Using standardised counting methods for seabirds to monitor marine mammals in the Dutch North Sea from fixed platforms

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Abstract: In the period 2003-2011 offshore platforms in the North Sea have been successfully used for ornithological monitoring programs following standardised observation protocols. As most seabird observers have a strong interest in other large marine animals, marine mammal observations were included in these systematic observation protocols for recording seabirds. Some of these programs ran for several years and the collated sightings have the potential to contribute to the knowledge on at-sea distribution of marine mammals around these platforms. However, detection of marine mammals from offshore platform has several limitations. This study showed that detection significantly increased with increasing altitude of the viewing platform and decreasing sea state. Also, in instances where observers aim to record both seabirds as well as marine mammals the latter have the potential to be missed during busy periods. Nevertheless, a total of 167 platform-based sightings of three species of marine mammal were collected during standardised counts on 132 observation days between 2003 and 2011. The 'seabird' observation protocols used have limitations for monitoring marine mammals but were useful to elucidate trends. In this study it was demonstrated that densities recorded from platforms were up to three orders of magnitude lower than during dedicated aerial marine mammal surveys but were comparable to ship-based surveys and aerial surveys that recorded both birds and marine mammals. Provided that limitations are taken into consideration, fixed platforms can provide suitable observation bases for recording the presence, relative abundance and seasonal changes of marine mammals in offshore environments. The potential application of survey data collected from platforms is discussed and recommendations for future work with the observation protocols used are given.

Keywords: cetaceans, pinnipeds, North Sea, harbour porpoise, harbour seal, grey seal, fixed platform, wind turbine, detection, density.

Introduction

The Dutch North Sea is subject to intense anthropogenic pressures. Ship traffic, fisheries, offshore wind farms, recreational activities, meteorological masts, military activities and one of the world's highest densities of offshore oil and gas platforms make it a heavily used part of the marine environment. Nevertheless, several species of marine mammal coexist amongst these human activities in the Dutch North Sea. Of the three cetacean species regularly present, the harbour porpoise (*Phocoena phocoena*) is the most numerous, occurring both at sea and in some inshore estuaries in the Netherlands (Haelters & Camphuysen 2009, Arts 2011). White-beaked dolphins (*Lagenorhynchus albirostris*) are less numerous than harbour porpoises, but are also observed regularly throughout the year (Hammond et al. 2002). Minke whales (*Balae-*

noptera acutorostrata) are regularly encountered in small numbers in the Dutch North Sea (de Boer 2010). In addition, two species of seals are regularly found: harbour seal (*Phoca vitulina*) and grey seal (*Halichoerus grypus*), both of which can forage far offshore (Brasseur et al. 2004, Lindeboom et al. 2005). Furthermore, several visitors and vagrant species of whales, dolphins and seals have been recorded in the central and southern North Sea (e.g. Reid et al. 2003, Reijnders & Brasseur 2003, Camphuysen & Peet 2006).

There are a variety of different methods to study the distribution and abundance of marine mammals. One of the most commonly used is direct observation from fixed points along the coast (Evans & Hammond 2004). With the increase in the number of offshore wind turbines and oil and gas platforms, there is an increasing potential to conduct similar fixed point counts at sea (Macleod et al. 2010), however, the extent to which these counts are comparable to other offshore methods, such as ship-based or aerial surveys, remains unknown. Marine mammals have been observed from offshore platforms in the North Sea previously (e.g. Camphuysen 1982, Haase 1987, van der Ham 1988, Weir 2001, van der Meij & Camphuysen 2006) but often these observations were not recorded or reported systematically, probably due to their incidental nature. Offshore fixed platform surveys of marine mammals using standardised methods are scarce, whereas standardised surveys of seabirds from these type of platforms are much more common. Whether these seabird protocols are applicable as standardised marine mammal surveys has not yet been studied. This paper is the first to present marine mammal data collected using seabird monitoring protocols and discusses the applicability of the results in the light of other monitoring methodologies.

In recent years novel legislation and tightened licensing procedures often requires platform based marine mammal observers during piling operations and other offshore activities involving noise emission. These marine mammal observers may encounter limitations in observing facilities and detection probability. In this article we provide an overview of the limitations of observing marine mammals from platforms. The implications of these limitations and recommendations for future research with the proposed observation protocols are given.

Methods

In this study we report on the results of three individual monitoring projects that have been undertaken at different platforms in the Dutch North Sea since 2003 (figure 1, table 1). These were bird surveys carried out from a former radio platform (Meetpost Noordwijk, MpN) at an altitude of 20 m above mean sea level, from a meteorological mast (Offshore Wind farm Egmond aan Zee Met-mast, OWEZ) at 13 m above mean sea level and from a gas production platform (K14) at 34 m above mean sea level. During these surveys marine mammals were also observed and recorded systematically.

The most commonly used survey technique was the *panorama scan*. Species, number and estimated distance were noted while making a 360° scan around the platform with a pair of tripod-mounted 10x42 binoculars with the horizon transecting mid-way through the field of view (see for a detailed methodolog-

Table 1. Estimated effort between 2003 and 2011 of fixed offshore platform fieldwork used for analysis in this study.

Year	Study period	Project location	Altitude above sea level	Effort (days/hours)
2003-2004	Year-round	Meetpost Noordwijk (MpN)	20	50 days (~600 hours)
2007-2010	Year-round	OWEZ Met-mast (OWEZ)	13	53 days (~ 636 hours)
2009-2010	Year-round	K14	34	29 days (~ 348 hours)

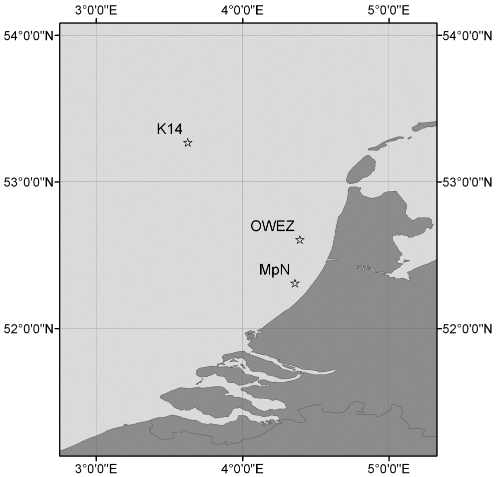

Figure 1. Locations of Meetpost Noordwijk (MpN), Met-mast OWEZ (OWEZ) and gas production platform K14, where fieldwork was conducted in this study.

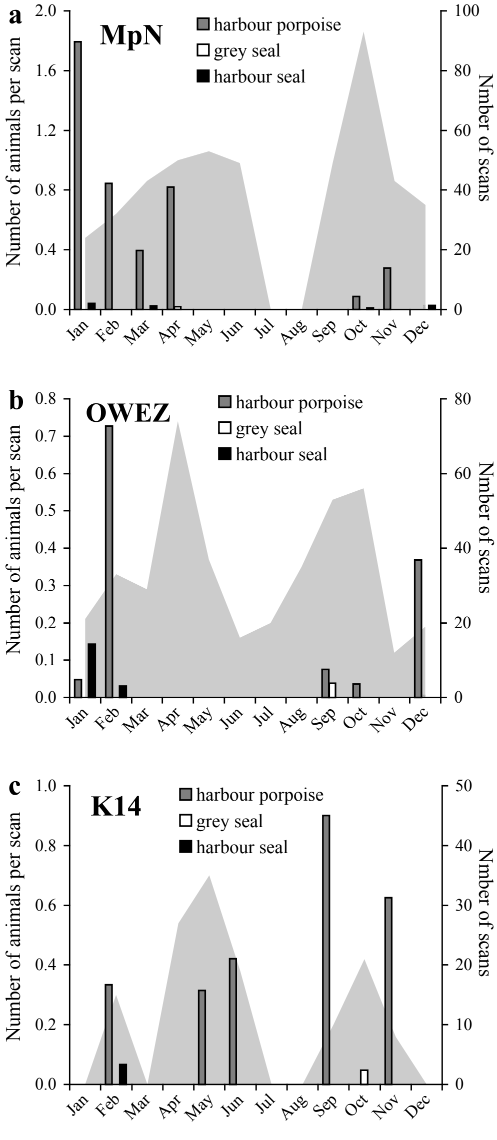

Figure 2a-c. Relative abundance of marine mammals (bars) expressed as number of animals per scan per month at MpN (a), OWEZ (b) and K14 (c) with the number of scans per month in grey shading.

ical description Krijgsveld et al. 2005). The observation distance was categorised in three distance classes: 270-500 m (a 'ring-shaped' surface of 0.556 km^2), 500-1,500 m (6.283 km^2), 1,500-3,000 m (21.991 km^2) summing up to ~28.83 km^2, and a fourth class further than 3,000 m. Distances were estimated based on relative distance to nearby structures like buoys, wind turbines and other platforms. The closest observation distance of the first distance class (270-500 m) was not 0 m due to the limited field of view of the binoculars. Observations beyond 3,000 m were not included in the further analysis in this study due to a low detection rate beyond 3,000 m and a limited visibility during some of the fieldwork days. Panorama scans were carried out with two observers, one person observing and one person writing observations down. Each panorama scan lasted between 20 and 55 minutes depending on the number of observations.

Another method used to collect data from fixed platforms was *line scans*. A line scan (or line count) is the method used by shore-based observers to collect data on passing seabirds along the coast (methods standardised by the Club van Zeetrektellers (CvZ) in the Netherlands; see e.g. Camphuysen & van Dijk 1983). A pair of binoculars was used to observe along a fixed line. All birds and marine mammals were noted and categorised into the same distance classes as with the panorama scans. Data from different projects were collated into

Table 2. Total number of panorama scans and total number of hours of line scans performed from different platforms, and cumulative number of scans with marine mammals.

Project location	Number of panorama scans	Hours of line scans	Days with sightings	Panorama scans with sightings	Number of species recorded
MpN	471	187	22	38	3
OWEZ	405	n/a	15	23	3
K14	135	9	14	18	3

a single database for analysis in this study.

During most surveys weather conditions were either collected by the observers or automatically by platform equipment and this information was added to the observation databases. Sea state class was always noted to give an indication of conditions of the sea surface.

Data were analysed using IBM SPSS Statistics 20. The recorded observation distances did not follow a normal or Poisson distribution, and therefore non-parametric statistics (Spearman Rank Correlation) were performed to model the influence of observation altitude above sea level and sea state on the detection distance of marine mammals. Grouped median values for categorical data were used to describe the median observation distance per platform. Animal densities were calculated per panorama scan per platform and were averaged for all scans combined.

Results

Three species of marine mammal (harbour porpoise, harbour seal and grey seal) were observed during standardised seabird surveys at MpN, OWEZ and K14. Marine mammals were observed during 22 observation days at MpN (44%) and during 38 panorama scans (8%) (table 2). After a correction for effort, the highest numbers of animals per scan were concentrated in winter and early spring (Jan – Apr) and in autumn (Oct/Nov) (figure 2a). At OWEZ, marine mammals were encountered during 15 observation days (28%) and during 23 panorama scans (6%) (table 2). These sightings were concentrated in winter (Dec – Feb) and in autumn (Sep/Oct) (figure 2b). Marine mammals were observed during 14 observation days at K14 (48%) and during 18 panorama scans (13%) (table 2). Marine mammals were encountered throughout the year at K14 (figure 2c).

The majority of marine mammals observed at MpN, OWEZ and K14 were harbour porpoises (n=152, figure 3) of which most were seen at MpN (67%). An average density of 0.010 harbour porpoises per km^2 (range: 0-0.065) was calculated for MpN from the panorama scan observations (table 3). An average of 0.003 harbour porpoises per km^2 was found at OWEZ (range: 0-0.017) and 0.009 harbour porpoises per km^2 (range: 0-0.018) at K14 (table 3). Seals were seen from all three platforms with the highest number of sightings at OWEZ and MpN, however, sample sizes were small (n=13, figure 3).

The median observation distance of harbour porpoises during panorama scans and line scans was highest at K14 (1,648 m, n=30) followed by MPN (1,103 m, n=109) and OWEZ (1,000 m, n=28). Most observations of harbour porpoise from platforms were made in the distance class 500 – 1,500 m from the platform, especially at OWEZ. However, harbour porpoises were still recorded at distances up to 3,000 m (figure 4), and even beyond 3,000 m (1% at MpN, 0% at OWEZ, 35% at K14, class was not depicted in figure 4). In general, a larger proportion of the harbour porpoise sightings at K14 were observed at greater distances (figure 4).

Harbour seals were recorded up to 3,000 m and grey seals up to 1,500 m. These were often spy-hopping animals or animals temporarily

Table 3. Overview of bird/marine mammal surveys in the Dutch coastal zone determining densities of harbour porpoises using standardised counting methods.

Source/area*	Years**	Target***	Method****	Average density*****
MpN[1]	2003 - 2004	B/MM	PS	0.010 (max. 0.065)
OWEZ[2]	2007 - 2010	B/MM	PS	0.003 (max. 0.017)
K14[3]	2010 - 2011	B/MM	PS	0.009 (max. 0.018)
MWTL[4]	1991 – 2010	B/MM	AS	0.1 – 0.3
SCANS[5]	1994	MM	SS	0.095
SCANS[6]	2005	MM	SS	0.36
OWEZ[7]	2007 - 2011	B/MM	SS	0.00 – 0.87
Shortlist & Offshore[8]	2008 - 2010	MM	AS	0.278 - 2.007
Shortlist[9]	2010 - 2011	B/MM	SS	0.01-0.04
Shortlist[10]	2010 - 2011	B/MM	AS	0.0 – 0.1

* Location where the study has been performed: 'MPN' = Meetpost Noordwijk, 'OWEZ' = Offshore Windfarm Egmond aan Zee, K14 = Gas production platform K14 (NAM), 'MWTL' = Entire Dutch North Sea, 'SCANS' = coastal area of Belgium, Netherlands and Eastern Frisia, 'Shortlist' = coastal zone of Netherlands up to 120 km offshore, 'Offshore' = section B in Scheidat et al. 2012a; ** study years when fieldwork was conducted; *** B = Bird survey, MM = Marine Mammal survey; **** PS = platform-based Panorama Scan, SS = Ship-based (transect) Survey, AS = Aerial (transect) Survey; ***** number (or range) of harbour porpoises per km^2.

[1] This study and Krijgsveld et al. 2005
[2] This study and Krijgsveld et al. 2011
[3] This study and Fijn et al. 2012
[4] Arts 2011
[5] Hammond et al. 2002
[6] SCANSII 2008
[7] Leopold et al. 2011
[8] Scheidat et al. 2012a
[9] van Bemmelen et al. 2011
[10] Poot et al. 2011

resting at the surface. Observation distances for seals showed large variations compared to the harbour porpoise data due to small sample sizes.

The observation distance of harbour porpoises was positively correlated with the altitude of the observation platform. Thus, observation distances during panorama scans and line scans were greater at K14 (highest observation altitude) than at MPN and subsequently OWEZ (figure 5, Spearman's correlation coefficient r_s=0.227, n=152, P=0.005). The average observation distance of harbour porpoise in this study decreased significantly with increasing sea state (figure 6, Spearman's correlation coefficient r_s=-0.223, n=152, P=0.006). No significant correlations were found between the observation distance of seals and the altitude of the platform (Spearman's correlation coefficient r_s=0.253, n=13, P=0.404) and sea state (Spearman's correlation coefficient r_s=-0.273, n=13, P=0.367).

Discussion

In recent years, several methods (line scans, transects) have been used from various observation platforms (shore-based, ships, airplanes) to study the distribution and abundance of marine mammals in the Dutch North Sea (e.g. Camphuysen 2004, Arts 2011, Leopold et al. 2011, Poot et al. 2011, Geelhoed et al. 2011, van Bemmelen et al. 2011). In addition to the difference in observation platforms, programs differed in their set-up with some using dedicated marine mammal observers and others using observers to sur-

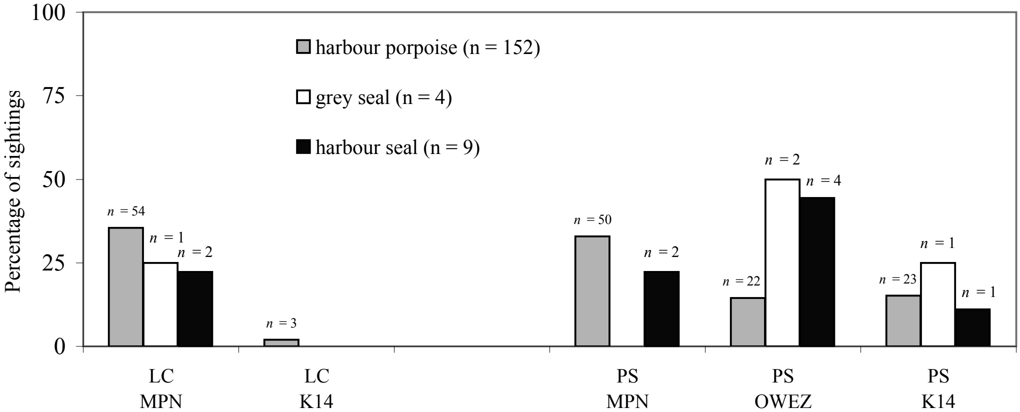

Figure 3. Percentage of sightings and sample sizes of harbour porpoise, grey seal and harbour seal on three different platforms, divided per observation method (LC = Line Count, PS = Panorama Scan). Note that no line counts were done at OWEZ (table 2).

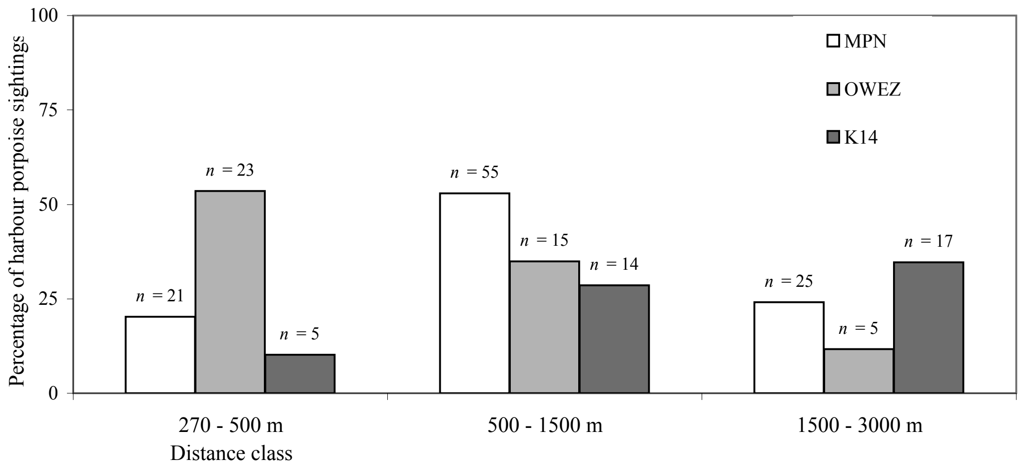

Figure 4. Percentage and sample size of total number of harbour porpoise sightings in different distance classes per platform. At K14 35% of all harbour porpoises were observed beyond 3,000 m but this is not depicted in this figure because these observations were not used for the analysis.

vey both seabirds and marine mammals. This variety of methods and set-ups provided different estimates of harbour porpoise densities off the Dutch coast. In general, the highest densities of animals were found in dedicated aerial surveys for marine mammals, followed by the combined bird and marine mammal aerial and ship-based surveys (table 3). The estimates from our platform-based research were among the lowest figures found for harbour porpoise densities but consistently in the same order of magnitude among the three different platforms. They were one to three orders of magnitude lower than some of the dedicated aerial marine mammal surveys (Scheidat et al. 2012a) but in the same order of magnitude as combined bird and marine mammal aerial surveys (Poot et al. 2011) and ship-based seabird surveys (van Bemmelen et al. 2011). Remarkably, the densities were very similar between MpN (near shore) and K14 (offshore), while in contrast other stud-

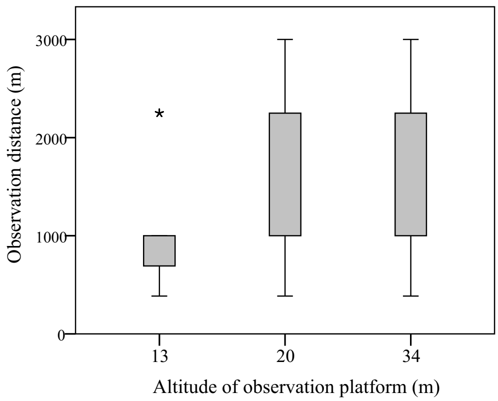

Figure 5. Boxplot of observation distances of harbour porpoise sightings with increasing altitude of the platform above sea level (Spearman's correlation coefficient r_s=0.227, n=152, P=0.005). Shown are lower and upper quartiles (squares), sd (bars) and outliers (stars).

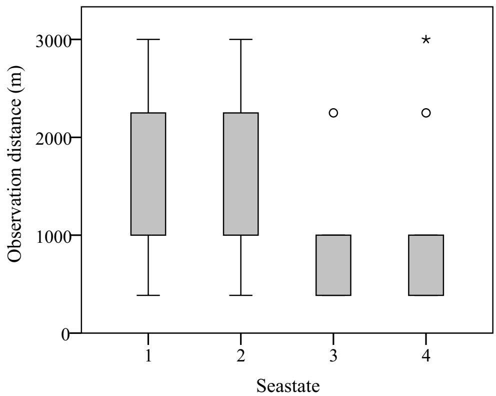

Figure 6. Boxplot of negative relation between the observation distance of harbour porpoise (Spearman's correlation coefficient r_s=-0.223, n=152, P=0.006) and increasing sea state. Shown are lower and upper quartiles (squares), sd (bars) and outliers (stars). Seastate: 1=ripples, no foam, 2=small wavelets, 3=crests break, 4=numerous white caps.

ies report higher densities further offshore (e.g. Geelhoed et al. 2011, Poot et al. 2011). One reason for this apparent similarity is that data from MpN were collected in 2003/2004 at the peak of annual mean abundance of harbour porpoise in the Dutch North Sea (Camphuysen 2008, Arts 2011), whereas data from K14 were collected in 2010/2011 when overall numbers of porpoises in the Dutch North Sea had decreased. The general pattern of higher porpoise densities offshore is better reflected when comparing the results of OWEZ (near shore platform, research in 2007-2010) and K14 (offshore, research in 2010-2011) with offshore densities roughly three times higher than closer to the coast. The above-mentioned patterns in abundance and the consistency between the estimates among the three platforms, suggest that similar results can be achieved from seabird protocols between years. Potentially, platform-based monitoring provides a good measure to study relative abundance, and opportunities should be explored to correct these figures with a measured factor (based on surveys with other observation techniques) to estimate more realistic figures for absolute abundance.

The lower animal densities that were found around platforms compared to the figures from aerial and ship-based surveys can be largely explained by the ecology of the study subject (behaviour and seasonal occurrence of animals, disturbance or attraction) and the methodology used (observer related differences, observation conditions, correction for distance sampling).

Detection and abundance of marine mammals from fixed platforms was affected by several different factors that were not determined by methodological choices. First, the behaviour of the study species can influence detection substantially. In this study, seals were often recorded when spy-hopping or resting at the surface. Therefore, this species-group was visible at the surface for longer periods than, for example, harbour porpoises, which increased their probability of detection. Cetaceans and seals, therefore, require a different search effort. A second factor affecting the abundance is the influence of the timing of a survey as the presence of marine mammals in the North Sea is highly correlated with the period of the year. The data from the platform studies in this study were collected year-round whereas results from other studies were collected in specific seasons only and perhaps only provide information for key periods (e.g. Hammond et al. 2002, SCANS 2008). A third reason for the apparently lower density around platforms is that offshore platforms are often places where substantial amounts of noise are generated. Commonly noticed effects of underwater noise are changes in diving behaviour and avoidance/displacement (e.g. Richardson et al. 1995, Weilgart 2007). The interpretation of results from platforms with substantial amounts of noise requires caution, as observed numbers are likely to be biased due to displacement (e.g. Morton & Symonds 2002, David 2006), although on the other hand attraction of marine mammals to platforms has also been reported (e.g. Scheidat et al. 2012b). In previous research on platforms where excessive underwater noise was emitted, harbour porpoises were absent from an area around the platform (during piling; Bouma & Fijn 2010, Krijgsveld et al. 2010) or present in very low densities (during flaring operations; Collier et al. 2011).

A variety of methodological choices can also affect detection and consequently the measured density of marine mammals around fixed platforms. This study showed that an increase in altitude of the viewing platform resulted in a significant increase of the detection distance of harbour porpoises. Naturally, at a certain point an optimal altitude will be reached, but in general we suggest a high view point from which positive species identification is still possible, as it proved to increase the detection rate of marine mammals. Our study also revealed that the detection of marine mammals was limited in rougher sea states. Detection proved to be good at large distances during sea state 1 and 2 but decreased significantly with increasing sea state. Relationships between sea state and observation distances have been found previously for marine mammals and sea turtles (Palka 1996, Beavers & Ramsey 1998, Barlow et al. 2001) but these were all during ship-based surveys. Compared to ship-based surveys the effect of sea state in platform-based observations might be less pronounced as they do not suffer from the instability that observers experience at high sea states on ships, but still sea state should be treated as a contributing factor in detection rates.

Recommendations for future research

Our results show that standardised counting methods for seabirds are potentially useful to monitor marine mammals provided the limitations are taken into consideration. When viewing conditions are good, platforms have a relatively easy access and provide comfortable observation opportunities to collect data on the presence of marine mammals. For quantitative research, however, the limitations urge a precautionary interpretation, as it remains questionable to what extent the results can be used to estimate absolute abundance. Ideally, the numbers of marine mammals observed from fixed platforms should be corrected to account for the consequences of suboptimal observation conditions and for a detection loss with distance from the platform. There are several methods in use to correct for imperfect detection conditions, such as in double-platform surveys or in point distance sampling (e.g. Buckland et al. 2001). Such analyses should be developed and applied in future studies from fixed platforms to allow for quantifications with a higher probability.

Novel legislation requires dedicated marine mammal observers to be present on platforms before and during offshore activities involving noise emission. Seabird protocols can be useful tools to study the presence of marine mammals before and during these operations, but reduced observation conditions due to increased sea state or a low observation height will limit the quality of data collected. When encountering adverse circumstances, alternative observation methods should be applied to fulfil the requirements taken up in the licences. Ideally, a combination of platform-based research with some dedicated aerial marine mammal surveys or passive acoustic monitoring should be used to monitor the presence of marine mammals around fixed platforms.

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Samenvatting

Het gebruik van gestandaardiseerde zeevogelprotocollen voor de monitoring van zeezoogdieren vanaf vaste platforms in de Nederlandse Noordzee

Tussen 2003 en 2011 zijn verschillende ecologische onderzoeksprojecten uitgevoerd vanaf offshore platforms in de Noordzee. Vaak waren dit monitoringprojecten van locale en vliegende vogels die volgens standaard telmethoden in kaart werden gebracht. In al deze programma's werden zeezoogdieren ook genoteerd en systematisch geteld omdat zeevogel onderzoekers vaak veel belang hechten aan de aanwezigheid van andere mariene toppredatoren. Sommige van deze projecten liepen meerdere jaren en de samengevoegde waarnemingen kunnen in potentie veel informatie verschaffen over de verspreiding en aantallen zeezoogdieren rond deze platforms. Echter de detectie van zeezoogdieren vanaf platforms kent verschillende beperkingen. De detectie van zeezoogdieren wordt bepaald door de waarnemingsinspanning, weersomstandigheden en 'sea state', een maat voor de conditie van het wateroppervlak. Daarnaast is het mogelijk dat waarnemers die hun aandacht moeten verdelen over zeevogels en zeezoogdieren de laatste groep makkelijker over het hoofd zien. In dit artikel wordt een overzicht gegeven van de gevolgen van de invloed van afstand en sea state op de waarnemingskans van zeezoogdieren bij observaties vanaf een platform. Daarnaast wordt nagegaan of zeevogelprotocollen geschikt zijn om zeezoogdieren te monitoren In totaal werden 167 zeezoogdieren van drie soorten (bruinvis (*Phocoena phocoena*), gewone zeehond (*Phoca vitulina*) en grijze zeehond (*Halichoerus grypus*)) waargenomen vanaf deze platforms tijdens in totaal 132 velddagen tussen 2003 en 2011. Hoewel de gebruikte zeevogelprotocollen goed bruikbaar bleken om zeezoogdieren in kaart te brengen, gaven ze enkele ordegroottes lagere dichtheden bruinvissen in vergelijking met die van vliegtuigsurveys die uitsluitend zeezoogdieren telden. De dichtheden vanaf platforms kwamen wel overeen met waarden die gevonden werden tijdens onderzoek vanaf schepen en vliegtuigsurveys die zowel vogels als zeezoogdieren telden. De oorzaak van onderlinge verschillen tussen de methoden ligt mogelijk in beperkingen van het uitvoeren van zeezoogdierobservaties vanaf platforms, die veroorzaakt worden door de invloed van het platform zelf. Daarnaast bleek de detectieafstand toe te nemen met een toename van de hoogte waarvan observaties werden uitgevoerd en met een afname van de toestand van het wateroppervlak ('sea state'). Deze detectieafname heeft gevolgen voor de betrouwbaarheid van het maken van waarnemingen van platforms en gevolgen en aanbevelingen voor toekomstig onderzoek worden besproken in dit artikel.

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