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Resident cetacean species in the North Sea

DATUM
21 november 2024

ONDERWERP
briefrapportage

ONS KENMERK
2429091/AJ-lcs
431100012 -24/21

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Contents

Introduction

In 2016, the Offshore Wind Ecological Program (Wozep) has been set up to reduce the knowledge gaps of the effects of offshore wind farms on the North Sea ecosystem, e.g. marine mammals. Until now, Wozep focussed on harbour porpoise (*Phocoena phocoena*) and two resident seal species, whilst other resident marine mammal species were not considered. The foreseen increase in total capacity of offshore wind, and changes in the North Sea ecosystem, e.g. climate change, triggers the need for information on other marine mammal species that could potentially become affected by offshore wind farms.

In this memo, the status of cetaceans in the Dutch North Sea will be sketched and resident species that were previously not considered by Wozep, will be described in more detail. Of these species distribution, population size, and potential vulnerability to offshore wind farms will be sketched. Some thoughts on research possibilities to address knowledge gaps related to offshore wind farms, rounds off this memo.

Status of cetaceans in the Dutch North Sea

In the Dutch North Sea, or the Dutch Continental Shelf (DCS), the occurrence of 27 cetacean species has been documented (Broekhuizen et al. 2016, Camphuysen & Peet 2006, van der Meij & Camphuysen 2006). The status qualification in Table 1 differs from the status used in the Dutch Red lists 1994 & 2006, in which most cetacean species are qualified as vagrants, except white-beaked dolphin (*Lagenorhynchus albirostris*) (regular guest) and harbour porpoise and bottlenose dolphin (*Tursiops truncatus*) (both resident). The Red List qualification follows the IUCN, in which a species is only considered resident if reproduction is proven in ten consecutive years (Zoogdiervereniging VZZ 2006). Species that occur annually outside the reproduction season can be qualified as residents as well. Camphuysen & Peet (2006), and van der Meij & Camphuysen (2006) have made an update of the status used in the Red List, and qualified around ten additional species as regular guests. Current knowledge leads to a change in the status of three species: bottlenose dolphin, humpback (*Megaptera novaeangliae*) and killer whale (*Orcinus orca*) (for details on changes for the first two species, see section Other non-resident species).

A third of these species have only been found dead and have never been observed alive in the DCS. Two thirds of the species have been observed and identified at sea. Five of these species are qualified as vagrants, ten as regular visitors and three as residents (Table 1). Apart from harbour porpoise, minke whale and white-beaked dolphin qualify as resident species, i.c. species that occur annually in the Dutch North Sea. In the Belgian North Sea harbour porpoise, white-beaked dolphin and to a lesser extent bottlenose dolphin were considered to occur regularly, whereas minke whale is a vagrant (Verkem et al. 2003). The status of these dolphins and minke whale off the southeast coast of the United Kingdom has not been assessed.

Table 1. Status of cetaceans in the Dutch North Sea. The status is mainly based on Camphuysen & Peet (2006) and van der Meij & Camphuysen (2006): resident = observed almost annually; regular guest = not observed annually; vagrant = observed irregularly, and as an additional category: stranded = species that have only been found dead.

Species	Scientific name	Status
Toothed Whales	***Odontoceti***	
Harbour porpoise	*Phocoena phocoena*	Resident
White-beaked dolphin	*Lagenorhynchus albirostris*	Resident
Bottlenose dolphin	*Tursiops truncatus*	Regular guest
Common dolphin	*Delphinus delphis*	Regular guest
Long-finned pilot whale	*Globicephala melas*	Regular guest
Northern bottlenose whale	*Hyperoodon ampullatus*	Regular guest
Sowerby's beaked whale	*Mesoplodon bidens*	Regular guest
Sperm whale	*Physeter macrocephalus*	Regular guest
Striped dolphin	*Stenella coeruleoalba*	Regular guest
White-sided dolphin	*Lagenorhynchus acutus*	Regular guest
Beluga	*Delphinapterus leucas*	Vagrant
Killer whale	*Orcinus orca*	Vagrant
Risso's dolphin	*Grampus griseus*	Vagrant
Rough-toothed dolphin	*Steno bredanensi*	Vagrant
Blainville's beaked whale	*Mesoplodon densirostris*	Stranded
Cuvier's beaked whale	*Ziphius cavirostris*	Stranded
False killer whale	*Pseudoorca crassidens*	Stranded
Gray's beaked whale	*Mesoplodon grayi*	Stranded
Narwhal	*Monodon monoceros*	Stranded
Pygmy sperm whale	*Kogia breviceps*	Stranded
Baleen Whales	***Mysticeti***	
Minke whale	*Balaenoptera acutorostrata*	Resident
Fin whale	*Balaenoptera physalus*	Regular guest
Humpback whale	*Megaptera novaeangliae*	Regular guest
Northern right whale	*Eubalaena glacialis*	Vagrant
Blue whale	*Balaenoptera musculus*	Stranded
Grey whale	*Eschrichtius robustus*	Stranded
Sei whale	*Balaenoptera borealis*	Stranded

Minke Whale

Distribution in the international North Sea and Dutch North Sea

The Minke whale has a worldwide distribution in relatively shallow waters (< 200 m). In the North Sea it is the most common baleen whale, but quantitative data on its occurrence in the Dutch Continental Shelf are scarce. The large-scale SCANS surveys between 1994 and 2022 provide the most comprehensive data, whereas aerial surveys of the Dutch Continental Shelf provide more frequent abundance estimates on a smaller scale. For an overview of conducted surveys see Geelhoed (2024).

In the North Sea, a shift from the Scottish east coast to more central and more southerly areas seems to have taken place between the SCANS-surveys in 1994 and 2005 (Hammond et al. 2011, 2013). However, during SCANS-III in 2016, the observed distribution in the North Sea was similar to the one in 2005. In 2022 SCANS-IV resulted in many sightings further south in the North Sea (Gilles et al. 2023). Although the number of sightings is low (n< 10), aerial surveys on the DCS in summer 2024 suggest a southward extension of the species' summer range. Observations on the DCS, however, are still concentrated in the western and northwestern part. In Belgian waters observations are scarce, with one beached individual and one sighting in the 20th century (Verkem et al. 2003, Van Nieuwenhove et al. 2023).

Abundance in the international North Sea and Dutch North Sea

During the four large-scale SCANS surveys of the European continental shelf in 1994 2005, 2016 and 2022 the abundance of minke whales in the North Sea was estimated between 7,800 and 10,500 individuals (Gilles et al. 2023, Hammond et al. 2021). The most recent SCANS-IV estimate for 2022 in the North Sea was 7,856 (CV[1] = 0.28), which is lower than the most recent Norwegian Independent Line Transect Surveying this area in 2018 (17,792, CV = 0.24, Solvang et al. 2021). However, a trend analysis by Gilles et al (2023) using the available ten estimates in the North Sea, showed no support for a change in abundance over the period 1989-2022 (Figure 1). Fluctuations in abundance were probably due to contraction and expansion of the distribution in the central and southern North Sea.

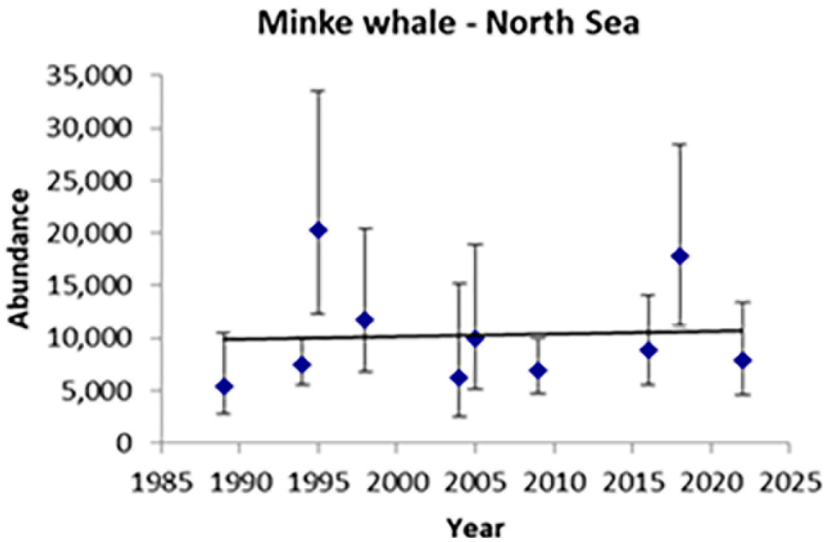

Figure 1. Trend lines fitted to time series of abundance estimates of minke whale in the North Sea: estimated rate of annual change = 0.52% (95%CI: -2.60; 3.73%), p = 0.72. Error bars are log-normal 95% confidence intervals. Source: Gilles et al. (2023).

[1] CV = coefficient of variation

Occurrence in the Dutch North Sea

In the central North Sea, most observations are made from May to September, which may be partly due to the poorer observing conditions and lower observation effort between October and April. In the (late) summer from July to October minke whales seem to migrate to the coastal zone and local aggregations of 10-15 foraging animals can be present there (Reid et al. 2003). The occurrence on the DCS fits well with the sketched occurrence. Here, most minke whales are seen in late spring and early summer (May-July). Ship-based surveys around the Dogger Bank from March to July 2007 (De Boer, 2010) showed a clear peak from the last April week to the third week of May. During this peak a high density (0.029 ex/km^2) was observed, twice as high as the density in the Greater North Sea during SCANS-IV (0.013 ex/km$^{2)}$ and in the same order of magnitude as the density in the central North Sea during the SCANS II-IV surveys in summer (0.028 ex/km^2) and the wider Dogger Bank surveys in summer 2011 and 2013 (Gilles et al. 2011, Geelhoed et al. 2014). The seasonal occurrence in other areas in the Dutch North Sea has never been studied.

White-beaked dolphin

Distribution in the international North Sea and Dutch North Sea

The white-beaked dolphin occurs in the temperate and sub-arctic waters on the continental shelf of the North Atlantic Ocean (Reid et al. 2003). In the northeastern Atlantic the species is distributed from Svalbard and Nova Zemlya in the north to the French coast in the south. The species' southern distribution limit, however, lies more or less in the southern North Sea, where highest numbers occur in the western part of the central and northern North Sea (Reid et al. 2003).

The distribution of white-beaked dolphins during the series of SCANS surveys in 1994, 2005, 2016 and 2022 estimated highest densities around the Shetland Islands, in northwest Scotland and in the northern North Sea, whereas the species was not recorded in the southern areas (Hammond et al. 2002, 2013 & 2021, Gilles et al. 2023).

Abundance in the international North Sea and Dutch North Sea

The SCANS-IV surveys resulted in an estimate for the North Sea of 46,300 individuals in 2022. Abundance estimates in the Dutch North Sea are currently not available. However, in the blocks NS-A, NS-C and NS-H encompassing the Dutch North Sea and adjacent UK and German waters an estimated 1,155 white-beaked dolphins were present (Gilles et al. 2023).
Although the SCANS-data only have sufficient power to detect a decline of at least 2% per year, trend analysis of the four SCANS estimates in the North Sea shows no significant change in abundance since 1994, (Gilles et al. 2023). Stranding data from 1991 to 2017, however, indicate that the number of strandings declined in the south-western part of the North Sea and increased in the north (IJsseldijk et al. 2018). Data from aerial surveys in Belgian waters showed regular white-beaked dolphin observations until 2012, the last years there observations are lacking (Van Nieuwenhove et al. 2023)

Occurrence in the Dutch North Sea

Observations of white-beaked dolphins are made throughout the year, with a dip in late summer and autumn (Camphuysen & Peet, 2006). Not many observations of white-beaked dolphins with calves are known on the DCS in this period, whereas calves are seen regularly during this period in British waters (Northridge et al. 1995). it can be assumed that reproduction takes place on the DCS, albeit at low rate.

Strandings along the coastlines of the southern North Sea show no seasonal pattern, whilst strandings along the central North Sea show a peak in summer (IJsseldijk et al. 2018).

Other non-resident species

Bottlenose dolphin

In the first half of the 20th century bottlenose dolphin was a resident species in the Netherlands. The species disappeared from Dutch waters mid-twentieth century (Verwey 1975). Since the late 1970s irregular sightings have been made in the Dutch North Sea. In most cases it concerns solitary individuals, but occasionally groups are seen. The decline resulted in the conclusion that the species disappeared in the Netherlands, equivalent to the IUCN category: Regionally extinct in the wild (Zoogdiervereniging VZZ, 2006).

The disappearance of the coastal population bottlenose dolphins in Dutch waters, which occurred from the northern French coast to the northern Dutch coast, is part of a more widespread phenomenon. Towards the end of the 19th century coastal populations disappeared from the Severn Estuary (United Kingdom) and estuaries in the east of England (United Kingdom), as well as from the Elbe and Weser estuaries (Germany). Nowadays, coastal bottlenose dolphin assessment units have been identified amongst others in East Scotland and in the western Channel and in Normandy and Brittany (based on Evans & Teilmann 2009, ICES 2013 & 2014, IAMMWG 2015). The East Coast Scotland population appears to be stable since 1990, and may be showing signs of increase and range expansion (Cheney et al. 2018), whereas two smaller populations in the Normandy and Brittany assessment unit (Ile de Sein >1992, Molene Archipelago >1999) indicate broadly stable populations (Geelhoed et al. 2022). Observations in the Dutch North Sea in recent years seem to involve individuals from both Scottish and French origin (Hoekendijk et al. 2021).

Humpback whale

In the southern North Sea humpback whale's status has changed from a very rare vagrant in the last century to a yearly visitor in the last twenty years, albeit in low numbers (45 observations/strandings in the North Sea 2003-2017 Leopold et al. 2018). This increase is probably related to a recovery of the (North-east) Atlantic population (Wedekin et al. 2017).

Vulnerability to offshore wind farms

A plethora of studies (see for instance ICES 2010, Verfuβ et al. 2016 for reviews) suggest a consensus that piling noise during construction is potentially the most harmful impact to marine mammals in offshore wind farm projects, with the possibility to cause auditory injury or behavioural disturbance and displacement. The impact during the operational phase is less well understood, but habitat changes can affect prey composition and availability for cetaceans, and subsequently the fitness of individual animals. To assess the potential vulnerability of minke whales and white-beaked dolphins to offshore wind farms, information on their hearing capacity and their diet is needed, as well as how both will be impacted by OWFs. As the latter information is lacking, diet and hearing capacity of both species will be sketched as rough proxies of their potential vulnerability to offshore wind farms.

Cetaceans have species-specific hearing capacities and thus species-specific susceptibility to underwater noise. Southall et al. (2007, 2019) proposed noise exposure criteria for marine mammals and refined the categorization of marine

mammals in groups based on functional hearing: Low-frequency cetaceans, high-frequency cetaceans, very high-frequency cetaceans, sirenians, phocid carnivores and other marine carnivores. Harbour porpoise belongs to very high-frequency cetaceans, dolphins are categorized as high-frequency cetaceans, and baleen whales are considered low-frequency cetaceans.
The low-frequency cetacean hearing group contains all baleen whales, thus including minke whale. Although the hearing capability of baleen whales had not yet been measured at the time the group was proposed, indirect studies indicated an audible frequency range from 7 Hz (5–20) to 20–30 kHz (Southall et al. 2019). The group might be subdivided in species (e.g. fin whale) that may have a higher (low-frequency) sensitivity and species that have a lower sensitivity (e.g. humpback, minke whale). Although the first auditory measurements of two live-caught minke whales were recently made (Kleivane et al. 2024), the results are not published yet.

White-beaked dolphin belongs to the high-frequency cetacean hearing group, like most other dolphin species, beaked whales, sperm whales and Killer whales. Hearing sensitivity has been measured for approximately one third of the species in this group, including two white-beaked dolphins (Nachtigall et al. 2008) yielding an audible frequency range from 150 Hz to 160 kHz with highest hearing sensitivity around 55-58 kHz (Southall et al. 2019).

Minke whales and white-beaked dolphins have different ecological niches, with partial overlapping diet. Minke whale feeds on a range of (small) pelagic schooling fish species and krill. In the (western) North Sea sand eel seems to be the dominant species (Pierce et al. 2004), but the diet is more diverse than in Norwegian waters where herring is the main prey (Haug et al. 1999, Holst & Olsen 2001). In northeast Scotland, a positive relation between sand eels, water temperature and the presence of minke whales has been found by Tetley et al. (2008). In the Dutch North Sea the sandy Dogger Bank probably forms a predictable prey source when sand eels emerge, after overwintering in the sand, and reach their highest densities in May-June. A relatively high primary production of plankton may occur along the steep slopes, resulting in a concentration of foraging sand eels. Minke whales may benefit from this abundant and predictable food supply (De Boer 2010).

The diet of white-beaked dolphins primarily contains larger fish than minke whales prefer, with 25 species found in the stomach contents of animals stranded along the Dutch coast in 1968-2005. Their primary prey (98% by weight) were whiting and cod (Jansen et al. 2010), which confirms the findings of the studies in Scotland (Canning et al. 2008).

Recommendations/research possibilities

In the Dutch North Sea, or the Dutch Continental Shelf (DCS), minke whale and white-beaked dolphin are resident species which might potentially be impacted by the ongoing development of offshore wind farms. Although their numbers on the DCS are relatively low, and potential effects on population level consequently low as well, from a precautionary approach it might be prudent to investigate possible measures to mitigate to potential impact of offshore wind farms. To assess this impact on minke whales and white-beaked dolphins several knowledge gaps need to be filled.

In their review of marine mammal noise criteria Southall et al. (2019) emphasized: *"It should be recognized that for all groups, these are estimated functions based on data from a few species and individuals. These curves represent the best fit to the limited existing data based on the assumptions and procedures described herein, but it should be clearly recognized that most species within each group have not been directly tested."* Therefore, measurements of hearing ability and subsequently onset of hearing threshold shifts of minke whales and white-beaked dolphins should be stimulated.

Basic information on seasonal occurrence of minke whales and white-beaked dolphins in the DCS is scarce; aerial surveys may provide better insight in the future. However, given the low densities the current survey effort should be increased to obtain information. Passive acoustic monitoring can give information on temporal occurrence. Dolphin whistles can be extracted from (available) data from offshore wind farm monitoring with CPODs (or similar devices); currently, species identification is not possible. Minke whales can be acoustically monitored with more sophisticated acoustic loggers, as has been shown to be feasible in a study at different sites along the UK east coast from 2015 to 2018 (Risch et al. 2019), and is currently done around the German part of the Dogger Bank (A.Gilles, *pers comm*).
Information on diet of minke whales and white-beaked dolphins in the DCS needs to be increased to get a more detailed picture of seasonal and age/gender-related variation in both species' diet (as suggested for white-beaked dolphin; Jansen et al. 2010). Information on prey occurrence and availability is key. Potential effects of habitat changes in and around offshore wind farms on prey should be quantified to predict and assess carry over effects on cetaceans.

References

- Boer, M.N. de, 2010. Spring distribution and density of minke whale Balaenoptera acutorostrata along an offshore bank in the central North Sea. Marine Ecology Progress Series 408: 265-274.
- Broekhuizen, S., Spoelstra, K., Thissen, J.B., Canters, K.J. & Buys, J.C., (eds) 2016. Atlas van de Nederlandse zoogdieren. Naturalis Biodiversity Center.
- Camphuysen, C.J. & Peet, G., 2006. Walvissen en dolfijnen in de Noordzee. Fontaine Uitgevers BV/Stichting de Noordzee, 's Graveland/Utrecht.
- Canning, S.J., Santos, M.B., Reid, R.J., Evans, P.G.H., Sabin, R.C., Bailey, N. & Pierce, G.J., 2008. Seasonal distribution of white-beaked dolphins (*Lagenorhynchus albirostris*) in UK waters with new information on diet and habitat use. Journal of the Marine Biological Association of the United Kingdom 88(6): 1159–1166.
- Cheney, B., Graham, I.M., Barton, T.R., Hammond, P.S. & Thompson, P.M. 2018. Site Condition Monitoring of bottlenose dolphins within the Moray Firth Special Area of Conservation: 2014–2016. Scottish Natural Heritage Research Report No. 1021
- Evans, P.G.H. & Teilmann, J. (editors), 2009. Report of ASCOBANS/HELCOM Small Cetacean Population Structure Workshop. ASCOBANS/UNEP Secretariat, Bonn, Germany. 140 pp.
- Geelhoed, S.C.V., 2024. Changes in Harbour porpoise distribution in the North Sea.
- Geelhoed, S.C.V., van Bemmelen, R.S.A. & Verdaat, J.P., 2014. Marine mammal surveys in the wider Dogger Bank area summer 2013. IMARES Report (no. C016/14) for Department for Environment, Food and Rural Affairs and Ministry of Economic Affairs, 27 pp. htp://edepot.wur.nl/293005
- Geelhoed, S.C.V., Authier, M., Pigeault, R. & Gilles, A., 2022. Abundance and distribution of cetaceans. In: OSPAR (2023): The 2023 Quality Status Report for the Northeast Atlantic. OSPAR Commission, London.
- Gilles, A., Peschko, V., Scheidat, M. & Siebert, U,, 2011. Survey for small cetaceans over the Dogger Bank and adjacent areas in summer 2011. ASCOBANS AC19/Doc.5-08.
- Gilles, A., Authier, M., Ramirez-Martinez, N.C., Araújo, H., Blanchard, A., Carlström, J., Eira, C., Dorémus, G., Fernández-Maldonado, C., Geelhoed, S.C.V., Kyhn, L., Laran, S., Nachtsheim, D., Panigada, S., Pigeault, R., Sequeira, M., Sveegaard, S., Taylor, N.L., Owen, K., Saavedra, C., Vázquez-Bonales, J.A., Unger, B. & Hammond, P.S. (2023). Estimates of cetacean abundance in European Atlantic waters in summer 2022 from the SCANS-IV aerial and shipboard surveys. Final report published 29 September 2023. 64 pp.
- Hammond, P.S., Berggren, P., Benke, H., Borchers, D.L., Collet, A., Heide Jorgensen, M.P., Heimlich, S., Hiby, A.R., Leopold, M.F. & Oien, N., 2002. Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. Journal of Applied Ecology 39(2): 361-376.
- Hammond, P.S., Macleod, K., Berggren, P., Borchers, D.L., Burt, M.L., Cañadas, A., Desportes, G., Donovan, G.P., Gilles, A., Gillespie, D., Gordon, J., Hedley, S., Hiby, L., Kuklik, I., Leaper, R., Lehnert, K., Leopold, M., Lovell, P., Øien, N., Paxton, C., Ridoux, V., Rogan, E., Samarra, F., Scheidat, M., Sequeira, M., Siebert, U., Skov, H., Swift, R., Tasker, M.L., Teilmann, J., Van Canneyt, O. & Vázquez, J.A., 2013. Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. Biological Conservation 164: 107-122.

- Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Börjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M.B., Scheidat, M., Teilmann, J., Vingada, J. & Øien, N., 2021. Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. SCANS-III project report 1, 39 pp.
- Haug T., Lindstrøm, U. & Nilssen, K.T., 1999. Variation in minke whale (Balaenoptera acutorostrata) diets in response to environmental changes in the Barents Sea. SC/51/E7 for the IWC Scientific Committee.
- Hoekendijk JPA, Leopold MF, Cheney BJ. 2021. Bottlenose dolphins in the Netherlands come from two sides: across the North Sea and through the English Channel. Journal of the Marine Biological Association of the United Kingdom.;101(5):853-859. doi:10.1017/S0025315421000679
- Holst, E. & Olsen J.C., 2001. A note on common minke whale diets in the Norwegian Sea and the North Sea. Journal of Cetacean Research and Management 3(2): 179-183.
- IAMMWG, 2015. Management Units for cetaceans in UK waters (January 2015). JNCC Report No. 547, JNCC Peterborough
- ICES, 2013. Report of the Working Group on Marine Mammal Ecology (WGMME), 4-7 February 2013, Paris, France. ICES CM 2013/ACOM:26. 117 pp.
- ICES, 2014. OSPAR request on implementation of MSFD for marine mammals. Special request. In: Report of the ICES Advisory Committee, 2014. ICES Advice 2014, Book 1, Section 1.6.6.1.
- Jansen, O.E., Leopold, M.F., Meesters, E.H.W.G. & Smeenk, C., 2010. Are white-beaked dolphins Lagenorhynchus albirostris food specialists? Their diet in the southern North Sea. Journal of the Marine Biological Association of the United Kingdom 90(8): 1501-1508.
- Kleivane, L., Kvadsheim, P.H. Pyne Vinje, A.V. Mulsow, J. Ølberg, R.A., Teilmann, J., Harms, C. & Houser, D., 2024. Capture and Release of Minke Whales Offers New Research Opportunities, Including Measurements of Mysticete Hearing. Aquatic Mammals 50(4):352-368
- Leopold MF, Rotshuizen E, Evans PG. 2018. From nought to 100 in no time: how humpback whales (*Megaptera novaeangliae*) came into the southern North Sea. Lutra 61:165-88.
- van der Meij, S.E.T. & Camphuysen, C.J., 2006. The distribution and diversity of whales and dolphins (Cetacea) in the southern North Sea: 1970-2005. Lutra 49(1): 3-28.
- Nachtigall, P.E., Mooney, T.A., Taylor, K.A., Miller, L.A., Rasmussen, M.H., Akamatsu, T., Teilmann, J., Linnenschmidt, M. & Vikingsson, G.A., 2008. Shipboard measurements of the hearing of the white-beaked *dolphin Lagenorhynchus albirostris*. J Exp Biol 11(4): 642–647.
- Van Nieuwenhove, A., Van Roozendael, B., Scheldeman, K., Merveille, J.-B., Haelters, J., Van Roy, W., Schallier, R., 2023. 30 Years of Belgian North Sea Aerial Surveillance – Evolution, Trends, and Developments. Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment. 120 pp.
- Northridge, S.P., Tasker, M.L., Webb, A. & Williams, J.M., 1995. Seasonal distribution and relative abundance of harbour porpoises *Phocoena phocoena* (L.), white-beaked dolphins *Lagenorhynchus albirostris* (Gray) and minke whales *Balaenoptera acutorostrata* (Lacepède) in the waters around the British Isles. ICES J. Mar. Science 52: 55-66.
- Pierce, G.J., Santos, M.B., Reid, R.J., Patterson, I.A.P. & Ross, H.M., 2004. Diet of minke whales *Balaenoptera acutorostrata* in Scottish (UK) waters with notes on strandings of this species in Scotland 1992-2002. Journal of the Marine Biological Association of the United Kingdom 84: 1241-1244.

- Reid, J.B., Evans, P.G.H. & Northridge, S.P., 2003. Atlas of Cetacean distribution in north-west European waters. Joint Nature Conservation Committee, Peterborough.
- Risch, D., Wilson, S.C., Hoogerwerf, M., Van Geel, N.C., Edwards, E.W. & Brookes, K.L., 2019. Seasonal and diel acoustic presence of North Atlantic minke whales in the North Sea. Scientific Reports, 9(1): 3571.
- Solvang, H.K., Skaug, H.J. & Oien, N.I., 2021. Abundance of common minke whales in the Northeast Atlantic based on survey data collected over the period 2014-2019. Paper SC/68C/ASI04 presented to the Scientific Committee of the International Whaling Commission.
- Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene, C.R., Jr. Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A., & Tyack, P.L., 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals 33: 411–521.
- Southall, B.L., Finneran, J.J., Reichmuth, C., Nachtigall, P.E., Ketten, D.R., Bowles, A.E., Ellison, W.T., Nowacek, D.P. & Tyack P.L., 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals 45(2): 125-232.
- Tetley M.J., Mitchelson-Jacob, E.G. & Robinson, K.P., 2008. The summer distribution of coastal minke whales (*Balaenoptera acutorostrata*) in the southern outer Moray Firth, NE Scotland, in relation to co-occurring mesoscale oceanographic features. Remote Sensing of Environment 112: 3449-3454.
- Verkem, S., De Maeseneer, J., Vandendriessche, B., Verbeylen, G. & Yskout, S., 2003. Zoogdieren in Vlaanderen: ecologie en verspreiding van 1987 tot 2002. Natuurpunt Studie/JNM-Zoogdierenwerkgroep, Mechelen/Gent, Belgium.
- Verfuβ, U.K., Sparling, C.E., Arnot, C., Judd, A., Coyle, M. , 2016. Review of Offshore Wind Farm Impact Monitoring and Mitigation with Regard to Marine Mammals. In: Popper, A. & Hawkins, A. (eds) The Effects of Noise on Aquatic Life II. Advances in Experimental Medicine and Biology, vol 875. Springer, New York, NY.
- Verwey, J., 1975. The cetaceans Phocoena phocoena and *Tursiops truncatus* in the Marsdiep area (Dutch Wadden Sea) in the years 1931-1973. I. Nederlands Instituut voor Onderzoek der Zee. Publikaties en Verslagen 17a: 1-98.
- Wedekin, L.L., Engel, M.H., Andriolo, A., Prado, P.I., Zerbini, A.N., Marcondes, M.M.C., Kinas, P.G. and Simões-Lopes, P.C., 2017. Running fast in the slow lane: rapid population growth of humpback whales after exploitation. Marine Ecology Progress Series, 575: 195-206.
- Zoogdiervereniging VZZ, 2006. Basisrapport voor de Rode Lijst Zoogdieren volgens Nederlandse en IUCN-criteria. VZZ rapport 2006.027. Zoogdiervereniging VZZ, Arnhem.

Kwaliteitsborging

Wageningen Marine Research beschikt over een ISO 9001:2015 gecertificeerd kwaliteitsmanagementsysteem. De organisatie is gecertificeerd sinds 27 februari 2001. De certificering is uitgevoerd door DNV.

Verantwoording

Brief rapport: 2429092-AJ-SG-lcs
Projectnummer: 431100012 -24/21

Dit rapport is met grote zorgvuldigheid tot stand gekomen. De wetenschappelijke kwaliteit is intern getoetst door een collega-onderzoeker en het verantwoordelijk lid van het managementteam van Wageningen Marine Research

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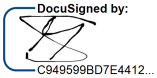
Meike Scheidat meike.scheidat@wur.nl Security Level: Email, Account Authentication (None)	 Signature Adoption: Drawn on Device Using IP Address: 77.173.42.152	Sent: 11/21/2024 3:57:56 PM Resent: 11/22/2024 12:55:59 PM Viewed: 11/26/2024 3:36:23 PM Signed: 11/26/2024 3:37:19 PM
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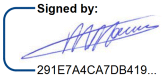
Maarten Mouissie maarten.mouissie@wur.nl Security Level: Email, Account Authentication (None)	 Signature Adoption: Uploaded Signature Image Using IP Address: 31.201.2.27	Sent: 11/26/2024 3:37:21 PM Viewed: 11/27/2024 9:08:25 AM Signed: 11/27/2024 9:21:22 AM
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