the platforms.

4.5 Harbour Porpoise observations

Aerial surveys that are specifically directed at Harbour Porpoises are superior to aerial-based surveys aimed primarily at seabirds. However, the observations made during aerial-based surveys for seabirds potentially fill possible gaps in the specialised aerial survey data for Harbour Porpoise, as they have a higher effort both in space (denser transect density) and in time (more months). Since seabirds were the main focus for the observers during this study the number of Harbour Porpoises recorded is surely an underestimate, especially in areas with high densities of seabirds. We refer to Geelhoed *et al.* (2011) for a discussion on how the observations made during the aerial surveys for seabirds relate to the specific surveys conducted for Harbour Porpoises.

Interpolation of the density data for Harbour Porpoise shows the highest densities of animals in winter and spring. April was the month in which the highest densities were recorded. It seems that in the course of spring animals tend to move more offshore to the north and return again in winter (Fig. 4.5.1).

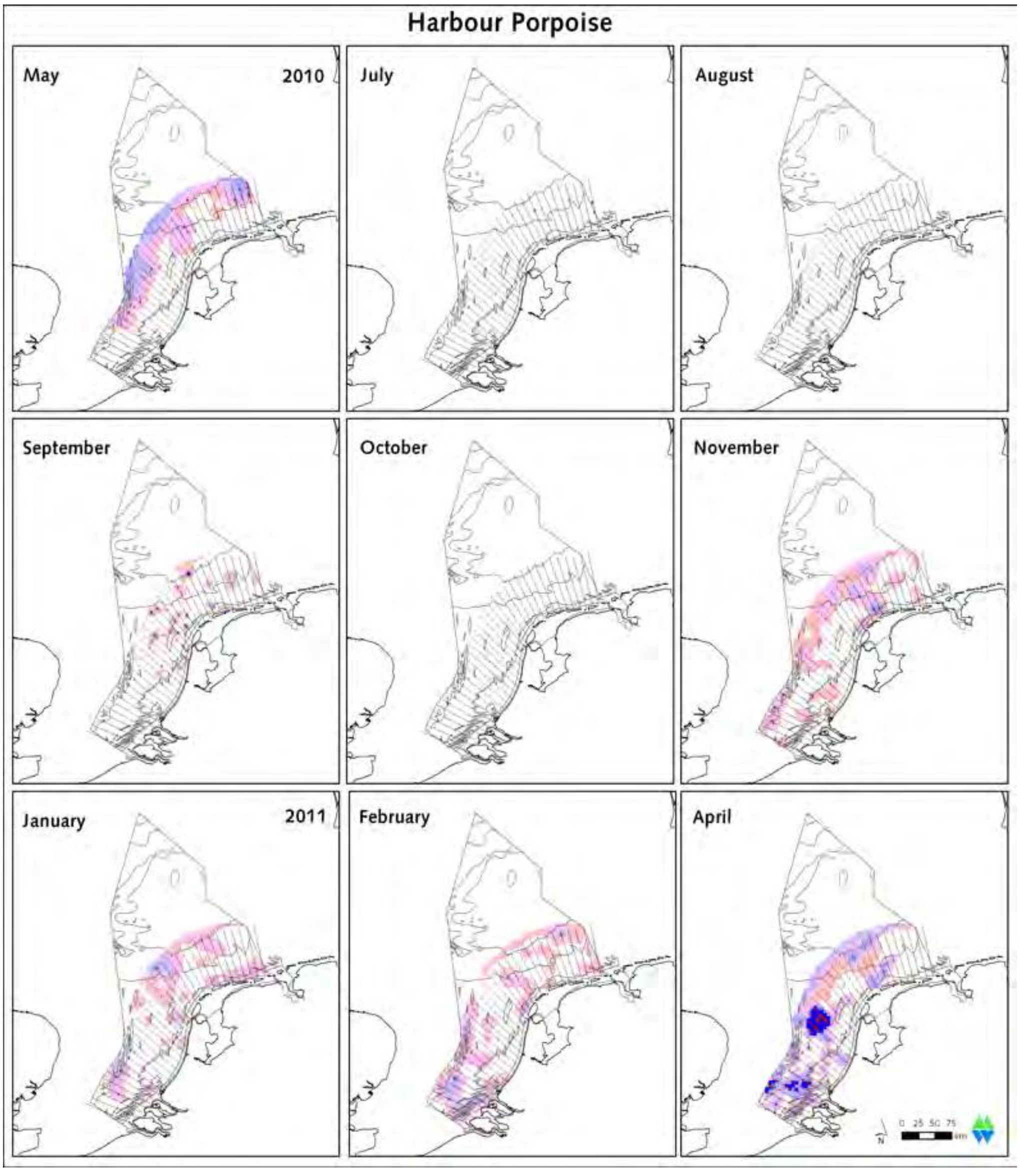
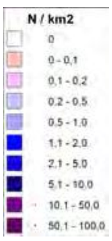


Figure 4.5.1 *Interpolated monthly densities of Harbour Porpoise from aerial survey data within the study area. The red dots show the measured density of that poskey and the colour gradient from pink to blue indicates the interpolated density. In July, August and October too few observations were available to conduct a reliable interpolation of the data.*



5 General discussion

5.1 One year of seabird data in relation to search areas for new offshore wind energy

In general, due to the survey design, the Shortlist Masterplan aerial surveys have yielded much more detailed large-scale distribution patterns of seabirds compared to the ongoing MWTL monitoring scheme or to the cumulative ship-based ESAS database. The Shortlist Masterplan aerial surveys revealed some surprising findings and have given new insights into the occurrence and distribution of seabird species in the Dutch part of the North Sea. Firstly, information on perpendicular distribution patterns of many species been obtained, which itself has provided new insights into the far-offshore occurrence of several species, such as Sandwich Tern and Little Gull. Secondly, the cumulative distribution patterns of several species have revealed a number of areas with low densities of seabirds.

In relation to current search areas for new offshore wind farms, seabird species-specific spatial patters are reported. Coastal species like Common Scoters and divers were not present within the search areas for offshore wind farms, however, during migration passage might occur through the search areas. Northern Gannets were recorded in all search areas, but clearly the least number of Northern Gannets were observed in the most northerly location. Great Cormorants were mainly absent from the defined search areas for new offshore wind farms. Since offshore wind farms provide resting habitat for Great Cormorants in the marine environment, offshore range expansion is likely to occur with newly built wind farms. Only in the most western search area for new wind farms substantial numbers of Northern Fulmars were recorded. In the search area near the Brown Ridge clearly the largest numbers of Great Skuas have been observed. As this species is on a European scale a rather rare seabird species research on potential impacts of new offshore wind farms to be developed in this area should be focussed on this species. Smaller skua species seem to migrate through all search areas. In all search areas Kittiwakes were observed. This study provides detailed information about the distribution patterns of Little Gull throughout the entire study area. Based on this study the distribution of Little Gulls seems to overlap with all search areas for new offshore wind farms. Common Gulls, European Herring Gulls and Lesser Black-backed Gulls were observed in all search areas but were less abundant in the search areas further offshore. Given the widespread distribution of Great Black-backed Gulls in the Dutch North Sea, the species occurs in all search areas. This also holds true for the two species of auks, Guillemot and Razorbill. Remarkably, Sandwich Terns were found in most of the search areas for wind farm development, however, their unexpected wide spread occurrence was restricted to April and August. A similar far offshore occurrence was found in 'comic terns' but the densities in the search areas were much lower.

Although these general distribution patterns and the changes throughout the year are likely to be representative, further data would be required in order to assess whether these data are representative over a longer time-scale. Furthermore, the importance of the search areas require certainly more data before firm conclusions can be drawn as this is the first time that aerial surveys have been carried out in the Dutch part of the North Sea at such a detailed spatial scale.

The data presented in this report, which have been collected through the Shortlist Masterplan aerial surveys, represent one year of surveys. Although the detailed survey design and applied methodology has proven successful in achieving its aims, the fact remains that limited conclusions can be drawn from a single year's data.

5.2 Methodology and study design of aerial programs

The main aim of the long-term MWTL seabird program is the monitoring of trends in distribution and numbers of seabirds of the total Dutch North Sea, hence the choice has been made, in order to representatively cover the total area in a limited amount of time, to have a low density but wide transect design in order to have coverage throughout the range of the Dutch North Sea. Furthermore, the applied methodology within the MWTL program has been kept the same for years since the beginning of the program in the early 1990s in order to safeguard strict comparable data and indices. This has resulted in a very reliable and longterm data set with trends in numbers and the distribution of seabirds in the Dutch part of the North Sea (see Arts 2010). However, in the course of time practical and methodological improvements in aerial-based survey techniques (use of specially designed observer aeroplanes, flying at low altitudes, using clinometers for distance measures in the field) and the analysis of survey data (Distance Sampling, Buckland *et al.* 1993) have been further developed, which have yielded improved methodological and analysis protocols. Togethere with a detailed survey design these are recommended in the context of effect studies on wind farms (Camphuysen *et al.* 2004) and therefore chosen in this study.

In this report the MWTL aerial-based survey data have been compared with the Shortlist Masterplan aerial data in the overlapping study area as well as with the ship-based survey data collected over the same period. Two of the observers of MWTL have partly participated in present study and helped with the interpretation of the differences in results. Most important, it is very clear that the survey design of the Shortlist Masterplan aerial surveys has yielded much more detailed large-scale distribution patterns of seabirds compared to the ongoing MWTL monitoring scheme. With the lower flight altitude of the aeroplane it seems that there is a bit less disturbance of seabirds, meaning that densities can be measured more accurately in some species. With a higher-flying aeroplane, birds have more time to respond, either flying out of the observation range or diving under water, resulting in lower encounter rates. Furthermore, in the case of the MWTL program, birds sometimes remain unrecorded, as they have moved out of the observation strip transect due to the disturbance of the aeroplane. In the distance approach of this project also birds further away of the aeroplane in a total of at least five strip bands are recorded. Another difference with Shortlist Masterplan surveys compared to the MWTL surveys is a better species identification in some of the species groups due to the lower flight altitude (especially in the auks).

5.3 Further research and analysis

The data collected allow more complex analyses than needed for the current question (what are good and less good areas for offshore wind farms in relation to seabirds abundance?). For instance, the "old" question of how to compare ship-based and aerial survey data of both MWTL and the Shortlist Masterplan can be properly addressed using sound and synoptic data for a range of seabirds species, weather conditions and geographical scales after the completion of several years of surveys. The set up of the Shortlist Masterplan aerial surveys, with its broad coverage, transects design and transect methodology and distance analysis lends itself to the large-scale and longterm monitoring of seabirds, specifically in relation to the search areas for new offshore wind farm developments. In particular, distance analysis allows differences resulting from observer variation, sea state, flock size, etc. to be controlled for and enables the comparison of density estimates over space and time, in particular towards future effect monitoring of wind farms developed in the search areas.

Ship-based data should be added to aerial data, to get more detail, e.g. calibration of densities and species identification. A logical step would be further analysis of older data from MWTL (Rijkswaterstaat Waterdienst/Ministry of Transport and Water Works) aerial surveys. For instance, the well-known 'razormot' as registered in the MWTL monitoring scheme (e.g. Berrevoets & Arts 2002) may be split into Razorbill and Guillemot, using different ratios between these two species for different months and different parts of the Dutch part of the North Sea. First and foremost, species identification can be improved, using ship-based survey data. Secondly, density estimates from aerial surveys may be improved. For instance, species that spend a considerable amount of time under water (diving for food) have little time to surface and be noticed by aerial observers, passing overhead at great speed. Poot *et al.* (2010) have made a first analysis with MWTL data compared to ESAS data and give directions for future analyses. As more ship-based data from the ESAS-database are needed here, we consider this as follow-up analyses.

6 Conclusions and recommendations

6.1 Conclusions

With nine aerial surveys in the period May 2010 – April 2011 the aim of the project to gather the first detailed information on densities and distribution of seabirds in the search area for round 2 and 3 wind farms in the Dutch part of the North Sea was achieved. Despite the geographical scale of the area, data were gathered on seabird distribution and behaviour (including feeding, migration and flying heights) in both the search areas for round 2 and 3 wind farms and the wider Dutch North Sea region. Furthermore, this was achieved year-round and for all species deemed relevant in relation to offshore wind power.

The survey design of the Shortlist Masterplan aerial surveys have indeed yielded much more detailed large-scale distribution patterns of seabirds compared to both the ongoing MWTL monitoring scheme and the cumulative ship-based ESAS database. The two key features of the Shortlist Masterplan aerial surveys is the extent of coverage that is achieved through the survey design, which has resulted in good density distributions of seabirds at sea, and secondly, the low flight altitude, which has enabled a level of species identification beyond that of high altitude aerial surveys.

The MWTL monitoring data complement the Shortlist Masterplan aerial-based survey project outside the study area, with coverage of the far offshore areas in the northern part of the Dutch North Sea. The MWTL results show that for several species and in several periods of the year higher densities of birds occur in the far offshore areas in the northern part of the Dutch North Sea (auks, Northern Fulmar, Kittiwake).

The Shortlist Masterplan aerial surveys revealed some surprising findings and have given new insights into the occurrence and distribution of seabird species in the Dutch part of the North Sea. Firstly, information on perpendicular distribution patterns of many species been obtained, which itself has provided new insights into the far-offshore occurrence of several species, such as Sandwich Tern and Little Gull. Secondly, the cumulative distribution patterns of several species have revealed a number of areas with low densities of seabirds.

The Shortlist Masterplan aerial surveys have proven to be an improved tool for generating density distribution patterns for seabird species in the Dutch North Sea. These surveys have proved suitable for the collection of data in order to compare the distribution and abundance of birds in the Dutch North Sea throughout the annual cycle for a series of objectives, the most important of which is to support the EIAs of offshore wind farms and to contribute to baseline, pre- and post-construction assessments into the effects of wind farms on bird distributions.

In relation to future developments and analyses of the data, the now gathered data can serve as part of a baseline for effect monitoring studies, the Distance sampling approach of the Shortlist Masterplan aerial surveys reduces many of the problems of interpreting data collected with the strip transects approach. This approach allows differences between observers, sea-states and flock size to be controlled and provides statistically robust density estimates with confidence intervals, which enable further future comparisons in both time and space. However, this is under the condition that a substantial number of surveys are carried out.

The data gathered by this first year of Shortlist Masterplan aerial surveys has provided baseline data, which was previously lacking. However, with only a single year's data the importance of the search areas for new offshore wind farms is difficult to define. Variations in the spatial and temporal patterns of seabirds can be high and, therefore, data from more than one year are preferable in order to assess the importance of the search areas.

6.2 Recommendations

The first year of Shortlist Masterplan aerial surveys has provided initial data on the distribution of seabirds. Further analysis of these data is recommended in order to explain the perpendicular distribution patterns in relation to physical parameters, but most of all in order to relate distribution patterns with in case of breeding seabirds the location of colonies. In the case of the Lesser Black-backed Gull current GPS logger studies should be incorporated in this analysis. Also, a further analysis of distribution patterns with human activities and structures such as oil and gas platforms, anchor areas and shipping lanes is recommended.

A total of nine surveys have been carried out. Some months were not covered. In the preparation phase the commissioner prevailed to have an extra survey in wintertime, but based on the large differences in distribution patterns of the different spring and summer months, a June survey is strongly recommended. During this month the chicks of both Lesser Black-backed Gulls and Sandwich Terns hatch and must be fed by the parents, thus representing a crucial period in the life cycle of these birds.

The methodology of the Shortlist Masterplan aerial surveys has proven to fulfil the aim of collecting data on the distributions and occurrence of seabirds in the Dutch North Sea. An initial year's data has already been collected and has enabled the distribution patterns of seabirds to be established. In order to strengthen these findings, an initial further two years of surveys are recommended. This will enable the level of variation in seabird distributions throughout the year to be assessed. Furthermore, increasing the frequency of surveys to two surveys each month would allow the variation within seasons to be better assessed and would provide the level of data needed for comprehensive analyses.

The importance of the search areas for offshore wind farms should be further investigated. Here ship-based surveys could provide additional essential information on the behaviour and flight altitudes of birds within these areas and would ensure a complete assessment of the distribution of seabirds.

7 Literature

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8 Appendices

Appendix 1 - Statistics on GLM models

Statistics on GLM models per survey per species and number, and in the last column the number of positive observations per survey.

significance:

0,001	bold and italic	5
0,01	italics underlined	**15**
0,05	black	**>15**

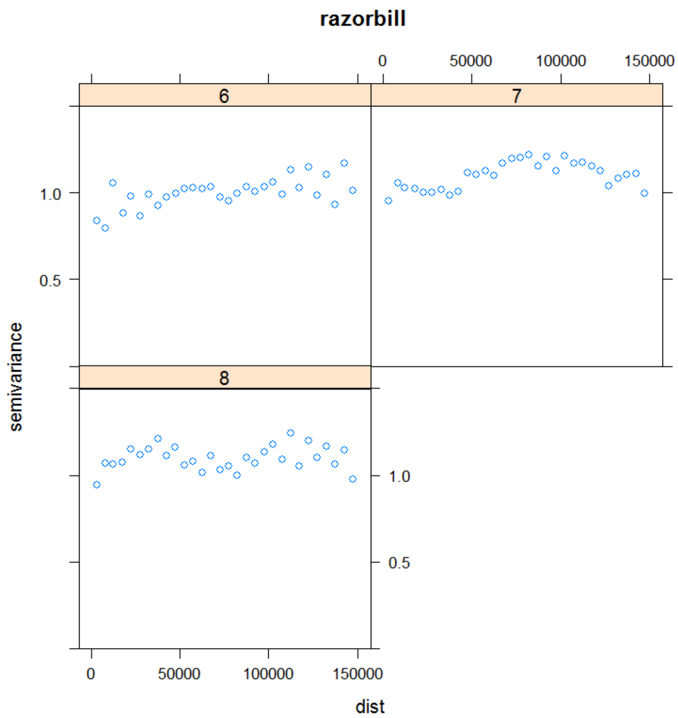
surveys and species		P value coefficients glm			dispersion and deviance					N (obs. >0)
survey	species	Intercept	diep	distkustKM	dispersion	deviance	null deviance	explained	**%ex-lained**	N
november 2010	razorbill	***0,00000***	0,02938	0,19648	5,55	1639,70	1756,38	0,07	**7**	62
january 2011		0,02466	0,17648	0,01334	9,17	2685,48	2739,01	0,02	2	79
februari 2011		0,03094	0,43494	0,89326	20,75	2217,20	2239,08	0,01	1	38
july 2010	guillemot	***0,00000***	***0,00000***	0,72864	15,88	4096,48	5254,27	0,22	**22**	102
august 2010		***0,00041***	0,35088	0,02655	7,36	1446,08	1481,25	0,02	2	45
september 2010		0,04945	*0,00212*	*0,00185*	58,20	7408,31	8212,31	0,10	**10**	103
october 2010		0,02058	0,50448	0,01181	8,76	3287,87	3349,51	0,02	2	127
november 2010		***0,00000***	***0,00000***	*0,00251*	10,67	5856,37	6923,16	0,15	**15**	262
january 2011		***0,00000***	0,87863	***0,00001***	5,95	2522,19	2704,11	0,07	**7**	127
februari 2011		0,34589	0,69058	0,08546	16,71	5670,40	5774,77	0,02	2	182
april 2011		***0,00050***	***0,00015***	***0,00000***	22,17	9107,83	11717,28	0,22	**22**	152
july 2010	alcids	***0,00000***	***0,00000***	0,72916	15,14	3906,33	5019,18	0,22	**22**	103
august 2010		***0,00031***	0,35033	0,02653	7,03	1381,61	1415,23	0,02	2	45
september 2010		0,04100	*0,00170*	*0,00155*	52,25	7100,59	7848,75	0,10	**10**	105
october 2010		0,01690	0,48832	*0,00569*	8,02	3273,81	3342,71	0,02	2	143
november 2010		*0,00805*	***0,00023***	0,58486	39,33	8521,51	9713,40	0,12	**12**	351
january 2011		*0,00716*	0,99581	***0,00014***	6,66	3380,49	3525,09	0,04	4	222
februari 2011		0,75838	0,33603	0,16443	15,90	6631,81	6754,30	0,02	2	228
april 2011		0,03035	***0,00062***	***0,00000***	30,75	9552,28	11792,64	0,19	**19**	159
november 2010	divers	0,59510	0,23581	*0,00192*	3,53	530,59	668,30	0,21	**21**	39
january 2011		***0,00000***	*0,00122*	*0,00651*	11,50	1002,58	1667,00	0,40	**40**	28
februari 2011		***0,00000***	***0,00043***	*0,00139*	8,16	1131,98	1690,24	0,33	**33**	29
august 2010	kittiwake	***0,00000***	0,37468	*0,00283*	4,67	1227,66	1271,50	0,03	3	75
september 2010		0,02989	0,75074	0,42726	23,13	1751,60	1794,91	0,02	2	68
october 2010		***0,00001***	0,23104	0,27752	3,41	1114,69	1120,66	0,01	1	78
november 2010		***0,00016***	0,08925	0,03010	9,55	3510,47	3717,07	0,06	**6**	207
january 2011		***0,00000***	0,79804	***0,00000***	4,30	1880,37	2185,67	0,14	**14**	159
februari 2011		***0,00000***	*0,00621*	0,15968	6,64	2686,28	2891,56	0,07	**7**	156
july 2010	gannet	0,01515	0,97299	0,05433	5,01	970,13	1008,52	0,04	4	72
august 2010		***0,00000***	0,87369	0,42237	2,76	1105,38	1107,63	0,00	0	135
september 2010		***0,00000***	0,01732	*0,00938*	2,69	907,52	930,26	0,02	2	92
october 2010		*0,00831*	0,31154	0,04294	8,15	2023,91	2055,98	0,02	2	157
november 2010		*0,00509*	0,51466	*0,00298*	17,39	2558,51	2729,94	0,06	**6**	137

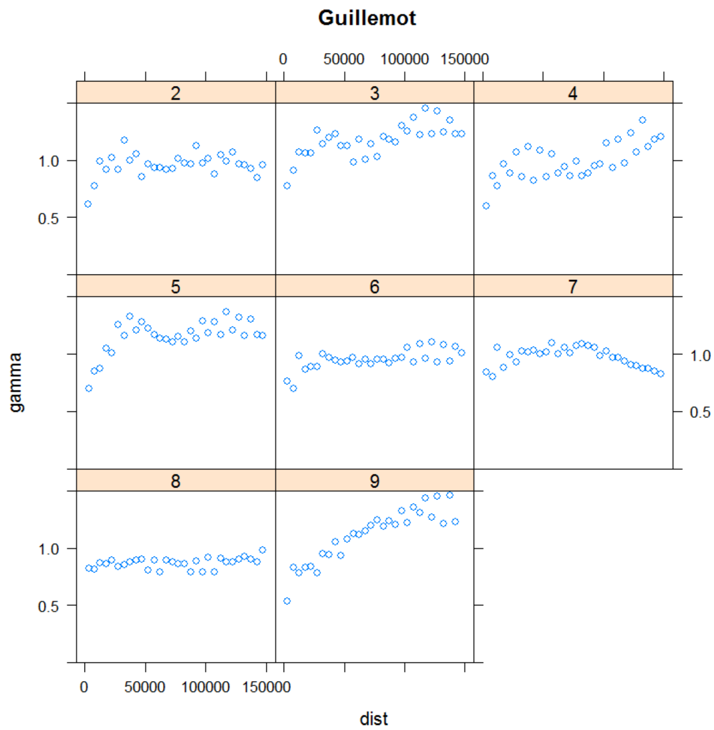
surveys and species		P value coefficients glm			dispersion and deviance					N (obs. >0)
survey	species	Intercept	diep	distkustKM	dispersion	deviance	null deviance	explained	**%ex-lained**	N
februari 2011		***0,00070***	0,04755	0,06569	6,52	692,60	728,39	0,05	5	31
august 2010	fulmar	***0,00000***	0,91499	***0,00000***	6,21	1166,67	1448,89	0,19	**19**	70
september 2010		***0,00000***	0,72083	***0,00058***	2,44	454,86	505,64	0,10	**10**	31
october 2010		***0,00000***	0,13951	0,22468	2,82	409,90	445,29	0,08	**8**	28
november 2010		0,06160	0,33427	0,03630	46,00	2321,82	2545,44	0,09	**9**	29
november 2010	litte gull	***0,00000***	***0,00068***	0,05673	3,60	1054,42	1114,89	0,05	**5**	84
februari 2011		0,44764	0,98765	0,09497	11,26	1886,57	1948,24	0,03	3	73
april 2011		***0,00000***	0,15795	*0,00578*	90,17	15934,59	18282,07	0,13	**13**	83
may 2010	sandwich tern	0,23653	0,28103	*0,00184*	41,75	3542,70	4566,71	0,22	**22**	76
july 2010		***0,00000***	***0,00000***	***0,00000***	16,17	4656,80	7928,48	0,41	**41**	87
august 2010		***0,00000***	*0,00114*	***0,00087***	16,36	4479,32	5362,21	0,16	**16**	171
april 2011		***0,00000***	0,32626	***0,00011***	22,28	7909,55	8780,84	0,10	**10**	159
august 2010	small terns	***0,00033***	0,13400	0,49338	7,39	1631,36	1654,37	0,01	1	54
november 2010	common gull	***0,00001***	0,91121	***0,00004***	13,55	3777,14	4313,61	0,12	**12**	246
january 2011		0,03148	0,01828	0,03418	6,51	2235,79	2378,50	0,06	**6**	114
februari 2011		0,46576	0,57963	0,17563	22,90	2630,56	2685,45	0,02	2	87
august 2010	great bl-backed gull	***0,00032***	*0,00112*	0,03794	21,23	1541,30	2218,65	0,31	**31**	32
september 2010		0,12036	*0,00336*	***0,00002***	17,06	3456,53	3912,31	0,12	**12**	86
october 2010		0,07484	0,02370	0,05342	11,36	2185,94	2400,59	0,09	**9**	82
november 2010		0,82446	0,16012	0,45213	36,25	4524,08	4584,69	0,01	1	114
january 2011		*0,00350*	0,58415	0,07183	19,47	2731,78	2879,43	0,05	**5**	67
februari 2011		***0,00001***	0,09854	0,40682	8,50	1386,15	1484,64	0,07	**7**	44
may 2010	lesser bl-backed gull	***0,00000***	0,41689	***0,00077***	23,66	4771,50	5676,17	0,16	**16**	149
july 2010		***0,00000***	0,44124	***0,00000***	16,50	6712,75	7545,59	0,11	**11**	391
august 2010		*0,00354*	***0,00086***	0,15623	23,51	2084,64	2566,03	0,19	**19**	84
september 2010		0,03858	0,03935	*0,00683*	18,11	1589,37	1772,82	0,10	**10**	44
april 2011		***0,00001***	0,88079	*0,00342*	28,48	8800,68	9258,32	0,05	5	175
may 2010	herring gull	0,02611	0,60160	*0,00457*	15,24	1841,42	2398,00	0,23	**23**	40
july 2010		0,08448	0,16035	0,01267	12,48	1236,80	1609,74	0,23	**23**	52
october 2010		0,73286	0,84015	0,47220	514,30	1585,25	2386,70	0,34	**34**	31
november 2010		0,05537	0,95666	0,94513	15,85	1908,40	1908,72	0,00	0	64
january 2011		0,88201	0,18010	0,98821	18,90	2671,63	2712,44	0,02	2	57
februari 2011		0,35965	0,15215	0,23715	28,58	2243,75	2453,84	0,09	**9**	32
april 2011		0,28150	0,80021	***0,00069***	11,57	1688,13	2108,90	0,20	**20**	39
may 2010	large gulls	***0,00000***	0,84076	***0,00000***	16,72	5321,40	6743,18	0,21	**21**	175
july 2010		***0,00000***	0,89963	***0,00000***	16,33	6417,63	7225,51	0,11	**11**	408
august 2010		***0,00001***	***0,00045***	0,13247	33,14	3543,27	4308,81	0,18	**18**	139
september 2010		0,79926	0,26549	0,08094	39,15	5538,39	5683,82	0,03	3	137
october 2010		***0,00000***	0,04600	*0,00123*	24,69	4720,55	5661,98	0,17	**17**	144
november 2010		0,32944	0,77040	0,34387	22,82	4155,23	4205,27	0,01	1	242
january 2011		0,31333	0,85989	0,25295	17,53	4159,71	4188,34	0,01	1	139

surveys and species		P value coefficients glm			dispersion and deviance					N (obs. >0)
survey	species	Intercept	diep	distkustKM	dispersion	deviance	null deviance	explained	**%ex-lained**	N
februari 2011		0,12016	0,62003	0,18741	34,41	5527,24	5689,83	0,03	3	100
april 2011		***0,00000***	0,76536	*0,00383*	32,11	9534,22	10004,07	0,05	5	229
may 2010	harbour porpoise	***0,00000***	0,44710	***0,00016***	3,58	1085,51	1203,51	0,10	**10**	70
september 2010		***0,00017***	0,39975	0,52771	4,37	849,78	853,24	0,00	0	39
november 2010		***0,00000***	0,11107	0,85373	3,70	829,79	854,04	0,03	3	44
january 2011		***0,00000***	0,05283	0,73920	3,33	719,68	744,88	0,03	3	40
februari 2011		***0,00000***	0,05262	0,49141	4,07	993,63	1018,23	0,02	2	48
april 2011		***0,00000***	0,39475	*0,00187*	6,25	2567,43	2702,02	0,05	5	99

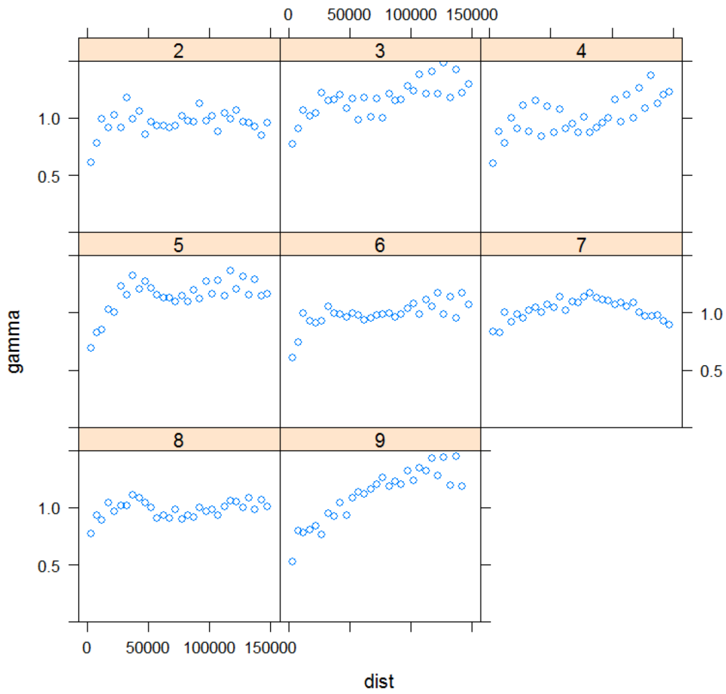
Appendix 2 - Variograms per species

Variograms per species for all surveys where density>0 is 25 or more . Semivariance/gamma is standardized for comparison. Numbers above graphs refer to survey number (1= may 2010, 2=july 2010 …., 9 = april 2011)



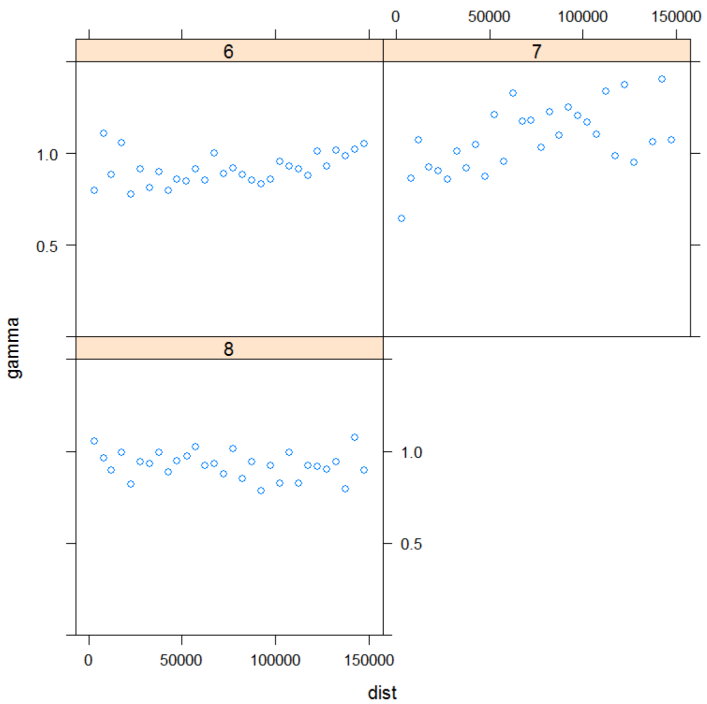


AUKS



0
50000
100000
150000
2
3
4
5
6
7
8
9
1.0
0.5
gamma
dist

DIVERS



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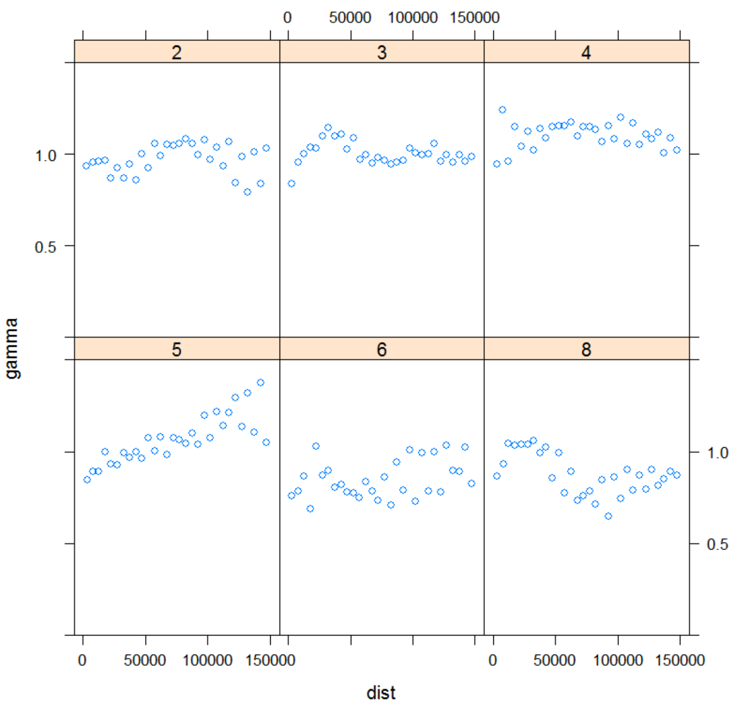
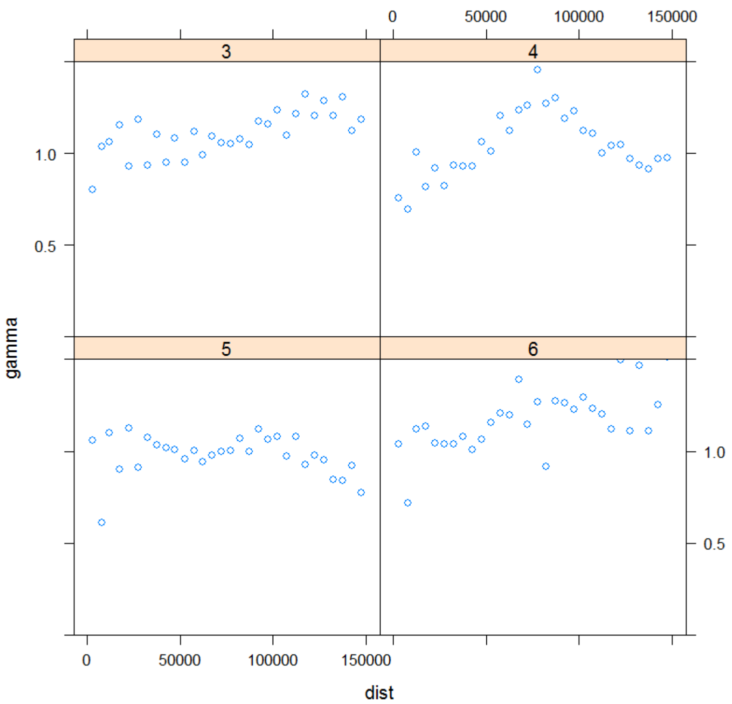
100000
150000
6
7
8
1.0
0.5
gamma
dist

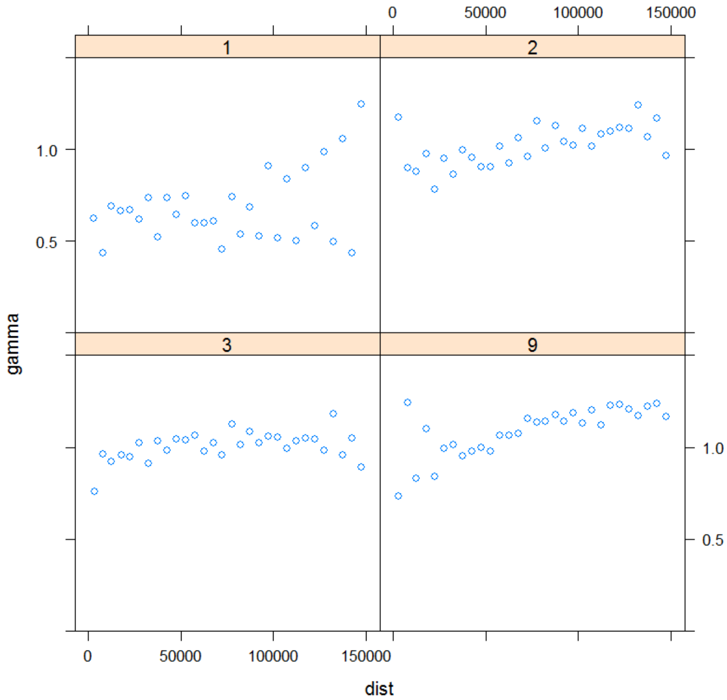
GANNET



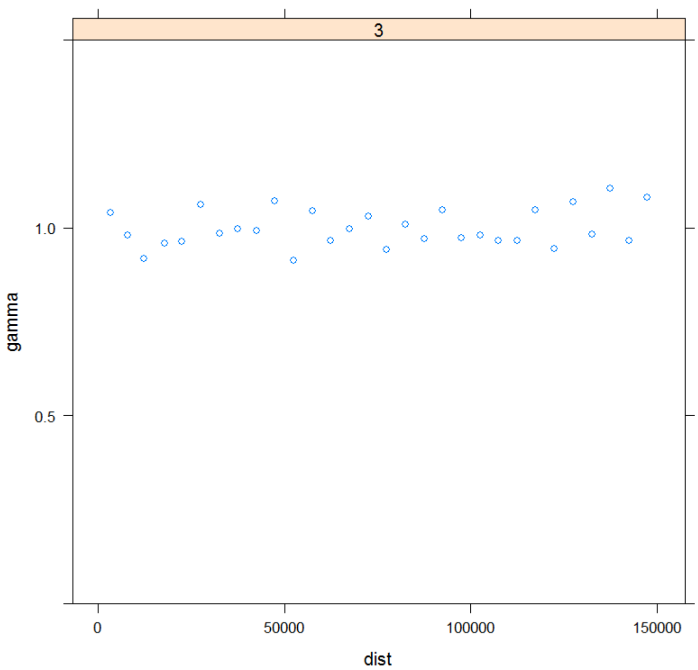
Fulmar

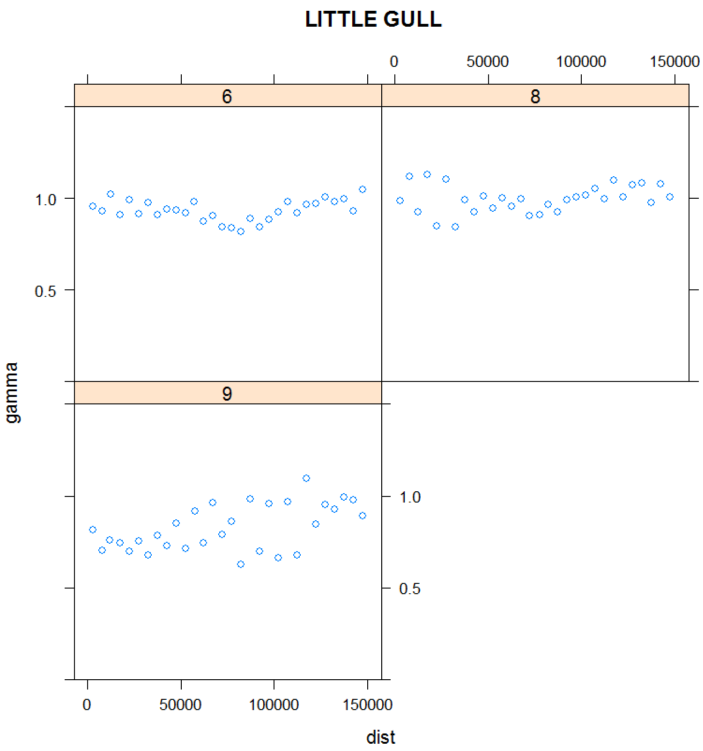


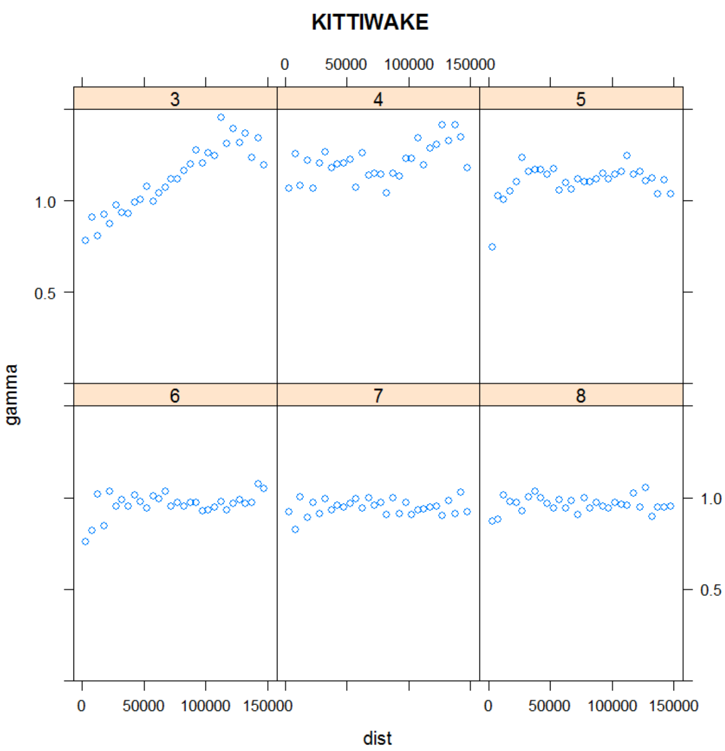
SANDWICH TERN



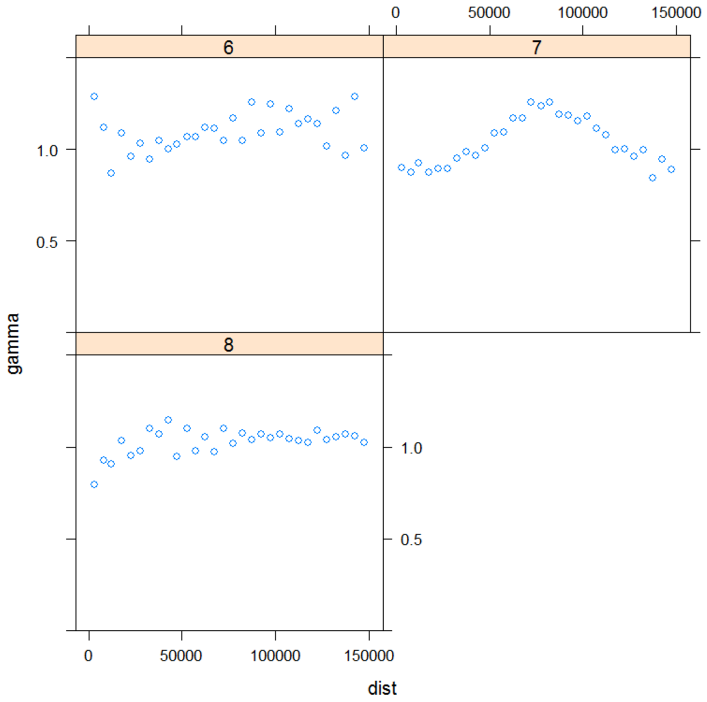
TERNS



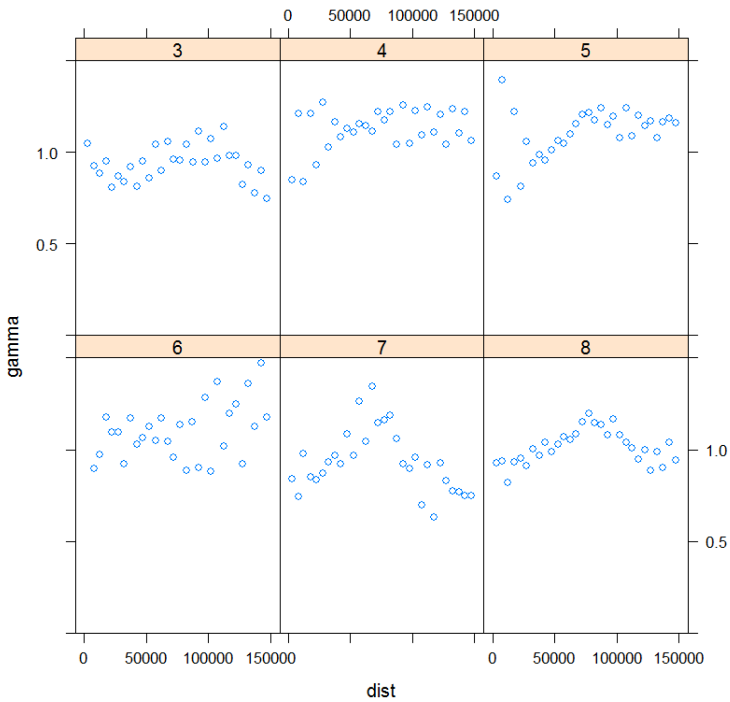

LITTLE GULL
6
8
9
gamma
1.0
0.5
0
50000
100000
150000
dist


KITTIWAKE
3
4
5
6
7
8
gamma
1.0
0.5
0
50000
100000
150000
dist

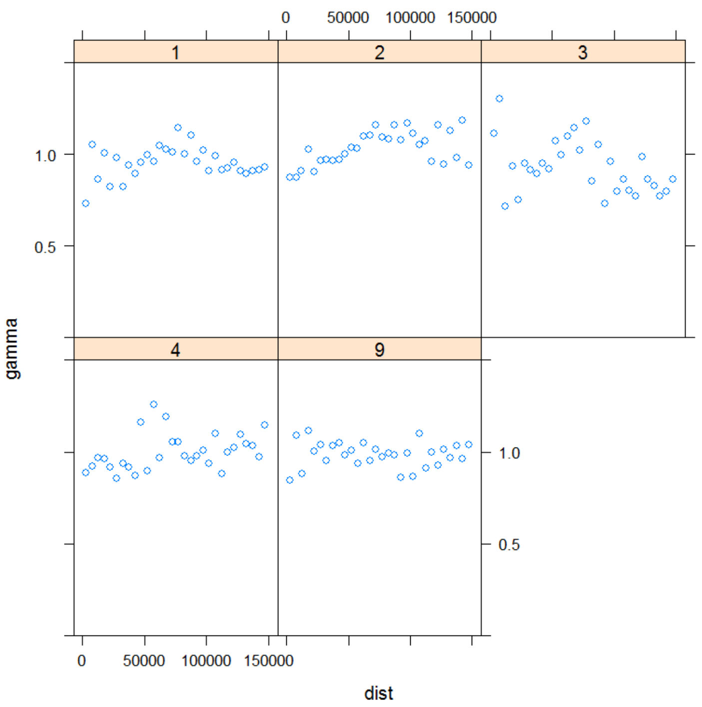
Common Gull



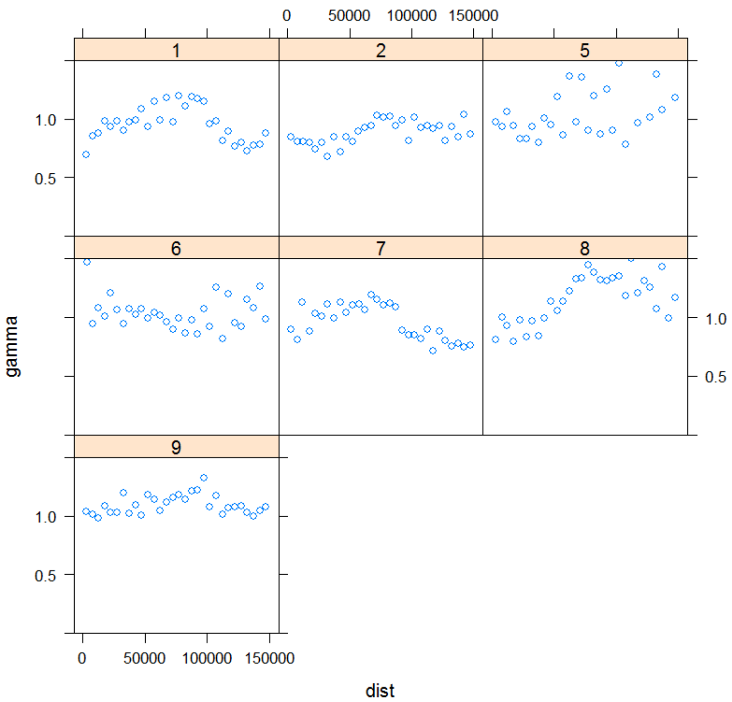
Great Black-backed Gull

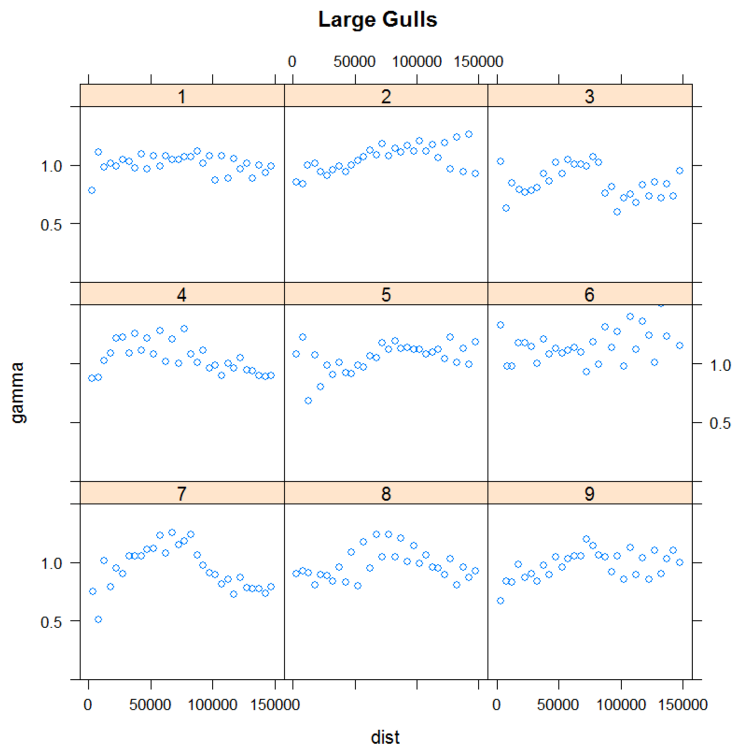


Lesser Black-backed Gull

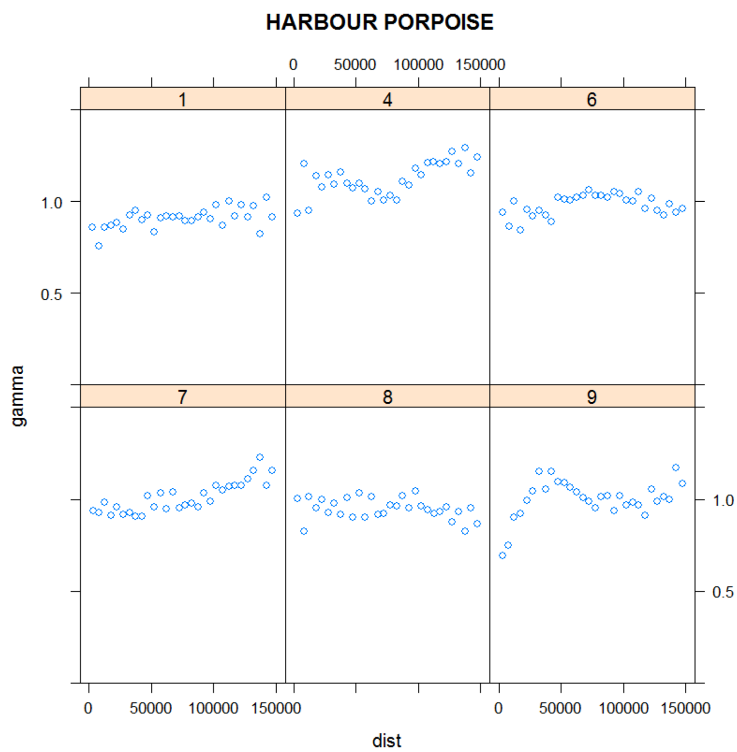


Herring Gull





Large Gulls
gamma
dist
1
2
3
4
5
6
7
8
9
0
50000
100000
150000
1.0
0.5



HARBOUR PORPOISE
gamma
dist
1
4
6
7
8
9
0
50000
100000
150000
1.0
0.5

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu
Postbus 365, 4100 AJ Culemborg
Telefoon 0345-512710, Fax 0345-519849
E-mail info@buwa.nl, www.buwa.nl