>

Ministry of Agriculture, Nature and
Food Quality of the Netherlands

Updated Conservation Plan for the Harbour Porpoise *Phocoena phocoena* in the Netherlands

Maintaining a Favourable Conservation Status

Citation
Ministry of Agriculture, Nature and Food Quality, 2020. Updated Conservation Plan for the Harbour Porpoise *Phocoena phocoena* in the Netherlands: maintaining a Favourable Conservation Status.

Commissioning
This project was commissioned and financed by the Dutch Ministry of Agriculture, Nature and Food Quality.

Commissioned to
M.L. (Marije) Siemensma

Marine Science & Communication
Bosstraat 123, 3971 XC Driebergen-Rijssenburg, NL
Tel. + 31 6 16830430
E-mail: m.siemensma@msandc.nl

Cover photo
Annemieke Podt, Stichting Rugvin

Updated Conservation Plan for the Harbour Porpoise *Phocoena phocoena* in the Netherlands

Maintaining a Favourable Conservation Status

Ministry of Agriculture, Nature and Food Quality

Contents

Glossary

ACCOBAMS:	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area
ADD:	Acoustic Deterrent Device
AIS:	Automatic Identification System
ASCOBANS:	Agreement on Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
BAT:	Best Available Techniques
BDC:	Biodiversity Committee (OSPAR)
CBS:	Central Bureau for Statistics (NL)
CEAF:	Common Environmental Assessment Framework
CFP:	Common Fisheries Policy (EU)
CLA:	Catch Limit Algorithm
CMS:	Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) (UN)
COBAM:	Intersessional Correspondence Group on Coordination of Biodiversity Assessment and Monitoring (OSPAR)
DCF:	Data Collection Framework (EU)
DCS:	Dutch Continental Shelf
DEF:	Ministry of Defense
DEPONS:	Disturbance Effects on the Harbour Porpoise Population in the North Sea model
EC:	European Commission
EEZ:	Exclusive Economic Zone
EIA:	Environmental Impact Assessment
EP:	European Parliament
EU:	European Union
EZK:	Ministry of Economic Affairs and Climate
FAO:	Food and Agriculture Organisation (UN)
GES:	Good Environmental Status (EU MSFD)
GPS:	Global Positioning System
HASEC:	Hazardous Substances and Eutrophication Committee (OSPAR)
HD:	Habitats Directive (EU)
HELCOM:	Convention on the Protection of the Marine Environment of the Baltic Sea Area
HiDef:	High Definition
IR:	Image Recognition
ICES:	International Council for the Exploration of the Sea
IMO:	International Maritime Organisation (UN)
I&W:	Ministry of Infrastructure and Water Management
IWC:	International Whaling Commission
KBIN:	Koninklijk Belgisch Instituut voor Natuurwetenschappen
KEC:	Framework for Assessing Ecological and Cumulative effects
LNV:	Ministry of Agriculture, Nature and Food Quality
MEP:	Monitoring and Evaluation Programme
MEPC:	Marine Environmental Protection Committee (UN, IMO)
MONS:	Monitoring, Research, Nature Restoration and Species Protection programme (NL)
MS&C:	Marine Science & Communication
MSFD:	Marine Strategy Framework Directive (EU)
MWTL:	Monitoring Waterstaatkundige Toestand des Lands (Dutch survey programme)
NAMMCO:	North Atlantic Marine Mammal Commission
N2000:	Natura 2000 (EU)
NGO:	Non-Governmental Organisation
NSA:	North Sea Agreement (NL)
NWO:	Dutch Research Council
OMMEG:	OSPAR Marine Mammal Expert Group
OSPAR:	Convention for the Protection of the Marine Environment of the North-East Atlantic
PAM:	Passive Acoustic Monitoring
PBR:	Potential Biological Removal
PCB:	Polychlorinated Biphenyls
(i)PCoD:	(interim) Population Consequences of Disturbance model
PFAS:	Per- and polyfluoroalkyl substances
POP:	Persistant Organic Pollutant
PTS:	Permanent Threshold Shift (impact on hearing abilities)
RLA:	Removal Limit Algorithm
RCG:	Regional Coordination Group (EU fisheries)
REM:	Remote Electronic Monitoring
RNLN:	Royal Netherlands Navy
RWS:	Rijkswaterstaat, executive agency for the Ministry of I&W
SCANS:	Small Cetaceans in the European Atlantic and North Sea (international survey project)
SEANSE:	Strategic Environmental Assessment North Sea Energy
SEL:	Sound Exposure Level
TNO:	Organisation for applied scientific research (NL)
TTS:	Temporary Threshold Shift (impact on hearing abilities)
TZ:	Territorial Zone (12 Nm)
UN:	United Nations
UU:	University of Utrecht
UXO:	Unexploded ordnance (unexploded bombs (UXBs)
WGBYC:	Working Group on Bycatch (ICES)
WGMME:	Working Group on Marine Mammal Ecology (ICES)
WOZEP:	Offshore Wind Ecological Programme (NL)
WWF:	World-Wide Fund for Nature (also known as World Wildlife Fund for Nature)
WMR:	Wageningen Marine Research (NL)
WUR:	Wageningen University of Research (NL)

1 Summary

1.1 Executive summary

The Ministry of Agriculture, Nature and Food Quality presents a revised and updated **Conservation Plan for the Harbour Porpoise** ***Phocoena phocoena*** in the Netherlands. The Ministry has chosen to work closely with many stakeholders (other Ministries, scientific experts, NGOs and industry), and these have been crucial in the preparation of this plan.

The plan provides an overview of research, policy and legal developments since the publicaton of the first Harbour Porpoise Conservation Plan in 2011. Concerns about the harbour porpoise are examined, and these, combined with the goal of maintaining a Favourable Conservation Status of the porpoise in Dutch waters, have led to identification of a number of priorities for action. As harbour porpoises are wide-ranging, the need is acknowledged not only for coordination of conservation measures at a national level, but also for an international transboundary and cross-sectoral conservation strategy to effectively tackle the cumulative impact of the key anthropogenic threats and to improve and combine research data streams.

Photo: Annemieke Podt, Stichting Rugvin

Key legislation at EU level is the Habitats Directive, the Marine Strategy Framework Directive and new Common Fisheries Policy Regulations. Other relevant resolutions have been adopted by ASCOBANS, CMS, IWC, and OSPAR. The conservation status has progressed to “favourable” in 2019, according to the assessment methodology of the Habitats Directive. Range, population and habitat were assessed “favourable”, while future prospect was assessed as “unknown”. According to the MSFD assessment in 2018, the status for marine mammals is improving, but Good Environmental Status has not yet been achieved.
The priority areas for research and conservation include population abundance and distribution, (foraging) ecology and habitat requirements, strandings, chemical pollution, incidental bycatch, and underwater noise (impulsive and continuous).

For each area, a number of recommendations has been formulated (as a follow up to those in the 2011 Conservation Plan). These are prioritised in time and urgency in the Harbour Porpoise Conservation Action Plan 2020-2026 (Annex I). Key recommendations are given in the following sections.

Population ecology, abundance & distribution - There are many survey programmes to assess abundance and (seasonal) distribution, and research is done on short and long-term diet, contaminant burden and offloading to offspring, pregnancy rates and foetal growth. These programmes provide however only limited information on habitat use and trophic relationships. Information on diet can be derived from the analysis of stomach content (last meals) of stranded porpoises. This data should be compared with results from other methods such as fatty acid and stable isotope analyses (long-term diet) to enhance the understanding of the porpoise diet. To fill the gap in knowledge about food quality and availability, integrated ecological and modelling studies should include prey availability and resource depletion. The MSFD abundance and distribution monitoring programme has been updated, and the results should be integrated with other data sources and international surveys that encompasses the wider North Sea.

There are several tools for studying the abundance, distribution and behaviour of the harbour porpoise (e.g. tags and high definition cameras). Tagging affects the animal and different tagging methods should be explored in dialogue with stakeholders. The harbour porpoise is part of complex food webs that requires an integrated approach to understand the species ecology, combining the different methodologies and modelling techniques. A comprehensive meta-analysis of available data on spatial and temporal patterns in abundance should include reproduction and prey resources.

Stranding of porpoises - All reported stranding events are documented in a central registration database, www.walvisstrandingen.nl, to facilitate analysis. The number of strandings has increased in the last decade, with strong seasonal and geographical fluctuations. This warrants further transboundary investigation. Necropsies of stranded animals provide valuable information about causes of death, diet, contaminants and life history, but these animals are not wholly representative for the population. Further analysis including offshore animals is required to throw more light on anthropogenic threats. An additional action is to increase the data quality from stranded dead porpoises that are sent for disposal and to make these data available for cross-border comparison and analysis.

Chemical pollution - Recent studies show that chemical pollution remains a significant threat to harbour porpoise possibly by increasing susceptibility to infectious diseases and impacting reproductivity. International approaches to establish indicators for contaminants, such as PCBs, are recommended.

Incidental bycatch - Tackling incidental bycatch remains a challenge, despite many efforts to reduce it. One hurdle is securing the involvement of the fisheries sector. The Remote Electronic Monitoring project in the Dutch commercial bottom-set gillnet fisheries (2013-2017) resulted in an estimated annual bycatch mortality for this fleet of 0,3% (maximum worst case), which is below mortality reference points that are consistent with ASCOBANS objectives. The impact of foreign commercial fisheries and recreational fisheries have not been quantified yet. The project also concluded there is a need for structural monitoring across the fishing fleet. There is a need to assess the potential for using alternative gear to mitigate bycatch. The most widely adopted mitigation measure to reduce bycatch of small cetaceans is by using acoustic alarms. Their use should be assessed on a case by case basis to quantify their effectiveness. An international bycatch project is proposed by the Netherlands.

Underwater noise - Recurring topics are the urgent need for assessing and addressing cumulative acoustic impact, the requirement for updated and validated population models, the validation of mitigation measures, and

developing cross-sectoral assessment frameworks for impulsive noise. A major source of noise is offshore wind farms, and although measures have been put in place to limit the effects of the construction, further study is recommended on noise related to the construction and operation of offshore wind turbines also due to the increase in the size of the turbines and the substantial vessel traffic associated with servicing wind farms. A methodology similar to the 'Framework for Assessing Ecological and Cumulative effects' (KEC) for assessing impact of seismic surveying is proposed, to be worked out together with stakeholders in the context of the North Sea Agreement. As a follow up on the guidance and procedural mitigation measures for the clearance of Unexploded Ordnance, the availability of alternative technologies for clearance of munitions at sea should be explored in the longer term and the use of explosives for other reasons should be restricted to a minimum. Measures to decrease noise impact at both national and international level and to improve knowledge on effects of continuous noise, mainly caused by shipping, should be encouraged.

Stakeholder consultation & engagement - It is strongly recommended that the work of the Scientific Harbour Porpoise Advisory Committee will be continued. International cooperation is vital to maintain a Favourable Conservation Status for a mobile marine species such as the harbour porpoise and an international workshop will be organised in collaboration with the EU Natura 2000 Biogeographical Process.

Next steps towards concrete conservation measures will be the implementation of the Harbour Porpoise Conservation Action Plan 2020-2026 (Annex I) into established policy such as the Framework for Assessing Ecological and Cumulative effects (KEC), N2000 management plans, and structural monitoring programmes, including the Monitoring, Research, Nature Restoration and Species Protection (MONS) programme, which was established under the umbrella of the North Sea Agreement.

1.2 Nederlandse managementsamenvatting

Het Ministerie van Landbouw, Natuur en Voedselkwaliteit presenteert hierbij het geactualiseerde Bruinvisbeschermingsplan 2020. Bij de totstandkoming van het plan heeft het Ministerie nauw samengewerkt met meerdere stakeholders (andere departementen, wetenschappelijke experts, NGO's en het bedrijfsleven).


Photo: Annemieke Podt, Stichting Rugvin

Het plan biedt een overzicht van ontwikkelingen op het gebied van onderzoek, beleid en wetgeving sinds de publicatie van het eerste Bruinvisbeschermingsplan in 2011. Zorgpunten over de bruinvis zijn geanalyseerd en hebben, samen met het doel om een gunstige Staat van Instandhouding voor de bruinvis te behouden, geleid tot de identificatie van een aantal prioriteiten voor actie. Aangezien bruinvissen sterk mobiele soorten zijn, is de noodzaak erkend om niet alleen beschermingsmaatregelen op nationaal, maar ook op internationaal niveau te nemen en een sector-overstijgende beschermingsstrategie te hanteren. Alleen hiermee kan de cumulatieve impact van de belangrijkste antropogene bedreigingen worden aangepakt en kunnen datastromen verbeterd en gecombineerd worden.

De belangrijkste wettelijke kaders op EU-niveau zijn de Habitatrichtlijn, Kaderrichtlijn Mariene Strategie en een aantal nieuwe Verordeningen binnen het Gemeenschappelijk Visserijbeleid. Er zijn ook relevante resoluties aangenomen door ASCOBANS, CMS, IWC en OSPAR. De Staat van Instandhouding is aangepast van "matig-ongunstig" naar "gunstig" in 2019, volgens de beoordelingssystematiek van de Habitatrichtlijn. Volgens de KRM verbetert de toestand wel, maar is de Goede Milieutoestand nog niet bereikt voor zeezoogdieren.

De prioriteiten voor onderzoek en bescherming richten zich op populatie aantallen en verspreiding, (voedsel) ecologie en habitat kwaliteit, strandingen, chemische vervuiling, bijvangst en onderwatergeluid (impulsief en continu).

Voor elk thema is een aantal aanbevelingen gedaan (als vervolg op de aanbevelingen in het 2011 plan). Deze zijn geprioriteerd in tijd en urgentie in het "Harbour Porpoise Action Plan 2020-2026" (Annex I).

Populatie-ecologie, abundantie & verspreiding - Er zijn meerdere survey programma's die abundantie en (seizoenale) verspreiding meten. Daarnaast wordt onderzoek gedaan naar korte- en lange termijn dieet, contaminanten, zwangerschapsratio's en foetusgroei. Dit biedt echter beperkte informatie over habitatgebruik en trofische relaties. Informatie over dieet kan worden verkregen uit de analyse van maaginhoud (recente maaltijden) van gestrande bruinvissen. Deze data zou moeten worden gecombineerd met andere methoden zoals vetzuren- en stabiele isotopen analyses (langere termijn dieet) om het dieet van de bruinvis beter te kunnen begrijpen. Om de kennisleemte over voedsel en voedselbeschikbaarheid op te vullen, zouden geïntegreerde ecologische- en modelstudies ook beschikbaarheid van prooisoorten moeten opnemen. Het KRM-monitoringsprogramma is geactualiseerd en geoptimaliseerd. De resultaten van surveys dienen geïntegreerd te worden met andere datastromen en internationale surveys die de hele Noordzee bestrijken.

Er zijn verschillende methoden om de abundantie, verspreiding en het gedrag van bruinvissen te bestuderen (b.v. zenderen en high definition camera's). Zenderen beïnvloedt het dier en verschillende manieren van zenderen dienen verkend te worden in overleg met stakeholders. Om de rol van de bruinvis in het voedselweb te kunnen begrijpen vergt dat een geïntegreerde aanpak waarin verschillende methoden en modelleringstechnieken worden gecombineerd. Een uitgebreide meta-analyse van beschikbare data over spatiele en temporele patronen in abundantie zou ook data over reproductie en voedselbeschikbaarheid moeten bevatten.

Strandingen - Alle gerapporteerde bruinvis strandingen worden gedocumenteerd in een centrale database, www.walvisstrandingen.nl, om analyses te kunnen faciliteren. Het aantal strandingen is gestegen in het laatste decennium, met sterke variatie tussen seizoenen en regio's. Om hiervan de oorzaken te achterhalen is verder, grensoverschrijdend onderzoek nodig. Postmortaal onderzoek van gestrande dieren biedt waardevolle informatie over doodsoorzaken, dieet, contaminanten en demografische kenmerken, maar deze dieren zijn waarschijnlijk niet helemaal representatief voor de gehele populatie. Verdere analyse, waaronder van offshore dieren, is nodig om meer inzicht te krijgen in de genoemde onderwerpen. Een andere actie is om de kwaliteit van de verzamelde data aan gestrande dode bruinvissen te verbeteren die voor destructie worden weggebracht en om deze data beschikbaar te maken voor een vergelijking tussen landen.

Chemische vervuiling - Recente studies laten zien dat chemische vervuiling een significante bedreiging blijft voor bruinvissen, mogelijk door verhoogde vatbaarheid voor infectieziekten en door een negatief effect op reproductie. Een internationale aanpak wordt aanbevolen om indicatoren voor contaminanten, zoals PCB's, op te stellen.

Incidentele bijvangst - Het aanpakken van incidentele bijvangst blijft een uitdaging, ondanks vele pogingen dit te verminderen. Eén van de belangrijkste aspecten is het betrekken van de visserijsector. Het "Remote Electronic Monitoring" project in de Nederlandse staandwant visserij (2013-2017) resulteerde in een geschatte jaarlijkse sterfte door bijvangst van 0,3% (meest negatieve scenario), dit is onder het mortaliteit niveau zoals tot doel gesteld door ASCOBANS. De impact van buitenlandse visserij en recreatieve visserij is nog niet gekwantificeerd. Het project heeft ook geconcludeerd dat betere, structurele monitoring nodig is over de hele visserij vloot. Er is behoefte om de mogelijkheden voor alternatieve tuigen te onderzoeken om bijvangst te mitigeren. De meest gebruikte mitigerende maatregel voor bijvangst bestaat uit akoestische afschrikmiddelen. Het gebruik daarvan zou per situatie moeten worden beoordeeld om de effectiviteit te beoordelen. Een internationaal bijvangst project wordt voorgesteld door Nederland.

Onderwatergeluid - Terugkerende onderwerpen uit eerder onderzoek zijn de urgente noodzaak om cumulatieve impact van onderwatergeluid te adresseren en te beoordelen, de behoefte aan het verbeteren en valideren van populatiemodellen, het valideren van mitigerende maatregelen en het ontwikkelen van sector-overstijgende beoordelingskaders voor impulsief geluid. Een belangrijke bron van geluid wordt gevormd door windparken op zee. Hoewel maatregelen zijn ingesteld om de effecten van de bouw te beperken, is aanvullend onderzoek nodig tijdens de bouw en operationele fase van windparken, ook doordat windmolens steeds groter worden en het windpark gerelateerde substantiële scheepsverkeer niet alleen bij de bouw, maar ook tijdens de operationele fase toeneemt. Een methodiek zoals het Kader Ecologie en Cumulatie (KEC) om de impact van seismisch onderzoek te kunnen beoordelen, wordt voorgesteld en zal nader worden uitgewerkt met stakeholders in de context van het Noordzee Akkoord. Als vervolg op de richtlijnen en procedurele mitigerende maatregelen voor het opruimen van explosieven, zal de beschikbaarheid van alternatieve technologieën moeten worden verkend en het gebruik van explosieven voor andere redenen moet tot een minimum worden beperkt. Maatregelen om de impact van continu geluid, op nationaal en internationaal niveau, te verminderen en om de kennis hierover te verbeteren, worden aangemoedigd.

Stakeholder consultatie & participatie - Het wordt sterk aanbevolen om het werk van de Bruinvisadviescommissie te continueren. Internationale samenwerking is zeer belangrijk om een gunstige Staat van Instandhouding te behouden voor een mobiele mariene soort als de bruinvis en een internationale workshop zal worden georganiseerd in samenwerking met het EU Natura 2000 Biogeografische proces.

Vervolg stappen naar concrete beschermingsmaatregelen zijn de implementatie van het "Harbour Porpoise Action Plan2020-2026" (Annex I) in vastgesteld beleid zoals het Kader Ecologie en Cumulatie, N2000 beheerplannen en structurele monitoringsplannen. Hierbij hoort ook de Werkgroep Monitoring, Onderzoek, Natuurherstel en Soortbescherming (MONS), die is opgericht onder het Noordzeeakkoord.

1.3 Full summary

Introduction

With this revised and updated Conservation Plan for the Harbour Porpoise, *Phocoena phocoena*, in the Netherlands, the Ministry of Agriculture, Nature and Food Quality presents an overview of research, policy and legal developments since 2011. The plan focuses on what is needed to fulfil the legal requirements from the perspective of policy and management (Chapter 3) with the overall aim of maintaining a Favourable Conservation Status of the species in Dutch waters. The plan does not contain an extensive literature review. Nevertheless, the most important and recent knowledge available from the Dutch perspective has been included. This plan replaces the Conservation Plan from 2011.

The 2020 plan was developed following an extensive stakeholder process. A group of scientific and policy experts contributed substantially, providing content and structural editing. Other actors from all the identified stakeholder groups (scientific experts, NGOs, industry, and government) were invited for consultation and information sharing in order to reflect properly their knowledge, expertise and commitment. In 2019, expert sessions were held on relevant topics (stranding events, contaminants and diet; underwater noise; population status and ecology, cooperation with the fisheries sector related to incidental bycatch, and recent legal developments). A comprehensive stakeholder day was organised in November 2019 to discuss the findings and recommendations with all the interested parties. These sessions, together with the advice of the Harbour Porpoise Scientific Advisory Committee and the knowledge and insights gained since 2011 were the basis for the revision and update of the 2011 Conservation Plan.

Each chapter briefly touches upon previous recommendations, then focuses on new developments and concludes with recommendations with the aim of maintaining a Favourable Conservation Status. These recommendations are summarised in the Harbour Porpoise Conservation Action Plan 2020-2026 (hereafter Action Plan, Annex I). They have been prioritised and ranked in time (time in years to start implementation).[1] Focal points are listed for each recommendation. Budgets are limited, and priority needs to be given to those recommendations considered most relevant, with the main focus on fulfilling the obligations arising from national and international legislation and agreements. It is recognised that this might limit the scope from a scientific perspective.

Since 2011, several key research needs have been prioritised and these are addressed in the relevant chapters. The priorities are focused on an integrated assessment of the abundance and distribution of the porpoise population (Chapter 5), the ecology and habitat requirements in the southern North Sea (Chapter 5), the development of representative stranding research (Chapter 6), improved knowledge on chemical pollution (Chapter 6), the assessment of incidental bycatch in cooperation with the fisheries sector (Chapter 7), and an approach to assessing the cumulative acoustic impact of impulsive and continuous underwater noise (Chapter 8).

Legislative & policy context

The harbour porpoise is legally protected in the Netherlands following international, European and national legislation. This means that intentional killing, intentional disturbance, and trading or collecting animals or parts of them is illegal. Various additional obligations have to be met to maintain a Favourable Conservation Status. Since 2011, developments have occurred in the applicable international, European and national law. An independent legal expert has reviewed recent legal developments and the (potential) implications for the conservation of harbour porpoises (see Chapter 3). Various international bodies (ASCOBANS, CMS and IWC) have adopted resolutions on bycatch, underwater noise and cumulative impacts related to cetaceans, and OSPAR has adopted recommendation 2013/11 to further the protection and restoration of harbour porpoises in the North Sea, instigating further actions. At EU level, the key legal instrument for the conservation of the harbour porpoise remains the Habitats Directive (HD) together with the Marine Strategy Framework Directive (MSFD) and the new Common Fisheries Policy (CFP) Regulations, which includes the Technical Measures Regulation (EU) 2019/124.

In 2019 a joint intergovernmental initiative called the North Sea Agreement was launched in the Netherlands, aiming to bring together government and stakeholders regarding the future development of the three "pillars" of

Photo: Frank Zanderink, Stichting Rugvin

[1] Prioritization was done based on five criteria: feasibility, data availability, allocated funding availability, policy context, and addressing a key threat. See also Chapter 9.

energy transition, nature conservation and restoration, and sustainable food transition including fisheries in the period up to 2030. Part of the Agreement is an extensive monitoring and research programme (MONS), within which priorities are defined. For the harbour porpoise, relevant priorities are: research to support species conservation plans, cumulative impact of underwater noise due to wind farm construction and seismic surveying, and research to improve selective fishing practices, including technical innovations.

The harbour porpoise, a highly mobile species, requires generic protection throughout its distribution area. While Dutch waters are evidently important for harbour porpoises, research to date has not been able to identify areas or regions of especial significance for harbour porpoises (e.g. clearly defined nursery areas). Nevertheless, four Natura 2000 sites (Dogger Bank, Cleaver Bank, North Sea Coastal Zone and Raan Flats) have been designated in the Dutch part of the North Sea for the harbour porpoise, and conservation objectives have been established in each of these sites. Management plans are in place for the North Sea Coastal Zone and Raan Flats, and are being finalised for the Dogger Bank and Cleaver Bank (expected in 2021). In four Natura 2000 sites (Wadden Sea, Voordelta, Eastern Scheldt and Western Scheldt & Saeftinghe), the harbour porpoise has recently been added in the Standard Data Form (SDF) and therefore needs to be taken up in these areas' management plans as well, in accordance with Articles 6.1 and 6.2 of the Habitats Directive. Management plans for Natura 2000 sites are legal instruments in which site-specific measures are specified spatially and temporally.

The conservation status of the harbour porpoise has progressed from "unfavourable - inadequate" in 2011 to "favourable" in 2019, according to the assessment methodology for conservation status in Article 17 of the Habitats Directive (see Chapter 3). Range, population and habitat have all been assessed "favourable", while future prospect was assessed as "unknown". This does not mean that conservation efforts are no longer needed. On the contrary, the obligation to maintain a Favourable Conservation Status is unchanged, and many uncertainties still exist, such as on the impact of (future) human activities, and even about fundamental topics such as changes in population abundance, distribution and ecology. The overall conservation status of the harbour porpoise was also assessed "favourable" in the marine Atlantic region.

The key anthropogenic pressures remain underwater noise (Chapter 8), incidental bycatch (North Sea-wide) (Chapter 7) and chemical pollution (Chapter 6). The cumulative effects of multiple anthropogenic pressures are a research priority in several national and international programmes, such as the CEAF programme (Chapter 3), North Sea Agreement (Chapters 3 and 9) and WOZEP (Chapter 8). Other threats such as resource depletion and predation by grey seals (albeit a natural mortality cause) can also have a large impact on harbour porpoise abundance and distribution, which emphasises the need to study cumulative effects on harbour porpoises in the context of the entire ecosystem (Chapter 5). Population models, such as PCoD[2] and DEPONS[3], can provide valuable insight into for which parameters (e.g. fecundity and mortality) there is insufficient data.

Under the MSFD, criteria have been developed for incidental bycatch of the harbour porpoise (D1C1), abundance and distribution of cetaceans (D1C2), and the number of porpoise disturbance days from impulsive noise (D11C1).[4] These indicators are developed mostly regionally, within OSPAR. Several (updated) Netherlands Marine Strategy documents for the Dutch part of the North Sea have been formally adopted and published online, among which is the recent MFSD monitoring programme (2020), which includes marine mammal monitoring.

New CFP regulations have been adopted. The CFP Technical Measures Regulation 2019/1241 (TMR) and the Data Collection Regulation 2017/1004 deal with bycatch mitigation and monitoring. However, (joint) recommendations to the European Commission for additional monitoring and mitigation measures should be submitted to implement the standing legal regulations fully. Requirements for monitoring and mitigation of the regulations remain of limited relevance for the Dutch fleet, especially for the bottom-set gillnets, as the majority of these fishing vessels are smaller than 12 meters. Article 12(3) of the new Technical Measures Regulation provides the legal opportunity for fishermen to land bycaught animals for scientific research.

Bycatch mitigation requirements under the US Marine Mammal Protection Act that are applicable to all countries exporting fishery products to the United States (effective since 1 January 2017), is likely to encourage EU Member States to move towards greater transparency in relation to the impact of fishery bycatch, and take steps to mitigate bycatch. These rules establish conditions for evaluating the occurrence of serious injury of marine mammals in Member State fisheries that export fish and fish products to the United States.

[2] Population Consequences of Disturbance (PCoD) model

[3] Disturbance Effects on the Harbour Porpoise Population in the North Sea (DEPONS) model

[4] The harbour porpoise disturbance days are the cumulative number of days harbour porpoises are disturbed (level of noise exceeds the threshold for disturbance) by impulsive noise (over the population in Dutch waters).

Despite a complete ban on recreational gillnet fishing that was recommended in the 2011 Conservation Plan, recreational gillnet fishing is still permitted, with the exception of targeted recreational fisheries on European sea bass with fixed nets under Council Regulation (EU) 2020/123. Recreational gillnet fishing is allowed only in specific areas in the Netherlands and under certain restrictions such as a maximum net length and height, and only one net per person. It has been reiterated that efforts should be focused on quantifying and subsequently reducing the impact of recreational fisheries on protected species. In Belgium, recreational gill- and trammel net fisheries were banned in the intertidal zone in 2015 (Flemish legislation).

The Natura 2000 management plans North Sea Coastal Zone 2016-2022 and Raan Flats 2016-2022 contain specific requirements for (recreational) gillnet fisheries, among which limitations on net length and the obligation to participate in the REM project (Chapter 7). As management plans are the legal instrument to work out site-specific measures , it is recommended to agree suitable measures for the next phase of Natura 2000 management plans relevant for the harbour porpoise.

At national level, the Nature Conservation Act (2017) and the Offshore Wind Energy Act (2015) have been important developments. The Environment Planning Act will replace the Nature Conservation Act when it comes into force (expected in 2022), but this will not change anything in the substantive rules dealing with protected areas and species protection. For N2000 sites, conservation objectives have to be assessed for any plan or project likely to have a significant effect thereon. The Nature Conservation Act requires that the assessment should take account of other activities, including activities outside N2000 sites. The Natura 2000 assessment and authorization of offshore wind farms falls under the Offshore Wind Energy Act (2015).

Underwater noise is mainly addressed in the Netherlands within the framework of the MSFD and the OSPAR Convention, and (for international shipping) the IMO. Activities that cause underwater noise at a level that is harmful to harbour porpoises can constitute a breach of the prohibitions on deliberate killing or disturbance contained in article 12(1) of the Habitats Directive. Therefore, the Framework for Assessing Ecological and Cumulative Effects (KEC 2015 and its update in 2019) has been developed to assess the cumulative effects of noise-emitting projects (to date the KEC includes construction of wind farms).

Since harbour porpoises are wide-ranging, there is a need not only for coordination of conservation measures at a national level but also for an international conservation strategy. There are a variety of international working groups related to the conservation of harbour porpoises. These focus on bycatch, marine mammal ecology, underwater noise and cumulative impacts. There are international stranding and sighting networks.

A strategic, cross-sectoral and transboundary approach is needed, involving international cooperation of monitoring and research, in particular regarding abundance, distribution, bycatch, pathology and health status, and contaminants, and also monitoring of anthropogenic noise, its impact and mitigation. Assessing and addressing the cumulative impact of anthropogenic activities is a priority, albeit one of the most complex ones to tackle.

Stakeholder consultation & engagement

It is recognised that the conservation of the harbour porpoise requires the engagement and effort of all stakeholders involved, not only policy-makers, scientists and NGOs, but also industry. It is strongly recommended that the work of the Scientific Harbour Porpoise Advisory Committee, fulfilling a role as an (inter)national scientific independent advisory body, be continued.

International cooperation is vital to maintain a Favourable Conservation Status for a mobile marine species. To promote and enhance the exchange of expertise and knowledge between policy-makers and experts involved with harbour porpoise conservation in the North East Atlantic, a networking event will be organised in collaboration with the EU Natura 2000 Biogeographical Process.

Reaching out to the general public, and especially the next generation, is essential to inform people about the presence of cetaceans in Dutch waters. In this plan, several initiatives are welcomed whereby Dutch stakeholders propose collaboration in the conservation of the harbour porpoise through a variety of education and outreach activities.

Population ecology, abundance & distribution

Knowledge about the population status of harbour porpoises on the Dutch Continental Shelf has increased substantially over the last decade. Different strands of research and monitoring have provided valuable new insights into their abundance, (seasonal) distribution, short and long-term diet, contaminant burden and offloading, pregnancy rates and foetal growth.

There are different options for finding answers and obtaining reliable and unbiased data on the population status and ecology of porpoises. Not all methods will provide the same level of accuracy and precision of information, and they will differ greatly in cost. Different types of surveys are carried out in the Netherlands, from voluntary land-based and ferry line surveys, to dedicated aerial surveys, either specifically for cetaceans (international SCANS and national SCANS-like surveys, which feed into the OSPAR/MSFD indicator on Abundance and Distribution of Cetaceans) or for marine birds, in which cetaceans are monitored additionally (MWTL). However, survey programmes provide only limited information on habitat use and trophic relationships.

Due to their relatively small body mass in comparison with their surface area, harbour porpoises lose relatively large amounts of body heat (energy), which needs to be compensated by a large and frequent energy uptake of high-quality prey, e.g. fatty fish. Stomach content studies show that stranded porpoises in poor condition have often fed on lean prey. Healthier individuals have been able to supplement their diet with fattier fish. Stomach content analysis, however, cannot determine whether diet or condition is cause or effect. Analysis of stable isotope and fatty acid composition of porpoise tissues can be used to investigate long-term diet. Research on this has highlighted that in offshore waters porpoises may feed on pelagic, schooling species, while closer to shore they feed on more benthic and demersal species shortly before they strand. It is therefore recommended to compare data from stomach analyses (last meals) with other methods such as fatty acid and stable isotope analyses (diet over up to several weeks) to assess the diet of harbour porpoises. Repeated disturbance of foraging activities may have negative effects on fitness. There is a recurring knowledge gap about food quality and availability. Therefore, work on prey availability and resources should be part of more integrated ecological and modelling studies.

Post-mortem examination of stranded animals offers valuable insight into life history parameters (pregnancy rate, age distribution, age of sexual maturity growth, and mortality rate), as well as insight into diet composition and contaminant load. This information is used to assess the health status of a population (Chapter 6). These parameters are a necessary input for population models to predict population development, including when impacted by anthropogenic activities. They can potentially be captured in an indicator for either habitat quality or food webs in the Habitats Directive or MSFD. However, it is not clear how representative the data from stranded


Photo: Annemieke Podt, Stichting Rugvin

animals are for the entire population, since they mainly seem to constitute relatively weak animals. Effort is needed to get access to offshore animals for comparison.

Genetic research can also add to knowledge on distribution and the existence (and number) of subpopulations. Using genomic techniques can offer possibilities to inform policy and management, such as for population abundance (past and present), adaptation to climate change or other stressors, and specific management actions relating to subpopulations and management units.

The harbour porpoise is the most abundant cetacean species in the North Sea. Harbour porpoises in Dutch waters belong to the population that inhabits the wider North Sea. A recent assessment of the status of the North-East-Atlantic harbour porpoise indicated that the population in the North Sea has been stable since around 2005. SCANS-like aerial surveys show that up to a fifth of the North Sea population, estimated at 345,000-361,000 individuals, was present on the Dutch Continental Shelf during the summer between 2010 and 2019.
These national surveys also show that, although relatively stable for the last 10 years, there has been considerable variability over time. In particular, there is no clear explanation why densities in Dutch waters were very low thirty years ago but have been much higher in recent years.

Around the year 2000 a small, presumably resident, number of harbour porpoise started inhabiting the Eastern Scheldt, a semi-enclosed tidal bay, which offers possibilities for studying the species' behaviour.

An analysis of national SCANS-like and MWTL aerial surveys and land-based counts has resulted in an update for the MSFD abundance and distribution monitoring programme (taken up in the revised 2020 programme) and an additional indicator for the harbour porpoise for the *Compendium voor de Leefomgeving*. It is further recommended to integrate other existing data sources and an international survey that encompasses the wider North Sea (Chapter 5 and Annex I). The analysis shows that the aerial datasets reveal similar temporal patterns, although absolute abundance estimates are possible only with SCANS-like data - and therefore these data are most suitable for HD and MSFD reporting. MWTL surveys, executed every two months since 1991, are suitable for identifying statistically reliable trends in the Dutch part of the North Sea, and to determine seasonal patterns for (sub)areas. The peak in abundance offshore is in March/April while minimum numbers offshore are seen in November/December. In the coastal zone, the observed peak is in January/February and minimum numbers are in July/August.

There are several technological tools that can add to the current methods to study the abundance, distribution and behaviour of the harbour porpoise. These include the (combined) use of tags to track animals and using passive acoustic monitoring (PAM), and high definition (HiDef) cameras.

Tagging and tracking of harbour porpoises have been proven to provide useful and detailed information on habitat use, (diving) behaviour, dive depth, and the timing of movements, including individual-specific behavioural changes. Tracking tagged animals can also be a valuable tool to investigate the impact of human activities on individuals. It is recognised that tagging has an impact on the animal and, to optimize the use of this research methodology, a step-by-step approach is recommended, starting with exploring different tagging methods and setting up a dialogue with stakeholders to explore different tagging methods.
PAM is based on detecting and recording the acoustic signal of the species. Since harbour porpoises use echolocation almost continuously, PAM could be useful to assess temporal patterns in overall relative abundance and could indicate patterns in the use of certain areas and in feeding activity. Despite the challenges of using PAM as a tool to derive absolute abundance, PAM is widely used in offshore wind farm impact studies abroad and in the Dutch part of the North Sea.

Increasing numbers of seabird and marine mammal surveys are performed using so-called high definition (HiDef) digital imagery techniques. The sea surface is either photographed or filmed with multiple cameras, providing images of predefined sectors along a transect. All footage is stored digitally for subsequent analysis. Although there are many advantages in the long run such as safety, less disturbance, less observer- or weather-related bias, and more precise estimates, HiDef is still under development and is costly. It also cannot yet estimate absolute density. As with conventional aerial surveys, automated processes are unlikely to yield all the necessary information on distribution, habitat characteristics and movements throughout the annual cycle, on multi-species interactions and on foraging activities.

The harbour porpoise is an integral component of complex food webs, interacting with multiple species. None of the studies on ecology, abundance, or distribution are sufficient in isolation. Therefore, what is needed is an integrated approach, combining the different methodologies and modelling techniques, including the production of an overview of existing data, and an analysis of the strengths and shortcomings of both existing datasets and emerging technologies. Such a comprehensive meta-analysis of currently available data on spatial and temporal patterns in abundance should also include aspects of reproduction and prey resources.

In Chapter 5 the latest developments and recommendations for future monitoring and research are given for population status and ecology, based on the legal requirements mentioned in Chapter 3.

Stranding events & stranding research

Valuable knowledge and insight have been gained through stranding research. Since 2016, each year approximately 50 of the freshest carcases are necropsied to determine the cause of death and to facilitate research on diet, contaminants and life history. Apart from the switch from using animals in all stages of decomposition to using only fresh animals, the sample size decreased significantly since 2016. A preliminary comparison of the cause of death before (2008-2013) and after 2016 (2016-2019) showed some differences. However a more thorough analysis is needed, also taking into account the representativeness of the samples. It is acknowledged that information from stranded animals is not representative of the population, but it provides the possibility to monitor trends in causes of death and specific anthropogenic threats.

As acquiring a representative sample of the harbour porpoise population has a high priority, offshore samples are needed as a first step. Cooperation with fishermen to land animals that are (by)caught in their nets is considered as one of the options to get access to offshore animals for post-mortem research. A pilot study to land animals has started with three fishermen, but has not yet resulted in offshore specimens.

An additional way forward is to increase the data quality from stranded dead porpoises that are sent for disposal by engaging both the general public and the voluntary stranding network to report about sex, age and body-condition, and to make these data available for cross-border comparison and analysis.

All reported stranding events are documented in a central registration database: www.walvisstrandingen.nl Efforts are underway to expand this database. Opportunities for international cooperation are being explored. Such a database can facilitate analysis of differences and similarities between regions. Results of a first spatio-temporal analysis of stranding events in the western, southern and eastern North Sea show an increase in stranding events since 1990, with a notably steeper increase in incidence after 2004/2005, particularly in the southern North Sea, corresponding with the increase in visual observations. However, after 2010 the number of stranded porpoises exceeded the number expected based on the sightings, with a peak in 2011. The possible cause for the apparently elevated mortality rate in the last decade might be natural or human-related. This warrants further in-depth investigations focusing on understanding what the fluctuating stranding numbers mean. A strong seasonal variation across the North Sea regions was also detected, as well as a clear southward shift and heterogeneity in age-specific sex ratio. This highlights the value of a transboundary approach to data analysis for a highly mobile marine species.

An important element of stranding research is contaminant research in order to signal trends and to identify new developments. Chemical pollution is known to suppress immune and hormone functions, which can result in increased susceptibility to infectious disease and reproductive failure. Studies in the UK have showed a relationship between marine pollutants (e.g. PCBs) and increased infectious disease mortality in harbour porpoises. Other recent studies show that chemical pollution, PCBs in particular, is still a significant threat to marine mammals. Despite regulations and mitigation measures to reduce PCB pollution, and recent work from the UK suggesting a decreasing trend of PCBs in harbour porpoises, levels are still high enough to cause elevated rates of infectious disease mortality and exposure of juveniles to a neurotoxic mixture of PCBs (probably as a consequence of pollutants offloading between mothers and calves during lactation). An ongoing study of contaminants in harbour porpoises that have stranded along the Dutch coast shows contaminant loads comparable to animals in the UK. The study focuses on the concentration of PCBs, brominated compounds (such as polybrominated diphenylethers – PBDEs), and hexachlorobenzene (HCB) in all age groups, and examines the transfer of these contaminants from adult female harbour porpoises to their offspring, the so-called generational transfer. A follow-up study has started on the concentrations and potential effects of PFAS (per- and polyfluoroalkyl substances) in harbour porpoises that are stranded along the Dutch coast.

These studies contribute to the necessary understanding of generational cycling of contaminants in cetaceans and of the health status of harbour porpoises in the southern North Sea. They feed into joint monitoring approaches (e.g. through OSPAR) to establish indicators for contaminants, such as PCBs.

The direct and indirect effects of marine litter, a recognized global problem, are still unknown. Different studies on marine litter indicate that although the occurrence of ingested marine litter is high, it has hardly ever been linked to a cause of death. The third IWC workshop on marine debris in 2019 gathered a wealth of knowledge on this issue. Some of the most important recommendations were to make use of harmonized protocols to assess marine litter presence and to record zero values for marine litter in necropsy reports and/or during diet analysis. These IWC recommendations have also been adopted in the present plan.

Incidental bycatch

Despite many efforts to reduce bycatch, tackling incidental bycatch remains a challenge. It involves a fisheries community that in the Netherlands is often made up of small single-manned vessels. This makes it difficult to use traditional means of monitoring such as on-board observers. Bycatch events on small vessels also have a negative impact on fishing practices, causing net damage and loss of time disentangling animals.

EU fisheries regulations require monitoring and mitigation of the bycatch of sensitive species. However there are still many barriers to effective implementation. For example, vessels that are under 15 m using bottom-set gillnets contribute to the highest bycatch risk to harbour porpoise in the southern North Sea, but are not specifically covered by monitoring or mitigation requirements in Annex XIII to Regulation 2019/1241. There is currently no robust total bycatch estimate for harbour porpoise in the North Sea.

The Remote Electronic Monitoring (REM) monitoring project of incidental harbour porpoise bycatch in the Dutch commercial bottom-set gillnet fisheries (2013-2017) resulted in an estimated annual bycatch mortality for this fleet of between 0.05 and 0.07 % of the Dutch harbour porpoise population (with a maximum worst-case value of 0.3 %). Bycatches occurred as expected in trammel nets (GTR) but also, although at a significantly lower rate, in single-walled gillnets (GNS). While the bycatch numbers in that time period were lower than the mortality reference points that are consistent with ASCOBANS objectives (both using the CLA approach or the 1 % of best population estimate), it is important to interpret this with caution. The fishing effort monitored did not include foreign fisheries or recreational fisheries with gillnets in Dutch waters. Changing porpoise distributions and fishing effort make necessary continued (REM) monitoring, across borders and fleets, including recreational fisheries. There is also a need for improved data collection at EU level on fishing effort, including net-length and soak time. Bycatch monitoring could be greatly improved through further cooperation with the fisheries sector on development of a cost-effective and practical mobile REM system.

Recreational gillnet fishing in the Netherlands are permitted in some coastal municipalities and pose an unquantified source of potential bycatch. Additional monitoring and quantification of effort is recommended for these fisheries.

Important data on bycatch occurrence comes from stranding networks in combination with necropsy, in particular where dedicated monitoring programmes are lacking. However, inferences about bycatch based on stranded animals may be subject to a number of sources of bias.

There is not a single solution to mitigate fisheries bycatch and it is worth investing in a diverse, adaptive portfolio of tools and approaches. One of the biggest challenges is to ensure the involvement of the fisheries sector. The Dutch REM project, despite several hurdles in the early phase of the project, resulted in successful cooperation with the fisheries sector. This showed that building a successful working relationship, trust, respect and mutual perspectives are key elements, as well as engagement from an early stage, when programmes for monitoring and mitigation are developed. This is a process that needs facilitation and coordination.

Acoustic alarms or 'pingers' are the most widely adopted mitigation measure to reduce bycatch of small cetaceans. Their effectiveness varies between areas and species and some limitations need to be taken into account, including correct spacing and deployment. The use of pingers should also be assessed on a case-by-case basis to evaluate the expected reduction in bycatch and the impact of potential habitat loss for porpoises.

Mitigation by switching from gillnets to alternative gear requires effort and investment from the fisheries sector. Questions about logistics, safety, profitability and income need to be addressed. Switching to other gear types could be encouraged through incentives, and the sector has already shown interest in trials to develop further the potential of pots/traps, which are possible suitable candidates as well as hooks (long and hand lines). It is recommended to assess the potential for using alternative gear in Dutch fisheries, with priority given to fisheries with higher bycatch rates (wreck, sea bass, and trammel nets).

A suggested step forward is an international bycatch project, looking at the aforementioned developments and lessons learned. the Netherlands envisages setting up such a project, together with other North Sea countries and in collaboration with the industry, to establish statistically robust cross-border bycatch numbers in small scale fisheries, and ultimately to achieve a significant bycatch reduction. The aim is to follow a multi-disciplinary approach with strong stakeholder involvement.

Underwater noise
Due to increasing human activities in the southern North Sea, anthropogenic noise is a growing concern. Sound propagates well under water, which makes it so important for cetaceans (e.g. for foraging and communication) and also for several human technologies. Underwater noise can be divided into two major categories: impulsive – loud, underwater noise (e.g. pile driving for offshore wind farms, seismic exploration, echo sounders, underwater explosions, acoustic deterrent devices and naval sonar systems) and continuous noise (mainly from shipping).

Impulsive and continuous noise under water can affect harbour porpoises through hearing damage, avoidance behaviour (disturbance) and masking. At a population level, the effects of disturbance are thought to have a greater impact on harbour porpoises than hearing damage because disturbance occurs at much greater distances from the sound source, affecting more animals.

Pile driving during the construction of offshore wind farms triggers avoidance behaviour of harbour porpoises and may also cause temporary or permanent hearing loss. Results from national and international research programmes, such as the Dutch Offshore Wind Ecological Programme (WOZEP), were used to develop a 'Framework for Assessing Ecological and Cumulative effects' (KEC). Based on the results of the KEC, a Sound Exposure Level (SEL) threshold value at 750 metre from the source for piling has been set for the construction of all offshore wind farms on the Dutch Continental Shelf. This threshold will remain subject to review as new information becomes available. In addition to the noise threshold, mitigation measures (Acoustic Deterrent Device (ADD), soft start) have to be used to encourage harbour porpoises to move away in order to reduce the risk of hearing damage (Permanent Threshold Shift (PTS)). Further study is recommended on noise related to the operation of offshore wind turbines because of the increase in the size of the turbines, the substantial vessel traffic associated with servicing wind farms, and the total covered area and cumulative sound produced by wind farms in the last and coming decades.

The North Sea is an area from which vast amounts of oil and gas have been extracted for decades. Especially Norway, the United Kingdom and the Netherlands have many offshore oil and gas production sites in their sectors of the North Sea. The production from small gas fields is expected to be continued in the next decades with the companies involved likely to conduct periodic seismic surveys to assess the remaining reserves. In seismic surveying an impulsive sound is generated by a towed array of air guns (compressed air that is released in a coordinated way). Noise generated by seismic surveys can be disturbing for harbour porpoises, with potential negative effects, although there is no evidence that historic activities have caused significant negative impacts on the population. Nevertheless, more detailed efforts to investigate and assess the impact of seismic surveying activity are recommended, in collaboration with the industry, and supported by recent legal developments (e.g. Nature Conservation Act 2017). A framework similar to the KEC for the construction of offshore wind farms is therefore proposed. Also, research will be conducted to determine the minimum amount of sound needed to achieve the objective of a survey, and thereby minimize the amount (and the frequency band) of sound sent into the water column.

A study on the potential effects of the clearance of Unexploded Ordnance (UXO), which are cleared from a concern for human safety and to avoid damage to equipment and infrastructure when accidentally encountered, showed that on a yearly basis potentially thousands of animals were at risk of permanent hearing damage (PTS). Therefore, the Netherlands Ministry of Defence has developed guidance and procedural mitigation measures, including the compulsory use of ADDs to reduce some of the adverse effects of underwater explosions. It may be useful to validate the effects of these mitigation measures by systematically recording details of clearances. The availability of alternative technologies for clearance of munitions at sea should be explored in the longer term. The use of explosives for other reasons than clearance of UXO, e.g. for demolition of old platforms, should be restricted to a minimum.

Mid-frequency (1-10 kHz) active military sonar, an impulsive sound source, is used by the Royal Netherlands Navy (RNLN) to detect and localize submarines. In practice, the use of mid-frequency active sonar in the southern North Sea is negligible, because this area is too shallow to be used by submarines. Use of military sonar in the Dutch part of the North Sea is therefore not considered to be a threat. In order to be aware of any significant

increase, it is recommended to assess the use of sonar sources other than military sonar (e.g. fish-finding sonars, single and multi-beam echo sounders and sub-bottom profilers, like pingers and chirp sonars) at the relevant frequencies.

A second category of underwater sound is continuous noise. There is growing awareness on the effects of continuous anthropogenic noise that is mainly caused by shipping. To address MSFD monitoring requirements, the programme JOMOPANS was initiated. This will deliver an innovative combination of modelling and high-quality measurements at sea in an operational joint monitoring programme for ambient noise in the North Sea. It is recommended to discuss and encourage development of measures to decrease noise impact at both national and international level (e.g. IMO) and to improve the knowledge on the effects, mostly masking, caused by continuous noise. This issue has not yet been regulated within the framework of the IMO, but the MEPC has approved non-mandatory guidelines for the reduction of underwater noise from commercial shipping to address adverse impacts on marine life (2014).

Recreational vessels (and other vessels without AIS) are not covered by the current initiatives. Especially in coastal areas, these recreational vessels (and in particular the fastest vessels) can cause serious problems related to underwater noise.

Although some ship classification societies offer different underwater noise categories there has been very little action to reduce underwater noise across the large merchant vessel fleet as a whole. Current incentives to reduce ship noise (e.g. in the Port of Vancouver) may be a promising way forward. In 2018, the International Whaling Commission (IWC) adopted a number of resolutions that address threats posed to all cetaceans, including anthropogenic underwater noise. The IWC will work together with the IMO on this topic.

To address underwater noise, apart from general overall recommendations, specific sound source recommendations have been developed. There is an overarching need to assess and address the temporal and spatial cumulative impact of acoustic anthropogenic activities and to improve and validate population models. To prevent adverse effects on populations of the species, an indicator has been developed in the Netherlands Marine Strategy (2018) for the number of harbour porpoise disturbance days. Over the last few years more insight has been gained into the sensitivity and the effects thereon of different frequencies of impulsive noise. Frequency weighting (differences in sensitivity for specific frequencies or parts of the frequency spectrum for different species) is becoming more apparent and the role hereof on the impact of impulsive sounds on porpoises is under investigation. Clearly the industry has an important role to play, and it needs to be motivated and stimulated by using (legislative) incentives to continue development, testing and use of mitigation measures.

Next steps towards concrete measures for conservation
Altogether, the suite of information gathered in this Conservation Plan has led to recommendations that are prioritised in time and urgency in the Action Plan (Annex I). The prioritisation has been amended based on the third advice of the HPAC (Van der Meer et al. 2020). The recommendations follow up on the outcomes of the original plan from 2011. In brief it can be concluded that despite the Favourable Conservation Status of the harbour porpoise in the Netherlands, efforts will be ambitious to maintain this status. It is widely acknowledged that there is an overarching need for a strategic, cross-sectoral and transboundary approach at all levels, to effectively tackle the cumulative impact of the key anthropogenic threats and to improve the current research and bring together different data streams. This acknowledgement has already led to actions and initiatives over the past decade, including, but not exhaustively, dedicated research and measures on underwater noise, such as the threshold for pile driving, incidental bycatch monitoring in cooperation with fisheries, a cross-boundary spatio-temporal stranding analysis and research on impacts of contaminants, demonstrating effects of generational cycling. This conservation plan proposes substantial steps, towards an integrated, multi-disciplinary ecosystem-based approach unravelling and accommodating the needs of the harbour porpoise.

This plan has been developed by the Ministry of Agriculture, Nature and Food Quality in collaboration with the Ministries of Defence, Economic Affairs and Climate Policy, and Infrastructure and Water Management, as well as scientific experts and stakeholders from NGOs and industry. The next steps towards concrete conservation measures will be the implementation of the Action Plan (Annex I) into established policy, such as the KEC, Netherlands Marine Strategy, N2000 management plans and structural monitoring programmes, as well as the Monitoring, Research, Nature Restoration and Species Protection (MONS) programme, which was established under the umbrella of the North Sea Agreement. The Ministry of LNV is committed to delivering these actions and working together with all partners in this endeavour.

2 Introduction

The Harbour Porpoise (*Phocoena phocoena*) is the most abundant cetacean species in the North Sea. A recent assessment of the status of the North-East-Atlantic harbour porpoise indicated that the population of harbour porpoise in the North Sea has been stable since around 2005 (NAMMCO 2019). The distribution seems to be largely similar after the southward shift at the end of the 20th century (Hammond et al. 2013, 2017, 2019), although porpoises have continued to increase in the Channel and off the coast of France (NAMMCO 2019). In addition porpoises have moved more into rivers, such as the Elbe, Weser and Eems (Weel 2016, Weel et al. 2018; Wenger & Koschinski 2012).

Abundance estimates show that up to a fifth of the North Sea population, estimated at 345,000-361,000 individuals (Gilles et al. 2016, Hammond et al. 2017), was present on the Dutch Continental Shelf during the summer surveys between 2010 and 2019 (Geelhoed et al. 2020). The harbour porpoise returned to Dutch coastal waters from the early 1990's after an absence of several decades. Its status changed from a rarity to a common resident in about 15 years (Camphuysen 2004). Around the year 2000 a small, presumably resident population, started inhabiting the Eastern Scheldt, a semi-enclosed tidal bay (Podt 2020). Despite their rather elusive nature, porpoises can often be observed from the Dutch shore in calm weather.


Photo: Annemieke Podt, Stichting Rugvin

The cause of the comeback of one of the smallest whales is as yet unknown.

Harbour porpoises have an average life-span of 8-10 years and become sexually mature between 3 and 4 years of age. Adult females produce one offspring on average every 1-2 years; gestation lasts 10-11 months. Adult females reach on average 1.6 m in length (and weigh 60 kg), while males are smaller, about 1.5 m long (and weighing 50 kg) (Lockyer 2003). The animal is a relatively small, endothermic predator with limited energy storage capacity, and is dependent on foraging throughout the year, without prolonged periods of fasting (Kastelein et al. 1997, 2019, Bjørge 2003). Like other cetaceans, they are heavily reliant on active echolocation for prey capture, communication and possibly for navigation (Au 1990, Kastelein et al. 1999, Au 2002, Teilmann et al. 2002). This makes them vulnerable to underwater noise in the marine environment (Pirotta et al. 2014, Senigaglia et al. 2016).

Knowledge about the population status and ecology of harbour porpoises in the Dutch Continental Shelf has increased substantially over the last decade. Dedicated research efforts have provided valuable insights into the abundance, distribution and behaviour of the species, and data that has allowed the evaluation of different threats. The key anthropogenic pressures remain underwater noise (Chapter 8), incidental bycatch (North Sea wide) (Chapter 7) and chemical pollution (Chapter 6). Predation by grey seals (Chapter 6) is a natural cause of mortality. A knowledge gap remains with respect to the impact of climate change and food availability in the southern North Sea (Chapter 5).

These pressures are supported by an expert elicitation (IJsseldijk et al. 2018), that identified incidental bycatch, population dynamics, and the cumulative effects of multiple stressors as the three most important knowledge gaps. The authors established a list of essential indicators with the aim of increasing the understanding of the health status of harbour porpoises. They scored as most relevant the study of the causes of death, distribution, abundance, habitat use, and diet composition (IJsseldijk et al. 2018).

The conservation status of the harbour porpoise in the Netherlands was assessed as "Inadequate" in 2009 (Jak et al. 2009) and the Dutch population of porpoises as "Vulnerable" in 2007 (VZZ 2007). Also, an increasing number of stranding events of harbour porpoise caused concern about the population status. Therefore, the Dutch Ministry of Agriculture, Nature and Food Quality (LNV) commissioned a conservation plan for the harbour porpoise in the Netherlands (Camphuysen & Siemensma 2015). One of the recommendations from this plan was to form an independent Harbour Porpoise Scientific Advisory Committee[5] (hereafter the HPAC), which would be able to advise on research needs and the quality of research. Based on the request of the Ministry of LNV in 2016, the HPAC provided advice on future scientific research and policy on harbour porpoises in the Netherlands (Van der Meer et al. 2016, 2019, 2020). New developments in terms of research, policy and management, led to an update of the conservation plan in 2020.

One of the main developments has been that in 2019 the conservation status of the harbour porpoise in the Netherlands was assessed "favourable" under the assessment methodology of Article 17 in the EU Habitats Directive (see Chapter 3). Range, population and habitat were all assessed "favourable", while future prospect was assessed as "unknown". This does not mean that conservation efforts are no longer needed. On the contrary, the obligation to maintain a favourable status is unchanged, and many uncertainties still exist, such as on the impact of (future) human activities, and even about fundamental topics such as changes in population abundance, distribution and ecology.

The harbour porpoise was listed as "Least Concern" on the IUCN Red List in 2008 and it remains "Least Concern" in the 2020 updated assessment (Braulik et al. 2020). Also the national Red List Mammals 2020 listed the harbour porpoise as "Least Concern".

With this revised and updated plan for the harbour porpoise, the Ministry of LNV presents an overview of research, policy and legal developments since 2011. This plan does not include an extensive literature review.[6] The plan focuses on what is needed to fulfil the legal requirements from the perspective of policy and management (Chapter 3 and Annex II) with the overall aim of maintaining a Favourable Conservation Status of the species in Dutch waters.

In 2019 expert sessions took place on the following topics: stranding events, contaminants & diet; underwater noise; population status- and ecology, and cooperation with the fisheries sector related to incidental bycatch. Based on these expert sessions, the HPAC provided advice on the draft recommendations, keeping in mind the

5 Established in 2015. The Committee was formed by Jaap van der Meer (Chair, NIOZ/VU until 2019, since 2019 WMR), Herman Eijsackers (WUR) en Jan Haelters (KBIN).

6 see IAMMWG 2015 for a literature review of conservation for the harbour porpoise.

overarching goal (Van der Meer et al. 2019). An independent legal expert reviewed recent legal developments and the (potential) implications for the conservation of harbour porpoises (see Chapter 3 and Dotinga 2020). In addition, NGOs[7] provided their joint vision on harbour porpoise conservation. Their suggestions were considered in the recommendations. Chapter 4 describes the stakeholder process. This revised and updated harbour porpoise conservation plan incorporates all the work described in this paragraph.

Each chapter briefly touches upon previous recommendations, then focuses on new developments and concludes with research and policy recommendations. These recommendations have been summarised in Annex I and will be prioritised and ranked in time.

Budgets are limited, and priorities need to be given to those research and policy recommendations considered most relevant, with the main focus on fulfilling the obligations arising from (inter)national legislation and agreements. It is recognised that this might limit the scope from a scientific perspective. Research areas can cover a wide spectrum, from research that is directly applicable to policy or measures involving more fundamental research. One example of the latter is population ecology research, where different and multidisciplinary approaches are needed. Although this is not (yet) directly applicable to the targets and indicators that are currently required for the Habitats Directive or the Marine Strategy Framework Directive, initiatives by stakeholders to collaborate on these issues are encouraged.

In the 2011 Conservation Plan, several research needs were prioritised. Later, an analysis by Siemensma & Scheidat (2015) provided an overview of actions carried out in the context of the Conservation Plan. They emphasized the importance of re-evaluating the priorities within the Conservation Plan as well as the involvement of the extensive network of expertise in the Netherlands. They also emphasized that all new research should be assessed by the HPAC for quality assurance. Finally, insight into the cumulative impact of anthropogenic activities would be needed. These recommendations have been reiterated by the HPAC, and also in this updated Conservation Plan. Based on this analysis, the HPAC provided recommendations for scientific research and policy in 2016 (Van der Meer et al. 2016).

All the research priorities are addressed in the following chapters, but a brief overview is given here of the main priorities and how these were addressed.

[7] IFAW, North Sea Foundation, Rugvin Foundation, SOS Dolfijn & WWF.

Harbour porpoise population abundance and distribution was the first priority, which focused on assessments undertaken since the 2011 Conservation Plan using state-of-the-art aerial surveys, including trend analysis of seasonality and spatial patterns. Large-scale population abundance and distribution assessment and the integrated use and analysis of different data sources were recommended by Siemensma & Scheidat (2015), and reiterated by the HPAC. This led to a statistical study by the CBS and recommendations for an adjusted design of the schemes for monitoring abundance and distribution. The developments on this topic are dealt with in more detail in Chapter 5 (population ecology and abundance).

Innovative studies of the **Harbour porpoise (foraging) ecology and habitat requirements** in the southern North Sea were recommended in 2011 and again in the 2015 analysis and by the HPAC. To date, there have been several efforts to study harbour porpoise ecology, but little success in bringing these together. The lack of a meta-analysis to outline an ecological context of harbour porpoises now and in the past has been recognized. Combining information from life history and diet studies as well as results from passive acoustic monitoring (PAM), survey work and tracking can improve our understanding of porpoise behaviour. Further suggestions to synthesize data are given in Chapter 5.

Research into stranding of porpoises is another priority. This has progressed significantly in recent years and provides the opportunity to study additional important factors, such as contaminants and diet. Gaining insight into the representativeness of the stranded animals investigated post-mortem was repeatedly identified as a high priority in 2011. Therefore, more samples from offshore and/or bycaught animals are needed. In addition further consideration is necessary to address this recurring knowledge gap by looking at other approaches to gain a representative health status of the population, which is elaborated in Chapter 5 and Chapter 6 (stranding events).

Chemical pollution is still considered to be a significant threat to marine mammals. Another priority remains gaining knowledge about the impact of chemical pollution, as was reiterated in the 2015 analysis and by the HPAC. It is known to suppress mammal immune and hormone functions, which may result in increased susceptibility to infectious diseases and may impact reproductivity. More concrete recommendations relating to chemical pollution and marine litter are provided in Chapter 6.

Both bycatch in fishing gear and underwater noise were identified as main threats in 2011.
Specific research and policy needs for **fisheries bycatch** were a high priority. This included an observer scheme on all fleets with passive gear to assess bycatch rates according to internationally accepted protocols to facilitate landing of bycaught porpoises, to evaluate the effectiveness of mitigation measures and to ban recreational fisheries with static gear. Although a Remote Electronic Monitoring project was implemented in the Dutch gillnet fisheries sector from 2013 to 2017, this has neither led to structural monitoring of incidental bycatch in the commercial or the recreational bottom-set gillnet fisheries, nor to a continued cooperation with the sector to achieve *inter alia* landing bycaught animals, or to exploring mitigation measures. All of these actions have been recommended in both the 2015 analysis and by the HPAC. Other efforts are therefore needed and are discussed in Chapter 7 (incidental bycatch).

Regarding **underwater noise**, the 2011 recommendations included the development of guidelines for impulsive sound (pile driving, explosives, seismic surveys), including alerting animals by ramping up sounds and/or using acoustic deterrents, and notification of the stranding network before acoustic impacts. Noise reduction was recommended using bubble curtains, solid barriers, alternatives for piling and other solutions if proven to be effective, and avoiding the use of explosives for offshore activities. Since 2011 much progress has been made both in terms of policy and research (a threshold for offshore wind construction, procedures for clearances of Unexploded Ordnance (UXO), effect of frequency weighting, a new legal framework, growing awareness and monitoring of continuous (shipping) noise), as described in Chapter 8. Recurring topics highlighted in the 2015 analysis and by the HPAC are the urgent need for assessing and addressing cumulative acoustic impact, the requirement for updated population models, the validation of mitigation measures, and cross-sectoral thresholds for impulsive noise.

Chapter 9 provides the next steps in accordance with the Harbour Porpoise Conservation Action Plan 2020 in Annex I.

3 Legislative & policy context

The harbour porpoise is, as all other cetaceans within the North Sea, legally protected in the Netherlands following international, European and national legislation. This means that intentional killing, intentional disturbance, and trading or collecting animals or parts of them is illegal and other obligations have to be met to maintain a Favourable Conservation Status.

Since the adoption of the Conservation Plan for the Harbour Porpoise in 2011, developments have occurred in the applicable international, European and national law. Based on a request from the Ministry of Agriculture, Natura & Food Quality, the main developments of relevance for the harbour porpoise in the applicable international, European and national (Dutch) law since 2011 have been identified in Dotinga 2020. This report contains an overview of the most important legal developments and discusses their significance for the conservation of the harbour porpoise in (the Dutch part of) the North Sea. The report does not provide a complete overview of the applicable legal instruments, but only discusses the most pertinent instruments. It also does not discuss or review the Netherlands' Conservation Plan for the harbour porpoise itself.[8] A summary of the most important developments are given in this chapter, as well as the most relevant developments from a policy perspective. Interactive links provide more background information on the different topics.

Photo: Annemieke Podt, Stichting Rugvin

3.1 Legal developments since 2011

3.1.1 General objectives

The overall objective has remained the same: to achieve and maintain a Favourable Conservation Status for the harbour porpoise, as required by the Habitats Directive. The 2019 Habitats Directive report has concluded a Favourable Conservation Status for the harbour porpoise, with an 'unknown' assessment for future prospects. Necessary measures have to be adopted for the harbour porpoise to this end, which includes the designation and management of protected areas, generic species protection and monitoring under the Habitats Directive. It also requires faithful implementation of the requirements and recommendations under the OSPAR Convention, ASCOBANS, the MSFD, the relevant CFP Regulations and other applicable instruments.

The harbour porpoise is a strictly protected species under the Habitats Directive, which requires measures to protect individuals from harm and measures to ensure good quality habitat. Species listed in Annex IV of the Habitats Directive (including the harbour porpoise) are protected not just within, but also outside Natura 2000 areas (generic protections throughout distribution area). Only when designated protected areas are of particular ecological (feeding, resting) or demographical (reproduction) significance for a highly mobile, migratory, aquatic species such as the harbour porpoise there would be a case for an area-based conservation approach. For the designation of N2000 areas, research in the Dutch waters has not been able to identify areas or regions of particular significance for harbour porpoises for any significant length of time.

Nevertheless, the N2000 areas Dogger Bank and Cleaver Bank qualify for this species because they occur there, but the occurrence is classified as category B1 (2-6 %; population in these areas expressed as % of the national population). Management plans for these areas are underway (see 3.1.6). There are indications that the Eastern Scheldt inhabits a small subpopulation (see 5.4), but here the occurrence is classified as category C (<2 %). Further monitoring and research in the entire Dutch North Sea, Wadden Sea and Delta waters is necessary to know more about feeding and breeding habits.

Research and monitoring are an important part of the system of strict protection. All human activities (new and ongoing) fall within the scope of the prohibitions on deliberate capture, killing and disturbance of individual harbour porpoises contained in article 12 of the Habitats Directive. Violations of these prohibitions can occur not just in case of deliberate acts, but also in situations where the offender consciously accepts the foreseeable results of his action. The application of clear, effective and well-monitored mitigation measures can be used to prevent the occurrence of a violation of the prohibitions. Systematic monitoring of incidental capture or killing and the adoption of the necessary conservation measures is required by article 12(4) of the Habitats Directive.

3.1.2 International

Within different international bodies dealing with cetacean protection, there have been a number of noteworthy developments. OSPAR recommendation 2013/11 on furthering the protection and restoration of the harbour porpoise in the North Sea was adopted. Furthermore, there were several ASCOBANS, CMS and IWC resolutions adopted such as those dealing with bycatch, underwater noise and cumulative impacts.

The Habitats Directive (1992) was in an EU 'fitness' check of its appropriateness found fit for purpose in 2016 and remains the key legal instrument for the conservation of the harbour porpoise, together with the MSFD and the new CFP Regulations (in particular the new CFP Technical Measures Regulation 2019/1241).

3.1.3 National

The adoption and entry into force of the Nature Conservation Act (2017) and the Offshore Wind Energy Act (2015) were important developments on a national level. The Offshore Wind Energy Act provides the possibility to issue a derogation from the prohibition to disturb strictly protected species such as the harbour porpoise. The Environment Planning Act will replace the Nature Conservation Act upon its entry into force (expected in 2022),

[8] See for a legal review of the plan: A. Trouwborst, *Legal Review of the Netherlands Conservation Plan for the Harbour Porpoise (Phocoena phocoena)*, Tilburg Law School, March 2012, commissioned by the North Sea Foundation (Stichting De Noordzee).

but this is not expected to change anything in the substantive rules dealing with protected areas and species protection.

3.1.4 Protected areas & management plans

Four Natura 2000 sites (Dogger Bank, Cleaver Bank, North Sea Coastal Zone and Raan Flats) have been designated as a special area of conservation on the Netherlands' part of the North Sea (see figure 3.1) for the harbour porpoise and conservation objectives have been established in each of these sites. In four Natura 2000 sites (Wadden Sea, Voordelta, Eastern Scheldt and Western Scheldt & Saeftinghe) the harbour porpoise has recently been added in the Standard Data Form (SDF) and therefore needs to be protected in these areas as well according to articles 6.1 and 6.2 of the Habitats Directive.

Management plans that include certain conservation measures for the species have been adopted for the North Sea Coastal Zone and Raan Flats; for the remaining sites such measures still need to be developed and included in existing or new management plans. The requirements contained in article 6 of the Habitats Directive for plans and projects have to be applied consistently to all activities that are potentially harmful for the harbour porpoise. This is currently done for the construction and operation of offshore wind farms and other projects.

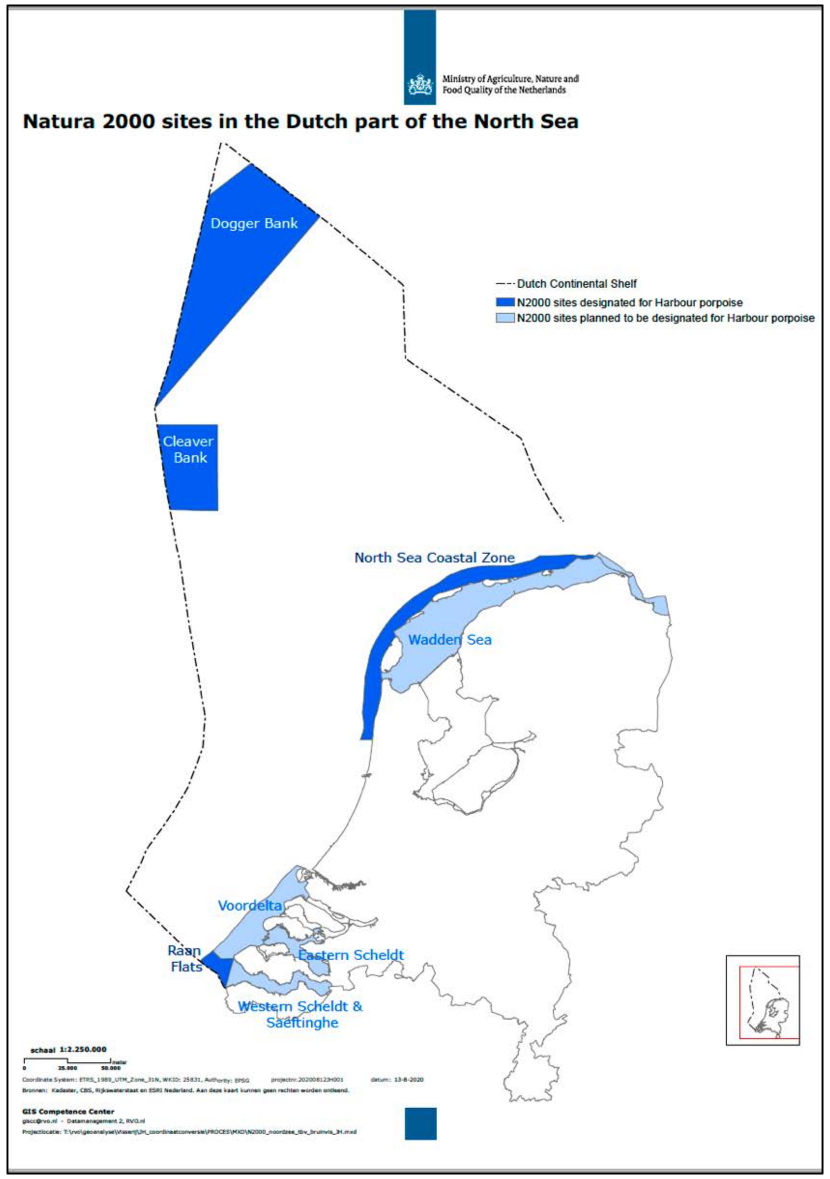


Figure 3.1. Natura 2000 Sites in the Dutch part of the North Sea

The Dogger Bank and Cleaver Bank have been designated by the Minister of Economic Affairs as Habitats Directive area based on article 10a (1) of the Nature Protection Act in May 2016. For the Dogger Bank and Cleaver Bank conservation objectives for species and habitats are set that contribute to maintaining European biodiversity. For the Dogger Bank and Cleaver Bank a conservation objective for harbour porpoise is adopted (maintain extent and quality area for maintaining the population).

Within and outside of Natura-2000 areas (economic) activities take place. In a management plan the competent authorities (for the North Sea this is the federal government) determine which activities are possible and how they can take place so that Natura-2000 conservation objectives can be reached. The starting point for this is always reaching ecological objectives with respect for and in good balance with the social environment.

The management plans for the Dogger Bank and Cleaver Bank are being drafted. The management plans are directed at realising the conservation objectives for the habitat types and species present in these areas. The plans describe the current situation and measures that are needed to reach the objectives. For this, the effects of current activities on the conservation objectives in and bordering the areas are assessed.

The management plan creates clarity for users which activities are allowed or permitted and under which conditions. In these management plans also, measures are taken specific for harbour porpoise, among others to limit the effects of disturbing activities and underwater noise in these areas. The management plans are expected to be published for consultation early 2021 and finalized in 2022.

3.1.5 North Sea Agreement

In 2019 the Ministries of Agriculture, Nature and Food Quality (LNV); Economic Affairs and Climate (EZK) and Infrastructure and Water Management (I&W) launched an initiative called the North Sea Agreement. This agreement aims to bring together government and stakeholders regarding the future development of the three "pillars" of energy transition, nature conservation and restoration and sustainable food transition including fisheries in the period until 2030. The energy sectors, fishing industry, environmental protection organisations and marine ports all support the agreement. Part of the Agreement is an extensive monitoring and research programme, in which priorities are defined. For harbour porpoise relevant priorities are: research to support species conservation plans, cumulative impact of underwater noise due to wind farm construction and seismic surveying and research to improve selective fishing practices, including technical innovations. In June 2020 a final agreement was adopted, which will be formally signed in the course of 2020.

3.1.6 Cumulative impacts

The harbour porpoise is faced with a series of impacts of human activities and pressures, of which underwater noise, incidental bycatch and chemical pollution are the most prominent. These multiple, cumulative and often synergistic threats can jeopardize the objective to achieve and maintain the Favourable Conservation Status of the harbour porpoise in the North Sea and beyond. The earlier mentioned Framework for Assessing Ecological and Cumulative Effects (KEC) is an attempt at this, but focuses mainly on the construction of wind farms. A strategic, cross-sectoral and transboundary approach is required to effectively tackle these threats. Not only research on cumulative impact, but also other research can gain enormous value when carried out internationally, has been reiterated by the HPAC. International streamlining should be pursued, especially for establishing monitoring plans. Within the North Sea Agreement, a specific priority for research and monitoring are cumulative effects, as well as carrying capacity, besides nature restoration and species protection.

3.1.6.1 International cooperation on cumulative impacts

In 2016, North Sea countries signed a Political Declaration on energy cooperation as a follow-up of the Paris Climate Agreement. North Sea countries are now in the process of preparing Maritime Spatial Plans (MSPs), including offshore wind parks. It is known that the construction and operation of large-scale wind farms will affect the marine environment and other users of the North Sea. In order to understand cross-border cumulative effects of large scale wind farms, new arrangements must be made to foster a transparent, coherent evaluation system that applies to the entire North Sea. To do so, the EU co-funded SEANSE project (Strategic Environmental Assessment North Sea Energy) was carried out between 2018 - 2020. Project partners include planning authorities in the Netherlands, Germany, France, Scotland and Denmark.

The SEANSE project focused on developing a Common Environmental Assessment Framework (CEAF), through:

- Development of a coherent approach to SEAs, with a focus on renewable energy and testing it in practice through case studies;
- Creation of a coherent understanding of how and when to use this part of the SEA through knowledge transfer and information exchange;
- Demonstration of the benefits of the implementation of a coherent SEA approach for the preparation of national MSPs;
- Facilitation of the efficient implementation of the "Political Declaration on energy cooperation between the North Seas Countries".

Two main case studies were commissioned in which the CEAF-methodology was tested on 4 bird species and harbour porpoise:

- German-Dutch case study on the cumulative effects of North Sea wide offshore wind energy;
- Regional case study on the cumulative effects of offshore wind energy in East-Scotland.

Apart from the case studies an approach was developed for estimating (quantitatively) the relative contribution on the population development of the pressure of pile driving compared to other pressures on the Harbour porpoise population.

Suggestions for next steps are to improve the differentiation of underwater sound, improve the understanding of impacts of sound disturbance levels on the recipient and further compare model output from iPCoD and DEPONS through calculation studies.

OSPAR is working on a Quality Status Report 2023. OSPAR Quality Status (or Good Environmental Status under the MSFD) is assessed by a suite of indicators, linked to eleven descriptors. These indicators fit under two broad categories, those assessing biodiversity status (e.g. fish, seabirds, marine mammals) and those assessing the status of pressures from human activities (e.g. hazardous substances, underwater noise, litter). The Working group on cumulative impacts (ICG-EcoC) have developed a risk-based approach to cumulative effects assessment for use in the Quality Status Report 2023. The approach is designed to make the best use of available data and to complement the individual indicator assessments. As such, it provides an effective and efficient basis for the thematic assessments. advocate that the Drivers, Activities, Pressures, State, Impact, (Welfare), Response, (Measures) (DAPSI(W)R(M)) framework described by Elliot et al. 2017 neatly integrates the core components. ICG-EcoC have developed a DAPSI(W)R(M) schema (Figure 1) As such, the schema provides a graphical representation of the components required to deliver an OSPAR defined Ecosystem Approach, namely: "*the comprehensive integrated management of human activities based on the best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity*".

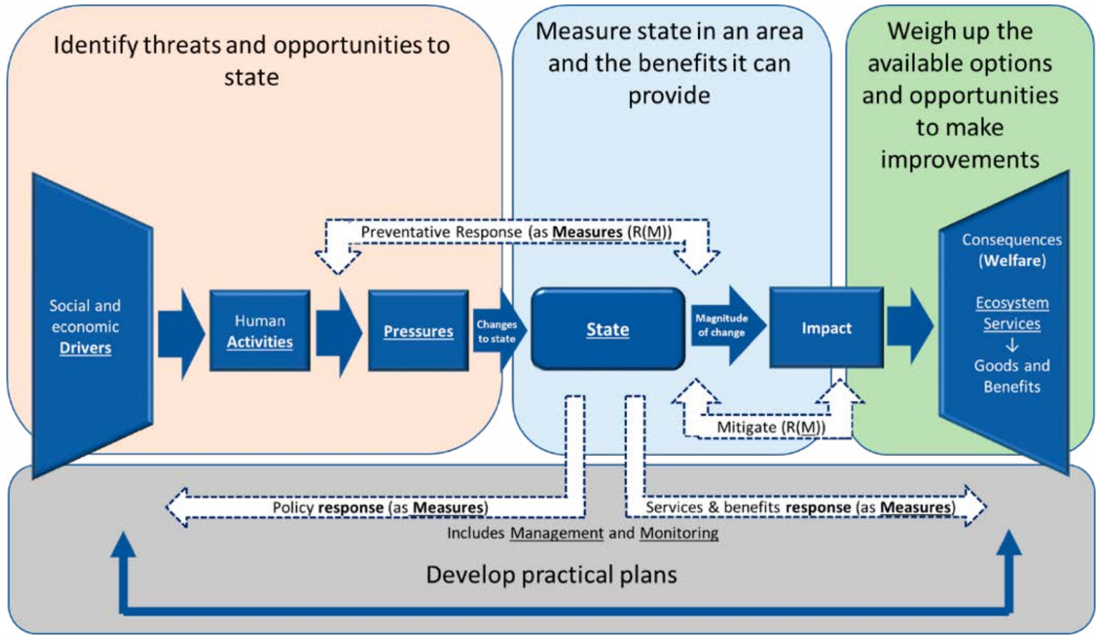


Figure 3.2 Recommended framework

ICG-EcoC have reviewed information contained in indicator assessment sheets and in Initial Assessment 2017 and is producing working drafts of DAPSI(W)R(M) including marine mammals (cetaceans) and underwater noise.

3.2 European Habitats Directive

The Habitats Directive remains a key legal instrument for the conservation of the harbour porpoise in the North Sea. It requires Member States to take measures to ensure that all animal and plant species of Community interest are maintained at or restored to a Favourable Conservation Status. This includes the harbour porpoise in Annex II ('Animal and plant species of Community interest whose conservation requires the designation of special areas of conservation') and the harbour porpoise and all other cetaceans, are listed as a group (Order Cetacea) in Annex IV ('Animal and plant species of Community interest which need to be strictly protected'). The Favourable Conservation Status is to be achieved through the adoption of generic species protection measures and the designation and protection of special areas of conservation (Natura 2000 sites) for the species.

3.2.1 Conservation Status harbour porpoise in the Netherlands

The Favourable Conservation Status of a species can be assessed at different levels (international, national, local), but needs to be achieved in any case by each Member State at a national level. The national conservation status of the harbour porpoise is reported every six years by the Member States under article 17 of the Habitats Directive. The status is assessed as being either 'favourable', 'unfavourable-inadequate', 'unfavourable-bad' or 'unknown', based on four parameters. For species these parameters are: range, population, habitat and future prospects. In 2013 the Netherlands reported the national conservation status of the harbour porpoise as unfavourable-inadequate, because it scored unfavourable-inadequate for the habitat of the species. The status is reported as favourable in the 2019 report of the Netherlands, with population, range and habitat assessed as favourable and future prospects for habitat and population assessed as unknown (figure 3.1). Another important factor is the trend compared to the previous assessments. The article 17 report is always based on the most recent data and expert judgement.

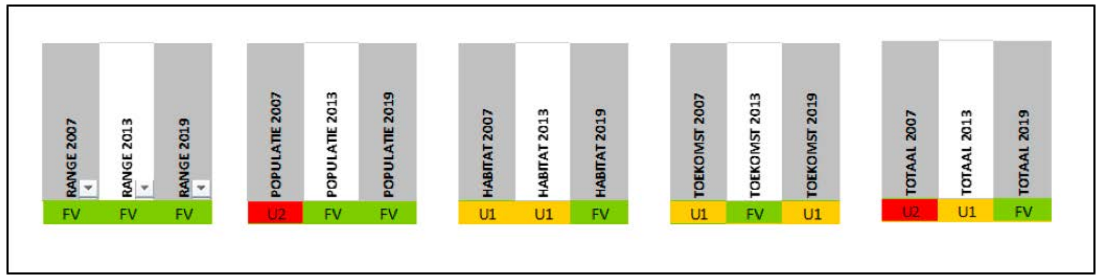


Figure 3.3. Article 17 assessment results for 2007, 2013 and 2019 for the four parameters range, population, habitat and future prospect, and a total score. Trends based on previous years are not listed here but are also an important factor in the assessment.

A brief summary and explanation for this assessment under the Habitats Directive is given here:

The range represents the entire Netherlands North Sea area, Wadden Sea and Delta waters as this species is a highly mobile species. This has not changed, therefore the trend is stable and favourable.

The population abundance estimate has also not changed significantly with regard to the previous assessment and is based on the latest national survey (Geelhoed 2017). The population is therefore considered favourable and stable with a population estimate range of 41300 and 76800 animals in the Dutch part of the North Sea. The most recent SCANS survey results show that the estimated population size of the North Sea harbour porpoise population has been stable over the last decades (Hammond, 2017).

Habitat is considered favourable if the area and quality of occupied habitat is sufficient (for long-term survival) and if there is a sufficiently large area of unoccupied habitat of suitable quality (for long-term survival). The habitat criterium scored unfavourable-inadequate in 2013 for harbour porpoise because the negative impact of underwater noise due to the planned offshore wind farm construction was deemed very large and there were also serious concerns about the impact of gillnet fisheries bycatch. Many developments have, however, suggested that the impact to date due to these activities is below levels that threaten the conservation status of the harbour porpoise. First, a large research project investigating the impact of offshore wind farm construction was established (see 8.2.2), resulting in the Framework for Assessing Ecological and Cumulative Effects, and its updated 3.0 version (2019). This showed that impacts of the current wind farms were less severe than previously assumed. Furthermore, a Sound Exposure Level (SEL) threshold level for wind farm construction was established, see Chapter 8. Secondly, the Remote Electronic Monitorig (REM) project on incidental bycatch in Dutch gillnet fisheries (see 7.2) showed that bycatch levels in this type of fisheries in the studied period (2013-2017) was much lower (0,3 % annual mortality for the Dutch commercial gillnet fisheries fleet of the Dutch harbour porpoise population in the 'worst case scenario') than expected. This was also substantiated by the discovery in 2013 that dead porpoises found with cuts and gashes had in fact been preyed on by grey seals and had not been bycaught as previously suggested. Notwithstanding the need that this type of research should be continued and preferably monitored structurally, it did provide enough information that the current levels of impact did not warrant an unfavourable status for the 2019 report. For more information on the results of this project and next steps, see Chapter 7.

The criteria: range, population and habitat are also scored with regard to their future prospect. For range this is considered favourable, as the North Sea region will remain the entire range of the species. Future prospect for the population is "unknown". National surveys show that, although relatively stable for the last 10 years, there has been considerable variability over time. In particular there is no clear explanation why densities in Dutch waters were very low thirty years ago but have been much higher in recent years. Future prospect for habitat is also "unknown", because the Dutch North Sea habitat is expected to see an enormous increase in offshore wind farms until 2030, but possibly also beyond that. It is still unknown what the impact will be on the habitat of the harbour porpoise. Wind farms might also offer opportunities for conservation and further study will be done on the behaviour of animals after construction compared to before.

The methodology of the Habitats Directive article 17 report is straightforward and, in the case of three favourable assessments (range, population and habitat) and one unknown (future prospect), concludes on an overall favourable status for the harbour porpoise in the Netherlands. The need to maintain a favourable status and the "unknown" assessment for future prospect, however, demonstrates why further research and monitoring on behaviour, distribution and impact of threats remains as needed as before.

3.2.2 Conservation status harbour porpoise in other countries

The conservation status of the harbour porpoise needs to be considered not only at the national level (i.e. marine areas that fall within the jurisdiction of the member state involved), but also at an international level in view of the fact that it is a transboundary species with a natural range that extends to the entire North Sea and adjacent waters. The overall conservation status of the harbour porpoise in the marine Atlantic region has been assessed as favourable on the basis of the species assessments contained in the national reports for the period 2013-2018 and is presented by the European Commission in October 2020. The trend for the species in the Atlantic region is also stable. The conservation status of the species is, however, assessed in several of the Member States in the region as unfavourable (Estonia, France, Germany, Portugal) or unknown (Belgium and the United Kingdom). Pressures and threats listed are small population size and degradation of habitat quality, disturbances due to offshore wind park construction, impact from fisheries and bycatch, pollution by a mix of contaminants and disturbances from increased shipping.

The Habitats Directive requires Member States to adopt the necessary measures to maintain or restore the populations of the species at a favourable status. Key measures are those involving the designation and management of protected areas and generic species protection.

3.3 Marine Strategy Framework Directive

The Marine Strategy Framework Directive (MSFD) establishes a legal framework within which Member States shall take the necessary measures to achieve or maintain good environmental status (GES) in the marine environment by the year 2020 at the latest. The conservation of the harbour porpoise is part of GES descriptor 1 contained in Annex I to the MSFD: "Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions." Other relevant descriptors include those dealing with commercial fish (descriptor 3), marine food webs (descriptor 4), contaminants (descriptor 8), contaminants in fish (descriptor 9), marine litter (descriptor 10) and underwater noise (descriptor 11). In 2017 the European Commission adopted a new decision containing detailed criteria and methodological standards for several descriptors of GES and specifications and standardised methods for monitoring and assessment that have to be used by the Member States.

Specific targets and measures to achieve GES are contained in the marine strategy that has to be developed and implemented within a six year cycle by each member state for its marine waters in close cooperation with neighbouring states in the respective region. The Netherlands adopted the first part of its marine strategy in 2012 (MinI&M 2012; initial assessment, determination of GES and establishment of environmental targets and associated indicators), which was revised and approved in 2018 (MinI&W 2018). The second part (monitoring programme) was adopted in 2014 (MinI&W 2014) and will be revised in 2020 (in press). The third part (programme of measures) was adopted in 2015 (MinI&M 2015) and will be revised in 2021. The Netherlands Marine Strategy contains specific targets for the harbour porpoise, which are aligned with the objectives and targets for the species under the OSPAR Convention, ASCOBANS and the Habitats Directive. The marine strategy refers to the Netherlands Conservation Plan for the harbour porpoise and several of the recommended actions contained therein.

3.3.1 Marine Strategy Part 1 – Harbour Porpoise

The first part of the Marine Strategy for the Dutch part of the North Sea was updated in 2018. The 2017 OSPAR Intermediate Assessment was used for identified common indicators, among which a number of indicators related to the harbour porpoise. The general conclusion for marine mammals was that the status is improving but good environmental status is not yet achieved. Here, a summary is given for the 2018 assessment on harbour porpoise indicators:

3.3.1.1 *Criterium D1C1*

The mortality rate per species from incidental bycatch is below levels which threaten the species, such that its long- term viability is ensured.

GES				
Bycatch of harbour porpoise is below 1 % of the best available abundance estimate (ASCOBANS/OSPAR).				
Indicator	**Threshold value**	**Value achieved**	**Conclusion**	**Additional policy assignment**
ICES estimate of the number of porpoises caught in fishing nets as % of best available abundance estimate in the North Sea	1 %	0,58 %	In the assessment a % lower than 1 was calculated	Potential (existing policy may not suffice) assignment: bycatch monitoring and research into the use of mitigating measures (pingers)

3.3.1.2 *Criterium D1C2*

The population abundance of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured.

GES				
Overarching: The population abundance and demographics of marine mammal populations are indicative of healthy populations				
Indicator	**Threshold value**	**Value achieved**	**Conclusion**	**Additional policy assignment**
OSPAR: Abundance and Distribution of Cetaceans in the Greater North Sea	At least stable numbers of harbour porpoise population	Small cetacean surveys in EU Altantic waters indicate stable population numbers (SCANS 1994, 2005 and 2016)	Although clear trends are not detectable from (SCANS 1994, 2005 and 2016), a southward shift has been demonstrated, making the Dutch part of the North Sea more important for the species	Potential (existing policy may not suffice) assignment: monitoring

GES				
Population of harbour porpoise on the Netherlands' part of the North Sea meets the Favourable Reference Value for Population (FRP) in the Habitats Directive Article 17 report				
Indicator	**Threshold value**	**Value achieved**	**Conclusion**	**Additional policy assignment**
FRP in the Habitats Directive	FRP (40000)	41300 (min) and 76800 (max)	In the 2019 Habitats Directive assessment a stable trend of above FRP was calculated	Potential (existing policy may not suffice) assignment: monitoring

3.3.1.3 *Criterium D1C4*

The species distributional range and, where relevant, pattern is in line with prevailing physiographic, geographic and climatic conditions.

GES				
Distribution of harbour porpoise on the Netherlands' part of the North Sea meets the Favourable Reference Value for Distribution Range (FRR) in the Habitats Directive Article 17 report				
Indicator	**Threshold value**	**Value achieved**	**Conclusion**	**Additional policy assignment**
FRR in the Habitats Directive	FRR (Dutch North Sea)	Dutch North Sea	In the 2019 Habitats Directive assessment FRR was achieved and stable	No

3.3.1.4 *Criterium D1C5*
The habitat for the species has the necessary extent and condition to support the different stages in the life history of the species.

GES				
Maintaining extent and quality of the habitat for harbour porpoise on the Netherlands' part of the North Sea in Habitats Directive article 17 report				
Indicator	**Threshold value**	**Value achieved**	**Conclusion**	**Additional policy assignment**
Maintaining extent and quality of the habitat for harbour porpoise (Habitats Directive)	Favourable status	Favourable status	In the 2019 Habitats Directive assessment a Favourable status was determined for habitat	Potential (existing policy may not suffice): preventing and reducing the harmful effects of underwater noise on porpoise populations

3.3.1.5 *Criterium D11C1*
Impulsive noise: distribution in time and space and levels of loud impulsive sound sources are such that the direct and indirect effects of loud impulsive sound do not threaten the Favourable Conservation Status of maintenance of species. The good environmental status for continuous sound is not yet known (no assessment method).

GES				
Impulsive noise: for harbour porpoises, reduction of population size is prevented by imposing a limit on the number of harbour porpoise disturbance days on the Netherlands' part of the North Sea.				
Indicator	**Threshold value**	**Value achieved**	**Conclusion**	**Additional policy assignment**
Number of porpoise disturbance days by impulsive noise	Under development	As yet, insufficient data are available for assessing the ecosystem effects of impulsive sound. On the basis of the precautionary principle, requirements are however already imposed on offshore construction activities.	Status in respect of impulsive sound is Improving.	Potential (existing policy may not suffice): preventing and reducing the harmful effects of underwater noise on porpoise populations

3.3.2 Marine Strategy Part 2 – Harbour Porpoise

As indicated before, the Marine Strategy part 2, the MSFD Monitoring Programme, has been revised in 2020. For harbour porpoise, the main conclusions are as follows: For the monitoring of cetaceans (D1C2), including harbour porpoise, OSPAR and ASCOBANS encourage of developing a SCANS survey programme for the entire North Sea with measurements once every six years. The Netherlands supplements this monitoring with surveys at DCS level. The surveys of harbour porpoises will be arranged differently (over the years and within a year) in order to produce a better estimate of the population.

The distribution (D1C4) of harbour porpoise has to comply with the Favourable Reference Range (FRR) in the Habitats Directive. Their distribution is monitored through the regular aerial surveys. As porpoises are very mobile and their occurrence changes within and between years the accuracy of the distribution assessment depends on the sampling effort. The current data shows that both the FRR and the distribution range of the species encompass the entire DCS as well as territorial waters, the Wadden Sea and the Delta Waters.

The extent and the condition of the habitats of marine mammals (D1C5) must be at least maintained. The assessment is linked to the article 17 reporting for the Habitats Directive. However, there is still considerable uncertainty regarding the quality of the habitats, mainly because the impact of various pressures, both now and in the future, is unknown. Studies are being carried out as part of a number of major projects, such as the Offshore Wind Ecological Programme (WOZEP), to increase knowledge of the effects of offshore wind farms. Also, there is a monitoring survey (for the Ministry of Agriculture, Nature and Food Quality) to ascertain the cause of death of a subset of stranded porpoises.

OSPAR has an indicator for incidental bycatch of porpoises. To deliver this indicator, demersal and pelagic fisheries are sampled yearly with 10 and 12 observer trips. In addition, per year also 10 trips are sampled with observers that operate with passive gear without pre-stratification to net type. Sampled fleets include vessels that fish with gillnets, fykes, lines and traps. This is however not a representative sample of the Dutch commercial bottom-set gill net fleet, as most vessels operating in this fleet are smaller than 15 meters. It should be noted that the DCF sampling design is primarily focused on commercial fish stock assessments, and is not necessarily adequate for assessing bycatch rates of sensitive species. ICES WGBYC did an analysis in 2020 in which the distribution of sampling effort in different métiers and area's was compared to sensitivity for bycatch of protected species(groups) and concluded (again) that gillnet fisheries is underrepresented (ICES, in press).

3.4 Common Fisheries Policy

One of the main threats to the conservation of the harbour porpoise in the North East Atlantic is incidental bycatch in fisheries (Bjørge & Moan 2017, Dolman et al. 2016, Peltier et al. 2016, ICES 2015, Reeves et al. 2013). Bycatch falls within the scope of article 12 of the EU Habitats Directive. Under the Common Fisheries Policy (CFP), bycatch mitigation and monitoring of cetaceans was explicitly dealt with in EU Regulation 812/2004; however, in an effort to simplify legislation, in April 2019 the European Parliament voted for Regulation 812/2004 to be repealed, and approved a new replacement Regulation, *Regulation on the conservation of fishery resources and the protection of marine ecosystems through technical measures* (2019/1241) (hereafter referred to as the Technical Measures Regulation). Bycatch of all protected species is addressed in this new Technical Measures Regulation 2019/1241 that prohibits catching these species and at the same time addresses the issue of incidental bycatch through monitoring and mitigation requirements.

The Technical Measures Regulation calls on Member States to develop on the basis of the best scientific advice mitigation measures to minimise, and where possible eliminate, the catches of specimens of protected species including the harbour porpoise. These measures are to ensure that incidental catches do not exceed 'levels provided for in Union legislation and international agreements that are binding on the Union' for these species. Currently, the only regionally agreed (non-binding) threshold is from ASCOBANS, which states that:
a. the general aim should be to minimize (i.e. ultimately to reduce to zero) anthropogenic removals (i.e. mortality), and in the short term, to restore and/or maintain biological or management units to/at 80 per cent or more of the carrying capacity;
b. in order to reach this objective, the intermediate precautionary aim is to reduce bycatch to less than 1 per cent of the best available population estimate;
c. a total anthropogenic removal (e.g. mortality from bycatch and vessel strikes) above 1.7 per cent of the best available estimate of abundance is to be considered unacceptable in the case of the harbour porpoise.

The Technical Measures Regulation includes a prohibition for vessels of 12 meters or more in overall length to use the specified fishing gear in the areas, for the periods, and as from the dates indicated therein without the simultaneous use of active Acoustic Deterrent Devices (ADD). For the North Sea this applies to any bottom-set gillnet or entangling net, or combination of these nets, the total length of which does not exceed 400 meters and any bottom-set gillnet or entangling net with a mesh size of 220 mm or more (this applies to so called 'tangle nets').[9] It is worth noting that most gillnets exceed 400 meters in length and are not required to have ADDs in the North Sea[10].

[9] Regulation 2019/1241, Annex XIII. Previously contained in Regulation 812/2004 laying down measures concerning incidental catches of cetaceans in fisheries.

[10] EU fisheries in the North Sea, specifically ICES sub-area 4 and ICES division 3a (only from 1 August to 31 October)

Additional mitigation measures (such as alternative gear or site specific limitations in high risk areas) are to be developed at a regional level for the reduction of incidental catches of the concerned species or in a concerned area and ultimately to be adopted by the European Commission on the basis of a 'joint recommendation' submitted by the Member States involved. These joint recommendations are expected to facilitate filling in the gaps in the existing mitigation measures and monitoring arrangements. Furthermore, the Technical Measures Regulation requires that monitoring schemes shall be undertaken on an annual basis[11] and established in countries for vessels flying their flag and with an overall length of 15 m or more to monitor cetacean bycatch although this is not required within the Dutch part of the North Sea according to the conditions defined in Annex XIII of the regulation.

Within the EU Data Collection Framework (Council Regulation 2017/1004) monitoring obligations are further specified. The Data Collection Framework establishes rules on the collection, management and use of biological, environmental, technical and socioeconomic data in the fisheries sector. It requires Member States to collect data to assess the impact of Union fisheries on the marine ecosystem in and outside Union waters, including data on bycatch of non-target species, in particular species protected under Union or international law, data on impacts of fisheries on marine habitats, including vulnerable marine areas, and data on impacts of fisheries on food webs.

Both requirements for monitoring and mitigation of the TMR remain of limited relevance for the Dutch fleet now, especially for the bottom-set gillnets, as the majority of these fishing vessels are smaller than 12 meters. Although the Netherlands could establish its own monitoring, it is recommended to align these monitoring programmes with neighbouring countries. This requires (joint) recommendations to the European Commission.

Finally, article 11(3) of the new Technical Measures Regulation provides the legal opportunity for fishermen to land bycaught animals for scientific research, which is one of the recommendations of this conservation plan. Reason for this is to get access to animals other than stranded along the Dutch coast to allow pathological investigation.

The monitoring and mitigation requirements under the CFP are in line with article 12(4) of the Habitats Directive. Compliance with the prohibition on deliberate capture or killing contained in article 12(1)(a) of the Habitats Directive may, however, still require that bycatch-prone fisheries are not allowed to take place without effective mitigation measures, unless there is clear and convincing objective evidence that bycatch does not occur.

3.5 US Marine Mammal Protection Act

It should also be noted that bycatch mitigation requirements comparable to the United States apply to all countries exporting fisheries products to the US. In 1972, they launched their Marine Mammal Protection Act (MMPA). It contains specific rules to address the problem of incidental mortality and serious injury of marine mammals in both domestic and foreign commercial fisheries. The Act includes bycatch requirements for all countries exporting fisheries products to the United States (effective since 1 January 2017). These rules establish conditions for evaluating a harvesting nation's regulatory program to address incidental bycatches and measures to address intentional mortality and serious injury of marine mammals in fisheries that export fish and fish products to the United. In practice, this means that countries had until May 2020 to update the US on their exporting fisheries, marine mammal stocks, where the two coincide, how this is monitored and which mitigation measures are taken. The Netherlands has reported five exporting fisheries: pelagic trawls in two regions, demersal trawls, bottom trawls for shrimp and gillnet fisheries. Only in pelagic trawls and gillnet fisheries very small numbers of bycatch have been reported. In pelagic trawls pingers are used as mitigation measure. Furthermore, countries should apply relevant fisheries for a so-called "comparability finding" by March 2021 and these comparability findings are then issued no later than November 2021. In 2022, all seafood exported to the US must have a comparability finding. In addition, the US have indicated that the ASCOBANS requirements are considered equivalent to theirs.

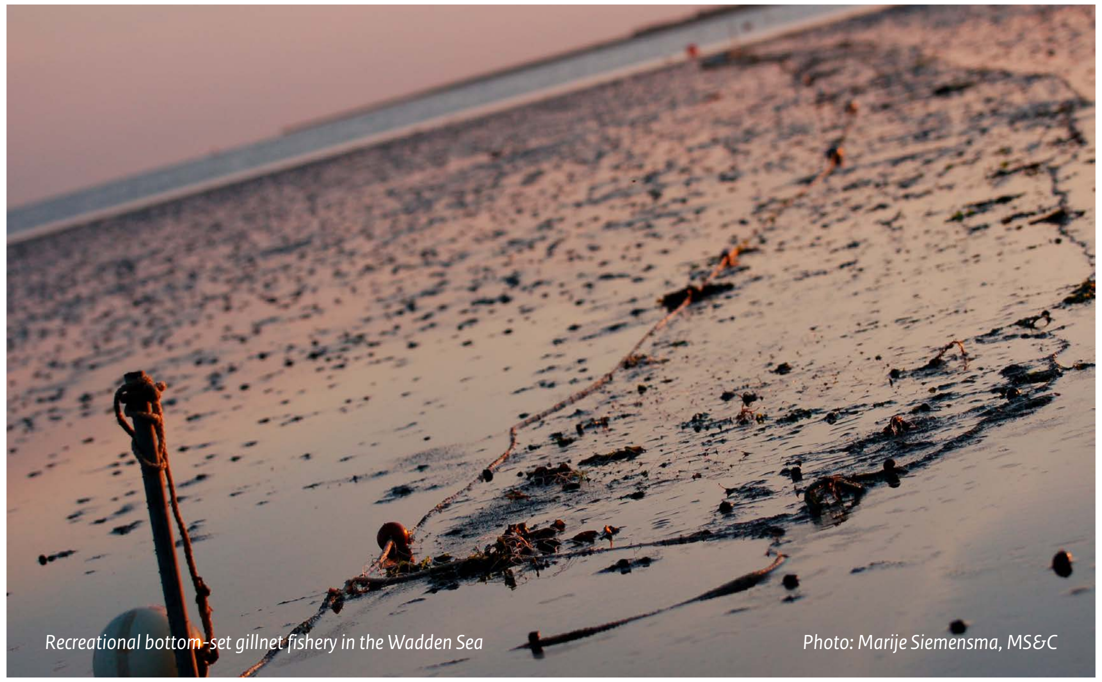
[11] The Commission shall report every three years on the implementation of Regulation 2019/1241 on the basis of national reports, including information on bycatch

3.6 Commercial gillnet fisheries in Natura 2000 sites

Management plans for Natura 2000 sites are legal instruments in which site-specific measures are worked out spatially and temporally. The management plans for the Natura 2000 area North Sea Coastal Zone 2016-2022 and Raan Flats 2016-2022 contain specific requirements for gillnet fisheries. These are limitations on net length, seasonal obligations for pinger use, area closures, the obligation to participate in the REM project (as a first step for monitoring bycatch) (Chapter 7) and other technical specifications. Management plans are developed following extensive processes, in which the impact of activities on the conservation status of listed species and habitats is assessed thoroughly. Also, stakeholders are consulted, informally as well as formally. For the next phase of Natura 2000 management plans relevant for the harbour porpoise it is recommended to agree similar, suitable measures with regards to gillnet fisheries, among which participating in a follow up monitoring programme. The results of the REM project should be taken into account for the evaluation of these management plans, as well as the conclusion that structural, extended monitoring is necessary across the fleet. Furthermore, the North Sea Agreement states that no new gillnet fisheries will be permitted in Natura 2000 sites.

3.7 Recreational gillnet fisheries

In the 2011 Harbour Porpoise Conservation Plan a complete ban on recreational gillnet fisheries was recommended, which was in effect from January 2011. However the House of Representatives asked to revise this policy in the light of cultural-historical reasons for coastal communities. Since January 2012 smallscale recreational gillnet fisheries is possible under certain conditions in the Western Scheldt and parts of the Wadden Sea (Staatscourant 2011). Since July 2012 it has been possible under certain conditions in the North Sea fishery zone of the following coastal municipalities: Schiermonnikoog, Ameland, Terschelling, Vlieland, Texel, Zijpe, Zandvoort, Katwijk and Westland (Staatscourant 2012). The management plan for the Natura2000 area North Sea Coastal Zone (2016-2022), also permits recreational gillnetting. One of the conditions is that a person has to notify this activity in advance in the concerning municipality. The municipality can provide a 'number' to a requesting person for the use of recreational gillnet fisheries within their territory. The total amount of issued numbers decreased from 716 in 2013 to 433 in 2019 (Van der Hammen & De Bruin 2020). The gear used has to be in compliance with the legal provisions in the Dutch Fisheries Implementing Regulation.



Recreational bottom-set gillnet fishery in the Wadden Sea *Photo: Marije Siemensma, MS&C*

For the above-mentioned North Sea municipalities this means: a maximum total net length of 50m, a maximum net height of 65cm, a simple (single walled) net type ('botwant'), placement between the high water and low water line and a maximum soak time of 24 hours and only one net per notified person. Since 1 January 2020 the European Commission prohibited the targeted recreational fisheries on European sea bass with fixed nets, under the Council Regulation (EU) 2020/123. Regular bycatch of harbour porpoises occurred in recreational gillnet fishery in Belgium (Haelters & Kerckhof 2004, Haelters et al. 2004). Since December 2001 the use of gill- and trammel nets in recreational fisheries of Belgium was banned below the low water mark (federal legislation). Due to the continuous bycatch of harbour porpoises in the intertidal zone and due to an infringement procedure by the European Commission, this fishery was also banned in the intertidal zone in 2015 (Flemish legislation). Since the ban in 2015 on the use of recreational gill- and tanglenets on the beach, the number of fresh stranded harbour porpoises diagnosed as having been bycaught has diminished, but regular efforts are being undertaken by recreational fishermen to lift the ban on this type of fishery.

3.8 International cooperation

Since harbour porpoises are wide-ranging, protection measures cannot only be coordinated on a national level. For the North Sea population all range states need to coordinate their conservatoin and monitoring measures. There is a variety of international conventions, agreements and action plans dealing with the protection and conservation of cetaceans. International treaties vary in scope, ranging from a multiple species level focus to regulation of specific habitats or species. They provide a framework for their contracting parties to adopt into national legislation. This consequently requires cooperation between other (EU) member states and in more detail cooperation and consultation between policy makers, scientists, stakeholders and the industrial sectors.

Most threats call for a national and international approach to be addressed and assessed. It is imperative that the problems caused by, for example marine litter and marine pollution should be addressed simultaneously at both national and international levels. This is also the case for addressing underwater noise and incidental bycatch in fishing gear. Within the framework of the MSFD Member states shall establish threshold values for levels of anthropogenic impulsive sound sources and continuous low-frequency sound that do not adversely affect populations of marine animals and the mortality rate from incidental bycath per species through regional or subregional cooperation.

3.8.1 ICES

There are several international working groups related to the conservation of harbour porpoises, although the focus is not always on porpoises in particular.

The International Council for the Exploration of the Sea (ICES) is an intergovernmental marine science organisation. ICES coordinates the work of around 150 expert groups that generate scientific knowledge and conduct the analyses that underpin ICES advice. Two such expert groups that are especially relevant for the harbour porpoise are: (1) The Working Group on Bycatch of Protected Species (WGBYC) that collates and assesses information on bycatch monitoring and assessment for protected species, including mammals, birds, turtles, and rare fish; (2) ICES Working Group on Marine Mammal Ecology (WGMME) that provides scientific advice in relation to marine mammals. Annually, WGMME examines any new information on population sizes, population structure and management frameworks for marine mammals and assesses how these can contribute to the regulatory requirements of Contracting Parties. It also reviews information on anthropogenic impacts, including their mitigation, with a focus on bycatch (and in this respect linking with WGBYC) and, in particular, marine industries.

3.8.2 OSPAR

The OSPAR Convention is the current legal instrument guiding regional cooperation on the protection of the marine environment of the North-East Atlantic. Work under the Convention is managed by the OSPAR Commission, made up of representatives of the Governments of 15 Contracting Parties and the European Commission, representing the European Union. As one of the four regional sea conventions in European waters[12], OSPAR works on developing indicators, targets and threshold values for MSFD implementation. In 2017 OSPAR published the Intermediate Assessment, which aimed to provide input on common indicators for the MSFD 2018 reporting. OSPAR re-convened the OSPAR Marine Mammal Expert Group (OMMEG) in 2018 aiming to (1) develop indicator, assessment and monitoring guidance for marine mammals so that they can be adopted and applied by OSPAR; (2) prepare OSPAR common biodiversity indicator assessments for the OSPAR Quality Status Report 2023 for implementation of the MSFD and (3), advise the BDC and other OSPAR bodies on gaps in the coverage of biodiversity indicators, including with respect to the implementation of the MSFD, and how to complete a representative set of biodiversity indicators. In 2020 OMMEG advised to OSPAR to include the harbour porpoise as an indicator for PCBs.

3.8.3 ASCOBANS

The Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) aims to promote close cooperation between countries with a view to achieving and maintaining a Favourable Conservation Status for small cetaceans throughout the Agreement Area. It consists of the Meeting of the Parties (MoP), the decision-making body which meets every three years, the Advisory Committee (AC) which meets every year when there is no MoP, and several regional groups, of which the North Sea Group is most relevant for the Netherlands. There are a large number of reporting requirements for ASCOBANS, and the yearly national reporting is therefore subdivided in different topics, to make it more manageable. ASCOBANS also has several relevant working groups, such as (1) Working group on noise and (2) a Joint ACCOBAMS/ASCOBANS bycatch working group. ASCOBANS developed three conservation plans for the harbour porpoise: (1) ASCOBANS Conservation plan Harbour Porpoises in the North Sea (Reijnders et al. 2009; (2) ASCOBANS Conservation plan for the Harbour Porpoise population in the Western Baltic, the Belt Sea and the Kattegat and (3) ASCOBANS Recovery Plan for Baltic Harbour Porpoises. In addition to the revision of the Dutch conservation plan, the HPAC suggests to align this plan with the next revision of the 2009 ASCOBANS North Sea conservation plan as well based on new insights and developments. In 2020, ASCOBANS published a special edition book on cetacean conservation: European Whales, Dolphins and Porpoises, Marine Mammal Conservation in Practice (Evans, 2020).

12 Together with the HELCOM Convention for the Baltic Sea, the Barcelona Convention for the Mediterranean and the Bucharest Convention for the Black Sea

3.9 Harbour Porpoise policy and management requirements

In conclusion, from a policy and management perspective there are many legal requirements for research, monitoring and assessment of the harbour porpoise in the Netherlands, which can also differ in scale. These requirements determine the priorities set for future harbour porpoise research and monitoring activities. A summary of these requirements is given in table 3.1.

1. International requirements	
a. EU – Habitats Directive:	i. Range = Dutch part of the North Sea;
	ii. (Trends in) population abundance (per reporting unit = Dutch North Sea, as part of the biogeographical region Marine Atlantic);
	iii. Habitat quality
	iv. (Future prospect
b. EU – MSFD:	i. Conservation status Habitats Directive
	ii. OSPAR indicator Cetacean Abundance and Distribution
	iii. OSPAR indicator Bycatch of Harbour Porpoise
c. EU – CFP: obligation monitoring bycatch	
d. ASCOBANS	i. Strandings and cause of death
	ii. Bycatch
2. Impact of anthropogenic activities in relation to licensing[13]	
a. Underwater noise – physical or behavioural	
b. Bycatch	
c. Chemical pollution	
d. Cumulative impact anthropogenic activities	

Table 3.1 Overview of legal and policy legislations.

3.10 Recommendations on policy and legislative context

- A strategic, cross-sectoral and transboundary approach is required to effectively tackle the most prominent threats. International cooperation and coordination of monitoring and research is strongly recommended, in particular regarding abundance, distribution, bycatch, pathology, health status, and contaminants but also in monitoring the cumulative impact of anthropogenic stressors, and assessing its impact and mitigation methods. When joint protocols for monitoring and research are established and followed, comparison of effort is possible, leading to more robust information at population level.
- Assess and address temporal and spatial cumulative impact of anthropogenic activities by continuing to invest in tackling this issue though modelling approaches and other available techniques, recognizing the challenge of quantifying cumulative impact. This can be taken up in the relevant existing programmes, such as WOZEP, but also in the new expert group on cumulative impacts under the North Sea Agreement Monitoring and Research programme (MONS).
- Consistent application and enforcement of the general species protection requirements (general prohibitions and derogations). This includes systematic monitoring of incidental capture or killing and the development of the necessary conservation measures.
- Consistent application and enforcement of the legal requirements for all Natura 2000 sites designated for the harbour porpoise. This comprises the adoption of specific conservation measures, if appropriate, and measures to prevent deterioration of the habitats and disturbance of the harbour porpoise, as well as the consistent application of the requirements for the assessment and authorization of plans and projects that can have significant negative effects on the harbour porpoise.
- Agree suitable measures for the next phase of Natura 2000 management plans relevant for the harbour porpoise.
- Develop at a national and international (joint) recommendations to the European Commission for additional monitoring and mitigation measures to address the limited applicability of current fisheries regulations requirements.
- Pursue streamlining this plan with the next revision of the 2009 ASCOBANS North Sea conservation plan as well based on new insights and developments.

[13] It should be noted that for the assessment of licensing activities, data should be used of maximum 5 years old. Furthermore, data can be needed on a finer scale than North Sea wide and per season. In the absence of seasonal distribution data, from a precautionary perspective, the most limiting numbers will be used. However, this will then not account for seasonal shifts.

4 Stakeholder consultation & engagement

The update of the harbour porpoise conservation plan was achieved following an extensive stakeholder consultation process. Actors from all identified stakeholder groups: scientific experts, NGOs, industry and government, have been invited for consultation and information in order to reflect the knowledge, expertise and commitment of all those stakeholders in this updated plan. It is recognised that the conservation of the harbour porpoise is only possible with the commitment of all these stakeholders. Not only management and science are important for safeguarding this species, but also to communicate and bring awareness to the general public. Several education and outreach initiatives are running to engage the general public with the harbour porpoise and its conservation.

Photo: Annemieke Podt, Stichting Rugvin

4.1 Harbour Porpoise Scientific Advisory Committee

The Harbour Porpoise Scientific Advisory Committee (hereafter the HPAC), established in 2015, provided both informal independent advice as well as a formal independent advice on the final draft throughout the process. The advice of the HPAC has been incorporated into this version of the plan (Van der Meer et al. 2016, 2019, 2020). The task of the HPAC was defined as to provide advice and direction to research programming, based on executed research and recent insights and developments.

4.2 Stakeholder process

The involvement of stakeholders in the process of creating a species conservation plan for the harbour porpoise in Dutch waters has been of significant relevance of the process. Most, if not all identified stakeholder groups have been consulted.

NGOs have been asked to give a joint vision on harbour porpoise conservation. Their suggestions have been considered in the recommendations. A wider consultation was done among all stakeholders, both at national and at international level, including the ASCOBANS North Sea Group, from 25 June until 1 August 2020. The North Sea Agreement members were also consulted on this harbour porpoise conservation plan from 25 June 2020 until 1 August 2020. All comments were assessed and responded to and an overview was sent to all stakeholders for transparency. 14 October an ad hoc expert meeting was held with the North Sea Agreement members. In this meeting several concrete measures specifically for bycatch and underwater noise were discussed, proposed by the NGOs. On 15 October the plan was approved by the Interdepartmental Directors Group North Sea (IDON) and on 21 October the plan was agreed to go forward by the North Sea Agreement partners.

The ministries of Agriculture, Nature and Food Quality (LNV), Defence (Def), Infrastructure & Water Management (I&W), Ministry of Economic Affairs and Climate Policy (EZK) were involved throughout the writing process, and together with a group of scientific experts, have substantially contributed to this plan through providing content and through structural editing.

4.2.1 Expert consultation

A series of expert meetings (6) have been held between March 2019 and November 2019. Invited experts included scientists and representatives from the relevant ministries, the Netherlands working group on underwater noise, industry and non-governmental organisations. The following topics were covered by these expert meetings: population status and ecology (including diet), strandings- and contaminants research, underwater noise and cooperation with the fisheries sector related to incidental bycatch. The input from, and discussions at these meetings were the foundation for the recommendations of this plan.
In addition to this, an overview (Dotinga 2020) has been composed by a legal expert on recent legal developments and the (potential) implications for the conservation of harbour porpoises.
The ASCOBANS North Sea expert group has been consulted for advice, feedback and proof-reading as well as a number of relevant international experts.

4.2.2 Stakeholder meeting

In October 2015 a stakeholder meeting (Bruinvisdag Groeneveld) was organised aiming to inform stakeholders on the state of the art of the implementation in 2015 and to collect input from the attendees to the ministry for future actions for the conservation of harbour porpoises in Dutch waters.

A draft of the recommendations for the updated plan was presented at a comprehensive stakeholder day (Bruinvisdag Teylers, November 22nd, 2019). All relevant national stakeholders were invited to attend. Focus of this meeting was to both inform the stakeholders about latest findings and developments and to get feedback, both during the meeting and in writing, on the proposed recommendations. All stakeholders were given the opportunity to comment in writing on the draft recommendations and also on the draft conservation plan.

4.2.3 International networking event 2020/2021

A networking event will be organised[14] in collaboration with the EU Natura 2000 Biogeographical Process with the purpose to promote and enhance the exchange of expertise and knowledge between policy makers and experts

[14] Expected spring 2021

involved with harbour porpoise conservation in the North East Atlantic. Discussing the prioritized needs for action in terms of both research and policy matters is one of the main topics of this workshop. With an overall objective to achieve an integrated management and research approach for the conservation of migratory species, in this case, the harbour porpoise.

4.3 Education and outreach

Several Dutch organisations (SOS Dolfijn, WWF, EUCC, Rugvin Foundation, North Sea Foundation & IVN) address the conservation of the harbour porpoise through a variety of activities such as a teaching materials or other educational presentations, leaflets or listening stations for porpoises on land, such as Studio Bruinvis. In 2020 a digital brochure written by Rugvin Foundation and commissioned by WWF about the harbour porpoise in the North Sea was published. Such initiatives are welcomed and highly encouraged as they can inform a broad audience on porpoises and the threats they face.
Although not very common in the Netherlands, there are some locations where porpoise watching tours are organised. The IWC launched its Whale Watching Handbook in 2018, an extensive online resource for managers, regulators, operators and anyone interested in whale watching. It incorporates international best practice, educational resources and a summary of the latest, relevant scientific information. Studio Bruinvis is listed as a successful case study to inform the public.

Studio Porpoise information pillar
Photo:Frank Zanderink, Stichting Rugvin

4.4 Recommendations on stakeholder consultation & engagement

- Continue the work of the Harbour Porpoise Advisory Committee fulfilling a role as an (inter)national scientific independent steering group, preferably including quality control of research proposals and independent peer review of project results and publications.
- Keep informing and interacting with all relevant stakeholders, amongst other within the North Sea Agreement platform.
- Encourage and or welcome initiatives that communicate and educate the general public, including children, about the harbour porpoise.
- Organise a networking event in collaboration with the EU Natura 2000 Biogeographical Process.

5 Population ecology, abundance & distribution

There are different approaches to find answers and to obtain reliable and unbiased data on the population status and ecology of porpoises. Not all methods will provide the same level of accuracy of information, and they will differ greatly in cost. Dedicated survey programmes are valuable. In the Netherlands, different types of surveys are done, from voluntary land based and ferry line surveys, to dedicated aerial surveys, either specifically for cetaceans (international SCANS and national SCANS-like surveys, which feed into the earlier mentioned OSPAR/MSFD abundance indicator) or for marine birds, in which cetaceans are monitored additionally (MWTL). But survey programmes are limited to the extent of information they can provide on habitat use and trophic relationships. In this chapter the latest developments and recommendations for future monitoring and research are given for population status and ecology, based on the legal requirements given in Chapter 3.


Photo: Annemieke Podt, Stichting Rugvin

5.1 Population ecology

5.1.1 Harbour porpoise ecology

Harbour porpoises in the European waters inhabit mostly relatively shallow sea areas, often in habitats characterized by high diversity and complexity in terms of bathymetry, substrate, oceanography, and resources (Fontaine 1998, Bowen & Siniff 1999, Bjørge 2003, Lockyer et al. 2003, Booth et al. 2013, IJsseldijk et al. 2015, Waggitt et al. 2017). Their trophic position may vary seasonally (e.g. seasonal and between-year fluctuations in the relative importance of predator and prey species), spatially (between regions and/or between habitats) and with age (Aarefjord et al. 1995, Santos 1998, Das et al. 2003, Gilles 2003, Lockyer & Kinze 2003, Skov & Thomsen 2008, Marubini et al. 2009, Booth 2010, Sveegaard et al. 2012, Jansen 2013, Leopold 2015) and should perhaps best be studied within a context of other predators (e.g. Etnier & Fowler 2005, MacLeod et al. 2006). Habitat use often shows diurnal or tidal rhythms or patterns, causing uncertainty as to where preferred areas for porpoises may be located (Johnston et al. 1997, Goodwin 2008, IJsseldijk et al. 2015, Zein et al. 2019). Bjørge (2003) suggested rightly that caution is needed when extrapolating knowledge from one area to another with regard to porpoise habitat use, given reported differences in habitat characteristics available to harbour porpoises in different parts of the European shelf seas and reported differences in prey choice between areas, seasonally, or when historical information is compared with more recent data (Verwey 1932, Rae 1965, 1973, Schulze 1987, Lick 1991, Robineau et al. 1995, Gilles 2003, Santos & Pierce 2003, Santos et al. 2004, Leopold 2015).

Gilles (2003) described the harbour porpoise as 'an important top predator and as such an indicator species for its environment' in German waters. From a management perspective a porpoise can be an indicator for the environmental status, both for ecological changes, such as climate change, shift in prey distribution, as changes due to anthropogenic activities (noise, contaminants, bycatch etc). In this section we focus on the position of the harbour porpoise in the ecosystem. While porpoises (as most marine predators) tend to eat prey types that are locally, and abundantly available, they probably select prey that is suitable given their own age- or size-specific requirements. Within any one area, different trophic positions may be occupied by conspecifics of different age, sex, size, or even preference. The energetic requirements of adult porpoises will probably vary throughout the reproductive cycle and the animals may (need to) move to elsewhere or switch prey when they can to accommodate their needs. Leopold (2015) reported, based on stomach content from individuals found along the Dutch coast, that young immature harbour porpoises in the southern North Sea tend to feed on small prey (here small gobies), while gradually switching to larger fish (here often whiting) when they mature and thereby increase in size.

Few studies have been conducted in which aspects like habitat characteristics and preferences, prey selection and predation risks were evaluated simultaneously within a context of harbour porpoise migratory movements and annual life cycle (Baines & Earl 2001, Fontaine *et al.* 2007, Hall 2011). Harbour porpoise feeding ecology, or some understanding of this, is traditionally derived from strandings programmes (González et al. 1994, Pierrepont et al. 2005, Rogan 2009, Leopold 2015), occasionally from animals kept in captivity (Andersen 1965, Kastelein et al. 1997), or from bycaught individuals (Vikingsson et al. 2003). Each of these data sets may be biased in some way or another, and it is not always clear how representative the data are for the area overseen, or the period covered, or for the population at large.

There is some evidence for seasonal movement patterns of harbour porpoises throughout the North Sea and elsewhere in the North Atlantic area (Read & Westgate 1997, Gilles 2003, Teilmann et al. 2004, Nielsen et al. 2018). Recent tracking data in Nielsen et al. (2018) have yielded most insightful and detailed information on habitat use, (diving) behaviour, dive depth, and the timing of movements, including individual specific behavioural changes. Tracking data in Wisniewska et al. (2016) provide insight in foraging rates and prey selection. In addition to this, evidence seems to exist for specialised feeding strategies with a focus on either benthic or pelagic prey and with a clear response to (local) oceanographical patterns, habitat characteristics, tidal and diurnal rhythms (Linnenschmidt et al. 2013). Furthermore, prey selection appears to be specific for the animals needs and/or capacities at least in part driven by patterns and trends in local availability (see the numerous earlier references on habitat characteristics and diets, Teilmann et al. 2007, Nielsen et al. 2018).

5.1.2 Need for more integrated ecological studies in offshore waters

A strong emphasis on the coastal appearances of harbour porpoises in the Netherlands (sightings as well as strandings) will not provide the information needed to help understand the specific conditions that porpoise require to live, and successfully reproduce in the southern North Sea. Aerial surveys are limited in yielding all the needed information on habitat characteristics throughout the annual cycle, on multi-species interactions and on foraging activities needed to understand the species' whereabouts and movements throughout the annual cycle. The harbour porpoise is an integrated component of complex food webs, interacting with multiple species. To understand their role in the ecosystem it is important not to focus on them in isolation. In some areas, harbour porpoises face the risk of predation or attack by for example grey seals *Halichoerus grypus* (Leopold 2015, Deaville et al. 2019), in other parts of the North Sea of bottlenose dolphins *Tursiops truncatus* (Ross & Wilson 1996, Deaville et al. 2019). From detailed multi-species observations highlighting (joint or separated) foraging activities throughout the annual cycle and in contrasting areas we might start to understand where and how harbour porpoises share resources with other predators. When linked to the appropriate diet studies, or otherwise inferred from the observed behaviour (e.g. water column feeding on pelagic prey versus bottom feeding on demersal prey), we may become able to link their abundance or absence to particular resources known from fisheries research or otherwise. Tracking studies (cf. Linnenschmidt et al. 2013) could greatly enhance our insight, for diving activities and whereabouts would become much better known. (Passive) acoustic monitoring could shed further light on temporal patterns in overall abundance, foraging behaviour or the use of high-density areas of harbour porpoises found by satellite tracking or visual surveys (Fisher et al. 2003, Sveegaard et al. 2011, Gallus et al. 2012, Augustijns 2018, Buyse 2018). See also the section on Harbour porpoise ecology and on Technical monitoring and research methodologies (paragraph 5.5). To understand what determines the population size and fluctuations therein knowledge is not only required of external limiting factors (prey availability, predation, parasites and anthropogenic activities), but of demographic parameters determining life history (reproduction, mortality, growth rate) as well. Porpoises should be studied in an ecological context and it is vital to understanding their foraging behaviour to also explain observed distribution patterns. Therefore, we need to include prey data (and to that feeding aggregations with known prey can maybe contribute) when modelling porpoise behaviour and occurrence.

5.1.3 Food availability and diet

Ultimately, both population size and health status are governed by food availability and the quality of that food. Both availability and quality have been reiterated as a recurring knowledge gap. Studies on the foraging ecology of harbour porpoises in the Southern North Sea were recommended repeatedly to shed more light on prey availability and resources (Camphuysen & Siemensma 2011, Siemensma & Scheidat 2015, Van der Meer et al. 2016, 2019, 2020, Bruinvisdag Groeneveld 2015), and should be part of more integrated ecological studies as elaborated in the paragraphs on harbour porpoise ecology.

The body mass of harbour porpoises is relatively small in comparison with their surface area. Because of this small volume to surface ratio, they lose relatively large amounts of body heat (energy) and this needs to be compensated by a large and frequent energy uptake (Kastelein et al. 1997, 2019).

To ensure their survival harbour porpoises are capable of extremely high feeding rates (Wisniewska et al. 2016, Hoekendijk et al. 2017 in Kastelein et al. 2019). Depending on food availability, even a small decrease in the foraging efficiency of a harbour porpoise due to e.g., an anthropogenic acoustic disturbance (see Chapter 8), may have negative effects on that animal's fitness. There are indications that higher parasite load associates with poorer nutritional condition (ten Doeschate et al. 2017) although there are confounding effects of age. Results from post-mortem examinations of Dutch porpoises from 2009-2013 show both infectious diseases as well as emaciation as one of the main categories of cause of death (Begeman et al. 2014) and based on post-mortem examinations from 2019, infectious diseases where the highest category of cause of death (30 %, IJsseldijk et al. 2020).

Research on animals in captivity has proven valuable to better understand the biology of the species. To improve knowledge on the impact of a decreased foraging efficiency, Kastelein et al. (2019) studied the effect of near-fasting for 24 hours with two animals, showing a decline in body mass (an indicator of body condition) in all near-fasting periods of approximately 4 % of initial body mass and small decreases in blubber thickness (0-3 mm). Mass loss was greatest overall in autumn, lowest in summer (for one tested porpoise) or winter (for the other tested porpoise). The mass losses however after a 24-h near fasting period are in themselves unlikely to result in declines in fitness of an animal in good condition. However, repeated disturbances may have negative effects on fitness or the effects of fasting due to disturbance by anthropogenic activities such as noise, may be more severe in animals with less than optimal body condition, and for animals that cannot avoid disturbance. Information from this study can be used to help inform models such as the PCoD model (King et al. 2015, Pirotta et al. 2018) and the DEPONS model (Nabe-Nielsen et al. 2014, 2018), which were developed to estimate population effects of disturbance for marine mammals (see Chapter 8). Information on marine mammal energetics contributes to define parameters affecting the vital rates (birth and death rates). The development of an energy budget model for harbour porpoise would allow for quantification of the effect of (repeated) fasting periods on individual fitness. Using such a model, the population level consequences of fasting could also be determined. More general, the effect of disturbances that lead to changes in food intake and/or energetic costs could be quantified with an energy budget model of the harbour porpoise (e.g. Soudijn et al. 2020, Hin et al. 2019).

As porpoises need a large energy intake, they need both bulk and high-quality prey, e.g., fatty fish (e.g. Leopold 2015). Leopold (2015) studied the diet of stranded harbour porpoises on the Dutch coast. This sampling of porpoises likely is biased towards porpoises living in nearshore waters as these have the highest probability of stranding after they die. Leopold showed that in the Southern North Sea, porpoises eat mostly small gobies while they are still young, and gradually switch to eating larger whiting when they grow older and larger. Both gobies and whiting are lean prey that seem rather unsuitable prey for a predator that needs a high-calory diet. In the Netherlands, porpoises supplement these dominant prey species with some fatty fish, like sandeels and clupeids, but only healthy porpoises appear able to do this: these preys are only rarely found in weaker (sick, emaciated) individuals. Porpoises tend to eat prey types that are locally, and abundantly available. For instance, in estuaries and rivers, smelts are taken relatively often. Porpoises that appeared to be caught (by grey seals or set-nets) near the seafloor had more demersal prey in their stomachs than seal victims killed higher in the water column (Leopold et al. 2015). However, some prey, like juvenile flatfish, are not often consumed, and clupeids and sandeels are taken to a much lower extent by porpoises than by fish-eating seabirds, feeding in the same waters. In contrast, gobies and whiting seem preferred prey. Gobies might be easy food, as these are taken in massive quantities (several thousands per porpoise per day). Whiting is an enigma, in that the stock is very low, while it is a dominant prey species for adult porpoises.

While stomach content can provide information on a species' most recent meals, stable isotopes and fatty acids can be used to investigate long-term diet. Jansen (2013) described the past and present feeding ecology of harbour porpoise in Dutch coastal waters and investigated whether changes in abundance and relative distribution of porpoises reflect changes in their food base. Analysis of stomach content, stable isotopes and fatty acids were combined to providing the most detailed description of their diet in time and space, elucidating differences between their short- and longer-term diet. Stable isotope analysis showed that 70-83 % of the diet of porpoises consisted mainly of poor cod, mackerel, greater sandeel, lesser sandeel, sprat and gobies. This highlights a higher importance of pelagic, schooling species in the porpoises' diet compared to stomach content, where 90.5 % of the diet consisted of gobies, whiting, lesser sandeel, herring, cod and sprat. In offshore waters porpoises thus may feed on pelagic, schooling species, while closer to shore they feed on more benthic and demersal species shortly before they strand. This could be due to the distribution of prey species as well as differences in behaviour of porpoises and their prey between the coastal zone and offshore waters. Similar differences were found comparing Quantitative Fatty Acid Analysis (QFASA) with stomach content, which revealed that the longer-term diet of porpoises in Dutch coastal waters consists both of coastal species (e.g. gobies, smelt and dragonet) and also pelagic, schooling species (e.g. mackerel and herring). Jansen demonstrated that using indirect methods for studying the feeding ecology of marine mammals is a valuable addition to the more direct approach using stomach content. It supports the need for multi-method approaches because by using only one technique, key prey species in the predator-prey relation may be missed or underestimated. It is therefore recommended to compare data from stomach analyses (recent meals) with other methods such as fatty acids and stable isotope studies (diet up to several weeks; Jansen 2013) to assess the diet of harbour porpoises.

Questions remain related to these insights on prey composition, such as why porpoises moved in large numbers to the southern North Sea, what onsets differences in short- and long-term diet, are current prey stocks sufficient and what are the repercussions of low fish stock sizes (of critical prey species) for porpoise vital rates. Note that pregnancy rates in porpoises in the southern North Sea appear to be lower than in other areas like east-Canada and Iceland, but similar to pregnancy rates reported for the UK, which may be a reflection of the relatively lean diet here (unpublished data, Utrecht University and Wageningen Marine Research, see also 5.1.4).

As diet composition studies in the Netherlands so far are based on the analysis of stranded dead harbour porpoises, a knowledge gap is to examine animals that died offshore. A pilot study with three fishing vessels was therefore initiated in 2019, in which fishermen could retain dead porpoises caught in their net for post-mortem examination and diet studies. As this situation occurs very rarely, this has to date not delivered any new results (see Chapter 6). Fishermen participating in the Remote Electronic Monitoring (REM) study landed several animals. These were post-mortem examined, and samples for diet studies were collected (Chapter 7, Scheidat et al. 2018).

In conclusion, it is important when monitoring diet, to link this to relevant fish stocks and porpoise condition, if we are to understand how porpoises function in our waters. For this the distribution of the most important prey species of the harbour porpoise at the DCS at least, but preferably at a wider scale, as well as their seasonal and annual distribution trend should be mapped, which is also recommended by the HPAC. A study of this complex problem by Ransijn et al. (2019) attempted to describe the spatio-temporal energetic availability of different prey species to harbour porpoises in the North Sea. Overall, large amounts of prey energy are predicted to be available both within and outside the Southern North Sea Special Area of Conservation boundary. However the authors state that the energy predicted may not correlate to the actual available energy for porpoises given the role of other marine predators and the fishing industry present in the North Sea. The fact that gobies have not been included in this study, might be a factor that can explain the difference between predicted and available energy.

In addition, as mentioned, direct observations at sea can add to provide a better insight into the foraging ecology of the harbour porpoise.

Finally, it is recommended to explore whether this type of information (diet, pregnancy rates, prey species distribution) can be captured in an indicator for either habitat quality or food webs in the Habitats Directive or MSFD.

5.1.4 Life history parameters

Pathological research on stranded animals cannot only determine an animal's most likely cause of death, but also offers valuable insight in life history parameters (pregnancy rate, age distribution, age of sexual maturity growth, and mortality rate) - which are vital to assess the status of a population - health status, diet composition and contaminant load (see Chapter 6). These parameters are necessary input for population models to predict population development, including when impacted by anthropogenic activities. It is not clear how representative the data from stranded animals is for the entire population, as these animals seem to be a subset of weaker animals, of a subset of animals closer to the coast. This is why efforts are needed to get access to offshore animals and bycaught animals or grey seal victims as they presumably acutely died (Haelters et al. 2012, Leopold et al. 2014, Van Bleijswijk et al. 2014). While there might also be a bias in what animals get caught in nets or fall prey to grey seals, the comparison could provide a more representative sample of the population than stranding events.

A preliminary exploration by IJsseldijk (in prep) of stranded adult females (n=~270) allowed assessment of pregnancy rates and foetal growth (n=~50). This indicated two major concerns: low pregnancy rates and foetal growth influenced by health condition of their mothers and the general diet (unpublished data, Utrecht University and Wageningen Marine Research). This topic needs further investigation, which is important as pregnancy rates and foetal growth directly influence population numbers. Therefore further investigation, combining pathology and diet with other parameters, such as contaminants, is recommended. Several studies (Murphy et al. 2015, 2018) indicate that there is a link between contaminants (PCBs) and reduced reproductive success in porpoises. See also section 6.3.1.

5.1.5 Genetics

Studying the genomes of porpoises offers the opportunity to learn more about what distinctions in (sub) populations there are and how populations have evolved over many years. In the North Atlantic and adjacent waters, genetic analyses revealed three distinct genetic clusters or subspecies of Harbour Porpoise *Phocoena phocoena*, i.e. (1) *P. p. relicta* in the Black Sea, (2) *P. p. phocoena* continuously distributed in continental shelf waters across the entire North Atlantic from the East coast of North America through Iceland, Norway, the British Isles, North and Baltic Sea to the northern Bay of Biscay, and (3) *P. p. merridionalis* inhabiting Iberian and Mauritanian waters (Rosel et al. 1999; Fontaine et al. 2014; 2017). Further studies by Fontaine (NE Atlantic) and Chehida (North Atlantic) demonstrated that these populations form a long range where individuals geographically closer to each other are genetically more similar, which is often seen in populations with a large geographical distribution (Fontaine et al. 2007; 2017; Chehida et al. 2020). This is called isolation by distance (IBD).

The North Sea out of the Netherlands belongs to ICES areas IVb and Ivc, which – in the context of harbour porpoise population assessment – is part of the greater North Sea assessment area (NAMMCO & IMR 2019). Studies assessing the fine-scale population genetic structure in the North Sea, including the Dutch coast, showed that at the local scale of the Dutch waters, porpoises are part of a broader interconnected system of populations (called demes). Nevertheless, porpoises from the southern North Sea and Channel are at the border of a contact zone between the two Atlantic sub-species – the continental shelf porpoises *P. p. phocoena* and the southern porpoises associated with the Iberian upwellings *P. p. merridionalis*. The subspecies meet and breed and can produce hybrid offspring, in a sharply delimited area, extending from the Bay of Biscay to the Irish and Celtic Seas and within the

Channel on the Atlantic side (Fontaine et al. (2017); Figure 3.1). Such hybrid zones can inform on how species are responding to climate driven environmental changes (Taylor et al. 2015). Therefore, harbour porpoises in European waters have become a model system to study how top marine predators are responding to climate changes.

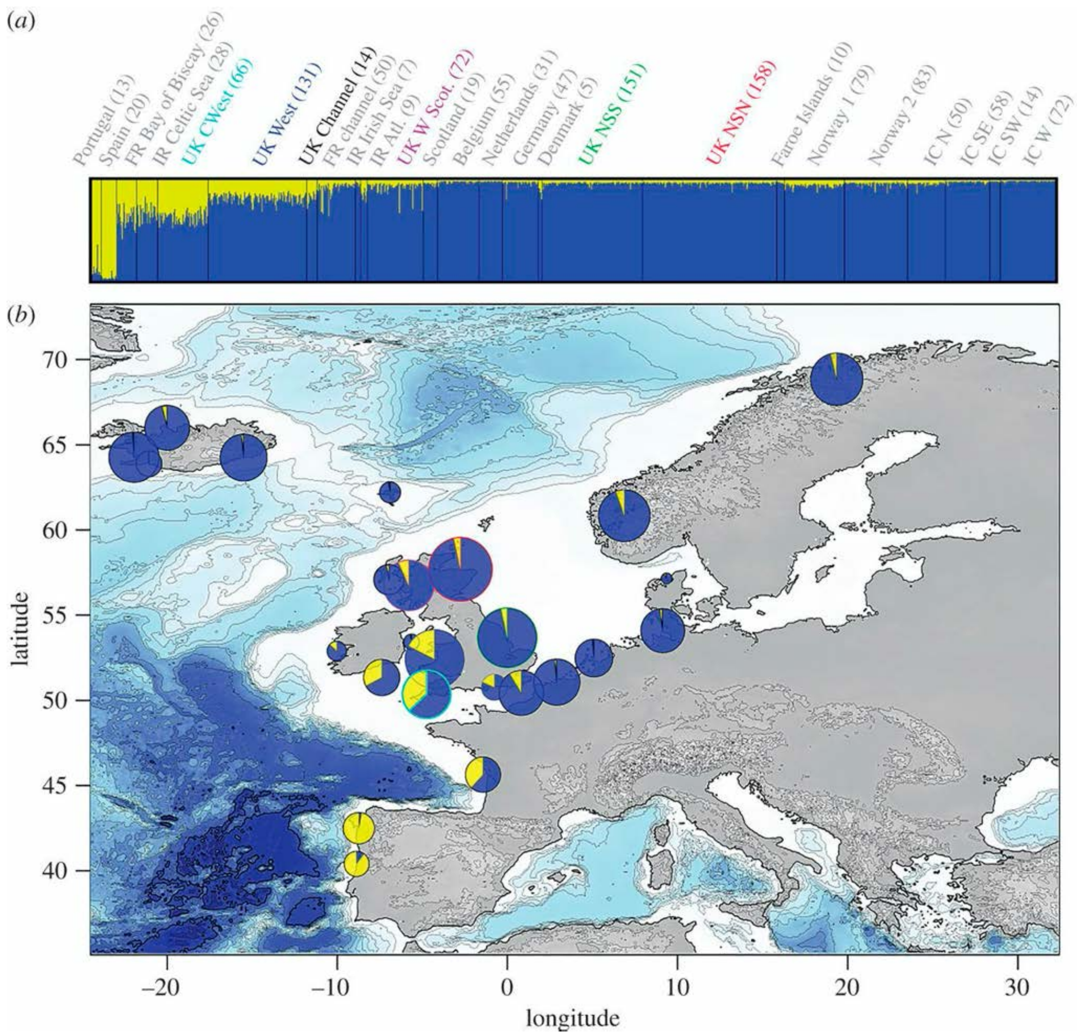


Figure 5.1. Genetic ancestry for each individual porpoise estimated based on the microsatellite data.
(a) Each vertical line in the bar plot represents an individual porpoise. The fraction of the individual genetic ancestry from the Iberian population of P. p. meridionalis and from P. p. phocoena are represented in yellow and blue, respectively.
(b) Map of the genetic ancestry proportions averaged for local geographic groups (Figure from Fontaine et al. 2017).

Another study is currently looking at whether the genetic structure had changed over the past 30 years. Combined datasets of in total ~2500 porpoises (two groups from 1990-2000 and 2005-2018) were used. Using information from whole genome sequences from each known sub-species of Harbour porpoises in the North Atlantic and North Pacific, a genetic assay was designed with which ~300 SNP genetic markers can be screened (Chehida et al. in prep). These markers are picked because these genetic variants are diagnostic for the subpopulations, therefore facilitating the assignment of animals to different genetic clusters. The panel has been successfully used to assess population genetic structure of ~500 porpoises along the NE Pacific coasts (Morin et al. 2020a). The analyses of the European data are ongoing and submission of the manuscript is expected in 2020-21.
The use of such 'SNP panels' improves the statistical power to assign individuals to genetic clusters and detect subtle population structure when it exists (Lah et al. 2016). Applications of SNPs in harbour porpoises have also shown that this type of markers can be more reliably applied to degraded samples (Morin et al. 2020a). Two SNP panels are thus currently available for North Atlantic porpoises. The one described was developed by Morin and

Fontaine (Morin et al. 2020a) and is informative to resolve the population structure and evolutionary history among populations within and between sub-species in the Atlantic and Pacific. The second panel by Autenrieth and Tiedemann is primarily informative on genetic structure within the *P. p. phocoena* subspecies (Autenrieth et al. in prep.) and contains a different set of genetic markers. Ultimately, the combination of these two SNP panels is desirable as well as the inclusion of Dutch samples into these efforts in order to contribute to a high resolution of population structure within the greater North Sea area in general and in Dutch waters in particular.

The combination of different techniques, and more reliable SNP data can be further used for determining familial relationships and the evolutionary history of populations and sub-species. Such data can inform about connectivity among local populations (Tiedemann et al. 2017, Fontaine et al. 2017, Chehida et al. 2019) and can also be used for identifying management units and with that, even to warrant targeted and distinct management actions (see Wiemann et al. 2010 for a porpoise example in the Baltic Sea). Furthermore, this type of data can be used for abundance estimation, as has been exemplified with the Icelandic harbour porpoise population (NAMMCO & IMR 2019).

Ultimately, characterizing each sub-species and populations within them using genome scale data is desirable not only to identify distinct populations, but also to assess their past and recent evolutionary history, and whether genetic adaptation has evolved in each of them. Chehida et al. (in prep.) have now sequenced the whole genome for multiple individuals from each known sub-species of harbour porpoises, which greatly facilitates addressing these types of questions. This knowledge is paramount to understand how populations and subspecies adapt to their local environment, and conserve evolutionary potentials in face of climate changes.

5.2 Population: abundance and distribution

Historically, in Dutch waters the harbour porpoise was a native species, common nearshore sometimes in very shallow waters near our sandy beaches (Anon. 1906, Viergever 1940, 1941, Kristensen & Willemsen 1949), with known excursions into the Wadden Sea (in pursuit of young herring *Clupea harengus*; Dudok van Heel 1960, Verwey 1937, Verwey et al. 1947). The former Zuiderzee was regularly visited, possibly in pursuit of garfish *Belone belone*, anchovy *Engraulis encrasicolus* and perhaps other seasonal prey fish (Hensius 1914, Redeke 1936). Harbour porpoises were not uncommon in harbours and occurred occasionally up rivers (Van Deinse 1925, Van Laar 1961). We know next to nothing about their historical abundance elsewhere on the Dutch Continental Shelf. An overall decline in the 1950s-1970s in the Southern North Sea, leading to an (almost) local extinction in Dutch waters, and its subsequent return starting in the 1990s are both well documented for as far as sightings- or strandings-frequencies are concerned (Kinze et al. 1987, Camphuysen 2004, Camphuysen & Smeenk 2016, Hammond et al. 2002, 2013, 2017). The reasons of their departure are possibly linked to a reduction in local prey (Evans 1990, Reijnders 1992). It is not clear what triggered their return to Dutch waters, at least not in terms of any changes in local conditions or resources. Nowadays, harbour porpoises do occur year-round in coastal waters, but numbers peak in winter and early spring (see paragraph 5.3).

Determining the population status of the harbour porpoise is, in terms of abundance and distribution, especially useful if it is executed according to the same research protocol and if careful consideration is given to the experimental design. Only then it is possible to determine trends in the progress or decline of the population. This has been reiterated by the HPAC as they expressed their concern about the added value of the stand-alone annual aerial surveys on the DCS. It was strongly advised to: (1) investigate the statistical methods on the basis of which confidence intervals of these surveys are determined; (2) evaluate the current population abundance and distribution monitoring design (frequency, season); (3) focus effort on internationally coordinated population-wide abundance surveys and (4) integrate data from other sources such as land based visual observations, preferably through an integrated and internationally coordinated approach, and data from stranded animals and PAM to estimate (relative) densities in a higher temporal resolution compared to aerial surveys. These concerns have led to a statistical study by CBS and recommendations for a new design of the future abundance and distribution monitoring schemes, including integrating other data sources and an international survey that encompasses the wider North Sea (see 5.3.3).

5.2.1 North Sea population - abundance

Harbour porpoises in Dutch waters belong to the population that uses the wider North Sea (Evans et al. 2009). This whole area (ICES divisions 4a, b, c, 7d and the northern part of 3a) was surveyed during the summers of 1994, 2005 and 2016 (SCANS, SCANS-II and SCANS-III), resulting in a design based abundance estimate of 289,000, 355,000 and 345,000 individuals respectively (figure 5.2, Hammond et al. 2002, 2013, 2017). Using a habitat-based model approach, using data from SCANS-II data and SCANS-like national surveys, Gilles et al. (2016) estimated the average population size (for 2005-2013) as 361,000 in the summer (Jun-Aug), 372,000 in the spring (Mar-May) and 224,000 in the autumn (Sep-Nov). The SCANS-surveys show that there is no statistical support yet for a change in abundance of porpoises over the period 1994-2016 (Hammond et al. 2017). Recently, an in-depth workshop to assess the status of the North-East-Atlantic harbour porpoise indicated that the population of harbour porpoise in the North Sea has been stable since around 2005 (NAMMCO 2019).

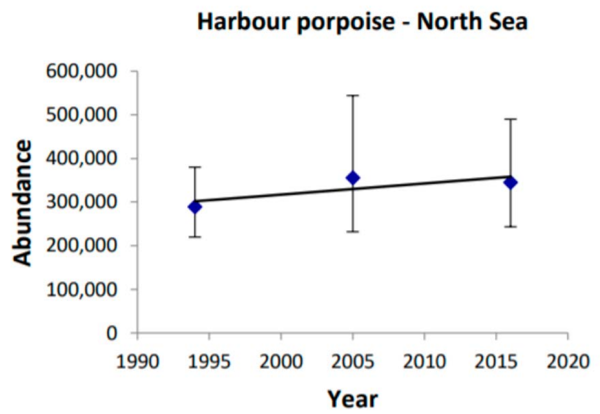


Figure 5.2 Estimates of abundance (error bars are log-normal 95 % confidence intervals) for harbour porpoise in the North Sea Assessment Unit. A trend line is fitted (Source: Hammond et al. 2017)

5.2.2 North Sea population - distribution

That the areas with highest densities in porpoise distribution shifted from the northern to the southern North Sea at the end of the last millenium, and that porpoises returned in Dutch waters, have been well documented (Camphuysen 2004, Hammond et al. 2013,). Changes in the last decade have been clear, distributions from SCANS-II in 2005 and SCANS-III in 2016 are largely similar after the southward shift at the end of the 20th century (Hammond et al. 2013, 2017). However, local surveys as well as other data, such as from stranding events, indicates that porpoise records have continued to increase for the Channel and the coast of France (NAMMCO 2019). In addition porpoises have moved more into rivers, such as the Elbe, Weser and Eems, probably following migratory fish (Weel 2016; Weel et al. 2018, Wenger & Koschinski 2012).

The seasonal distribution of harbour porpoises in the North Sea was modelled by Gilles et al. (2016) for the period 2005-2013 for spring, summer and autumn. Surveys have not been conducted in winter (Dec-Feb). The results (figures 5.3-5.5) show higher densities in the western than in the eastern North Sea, as well as a change in distribution between the seasons.

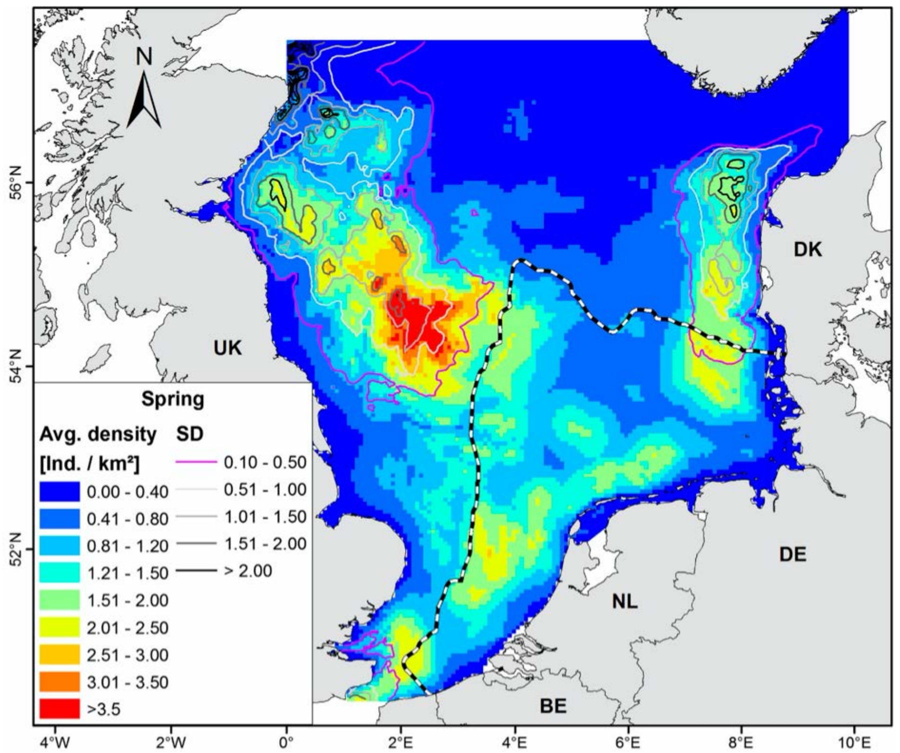


Figure 5.3: Predicted harbour porpoise densities in the North Sea in spring (Mar–May).
Upper panel: The overlaid contours are associated standard deviations (SD), whereas the black and white dashed boundary depicts the aerial sampling coverage in spring. Gilles et al. 2016

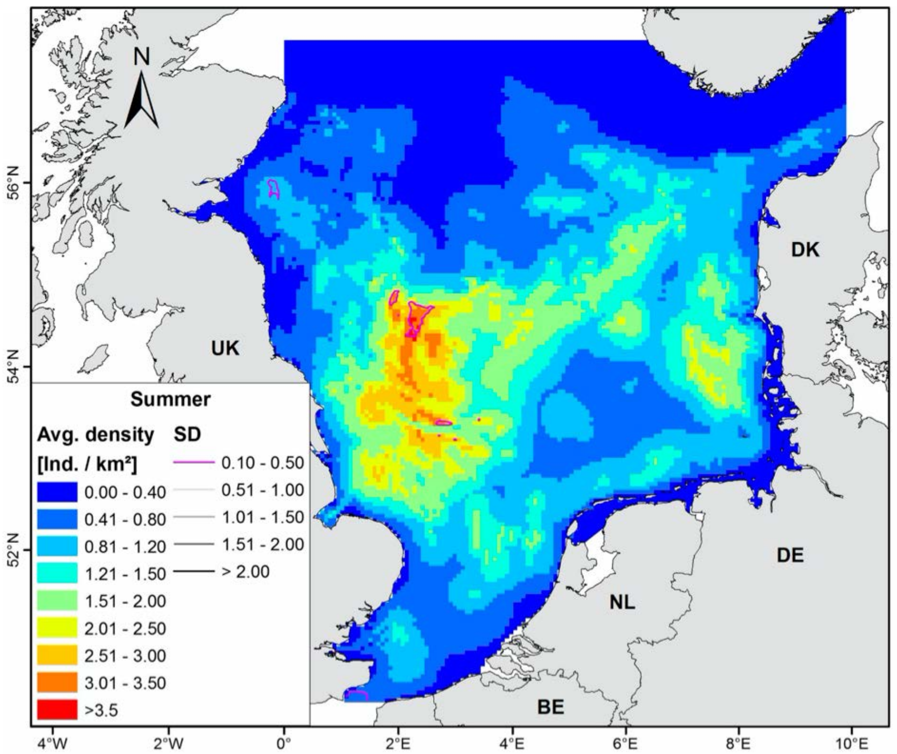


Figure 5.4 Predicted harbour porpoise densities in the North Sea in summer (Jun–Aug)
Upper panel: The overlaid contours are associated standard deviations (SD). Gilles et al. 2016

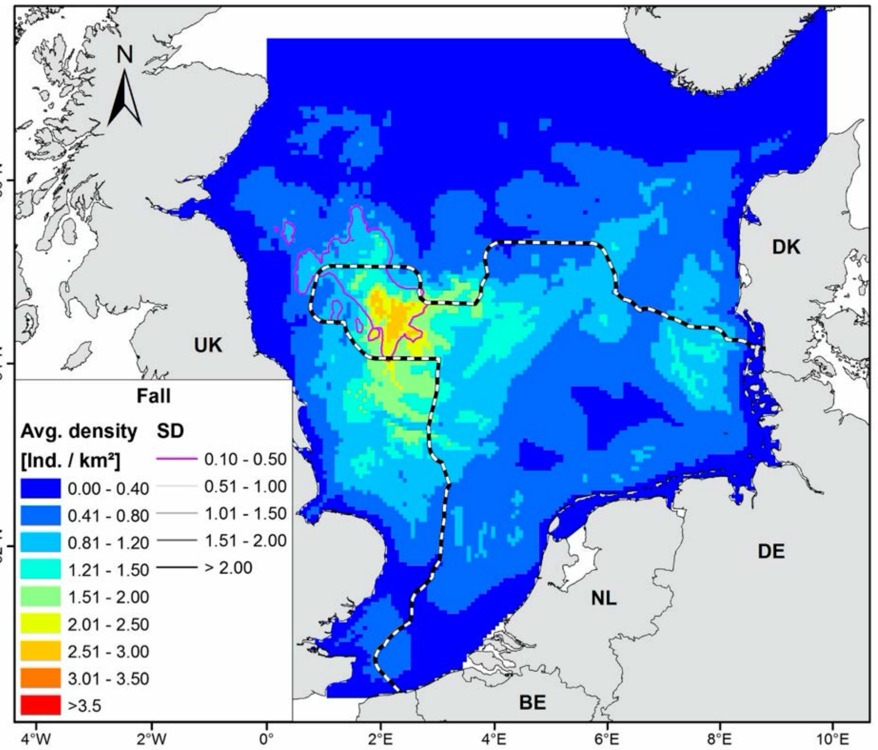


Figure 5.5: Predicted harbour porpoise densities in the North Sea in autumn (Sep–Nov). Upper panel: The overlaid contours are associated standard deviations (SD), whereas the black and white dashed boundary depicts the aerial sampling coverage in fall. Gilles et al. 2016

5.3 Population distribution and abundance Dutch part of the North Sea

5.3.1 Aerial surveys DCS

In the Dutch Harbour Porpoise Conservation plan (Camphuysen & Siemensma 2011) abundance estimates of the Dutch population of harbour porpoise were identified as one of the research needs with the highest priority. Abundance estimates for the entire DCS were lacking until 2010 (Scheidat et al. 2012). In July 2010-March 2011, under the umbrella of the Shortlist Masterplan Wind programme, dedicated SCANS-like aerial surveys of the entire Dutch Continental Shelf were conducted for the first time, in three different seasons (Geelhoed et al. 2011 & 2013a). These surveys were conducted along predetermined transects (figure 5.6 for the survey design), that are used since the first aerial surveys in 2008 (Scheidat et al. 2012). These surveys resulted in absolute abundance estimates and distribution maps of harbour porpoises in Dutch waters.

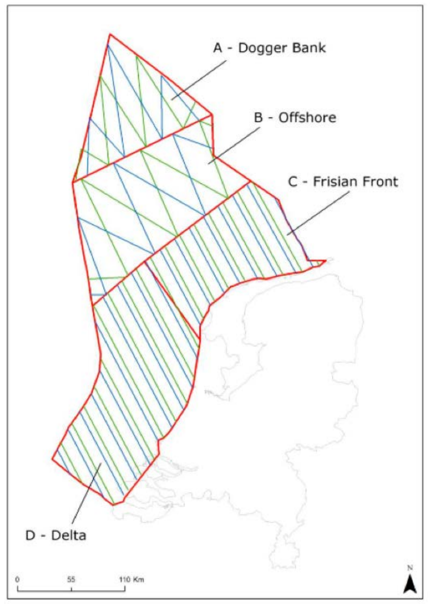
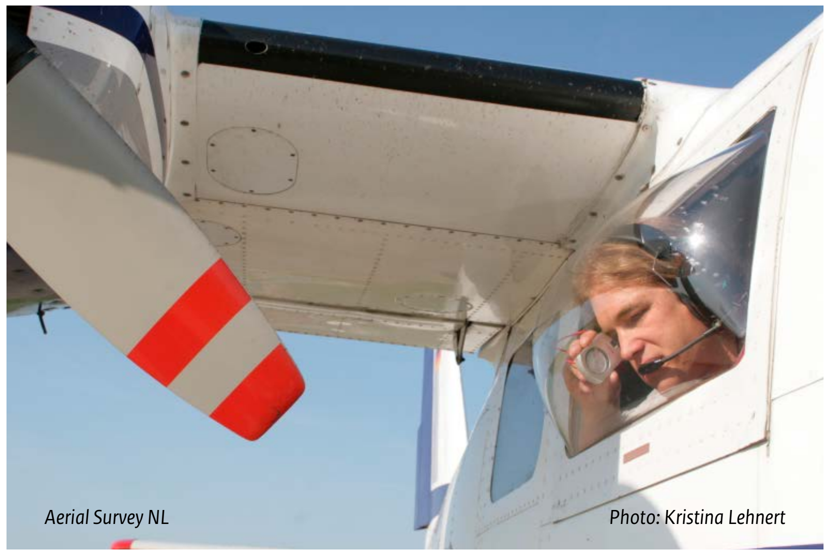


Figure 5.6. Map of the Dutch Continental Shelf with the planned track lines for the SCANS-like aerial surveys in study areas A - Dogger Bank, B - Offshore, C - Frisian Front and D - Delta. Colours indicate sets of track lines. Scheidat et al. 2012.

The surveys continued and were conducted in spring 2012 and 2013 (Geelhoed et al. 2013b, 2014a), and summer 2014, 2015, 2017, 2018 and 2019 (Geelhoed et al. 2014b, 2015, 2018ab, Geelhoed & Scheidat 2018, Geelhoed et al. 2020). In summer 2019 the total number of harbour porpoises on the Dutch Continental Shelf (areas A-D) was estimated at 38,911 individuals (CI = 20,791-76,822) (Geelhoed et al, 2020, table 5.1). This estimate falls in the range of abundance estimates since 2010, with a minimum of 25,998 (CI = 13,988 – 53,623) in 2010 and a maximum of 76,773 (CI = 43,414-154,265) in 2014 individuals. Summer densities vary between 0.14 and 3.08 animals/km2 in the different years, highlighting that the density between the sub-areas is highly variable. The confidence intervals of the abundance estimates overlap, indicating no statistically significant differences between the years. The time series, however, is relatively short to measure trends. There are different ways to determine whether the difference between different estimates is significant. One of the more advanced methods for instance is the Bayesian trend analysis. The current sample size is too low for this now, however this can be done in the future. What is needed first is to assess which method is most suitable for this particular data.

In conclusion, these abundance estimates show that up to a fifth of the North Sea population, estimated at 345,000-361,000 individuals (Hammond et al. 2017, Gilles et al. 2016), has been present on the Dutch Continental Shelf (~10 % of the North Sea area) during the summer surveys in 2010-2019.



	Density (animals/km^2)	95% Confidence Interval (CI)	Abundance (n animals)	95% Confidence Interval (CI)	Coefficient of Variation (CV)
2010	0.44	0.24-0.90	25,998	13,988–53,623	0.34
2014	1.29	0.73–2.60	76,773	43,414–154,265	0.34
2015	0.70	0.36-1.34	41,299	21,194-79,256	0.33
2017	0.79	0.41–1.86	46,902	24,389–93,532	0.35
2018	1.07	0.58-2.02	63,514	34,276-119,734	0.32
2019	0.66	0.35-1.39	38,911	20,791- 76,822	0.35

Table 5.1 Density and abundance estimates of harbour porpoises obtained in July 2010-2019 (Geelhoed et al. 2011, 2013a, 2014b. 2018ab, 2019, Geelhoed & Scheidat 2018). Geelhoed et al. 2020

In addition to SCANS, Rijkswaterstaat's waterbird monitoring survey also provides valuable information. Marine mammals are also counted during these flights. Statistical analysis by the CBS showed that although no estimates of populations can be made with these counts, trends can be clearly identified.

The aerial counts commenced in 1991, since when there have been some changes, for example in the spatial pattern, the frequency and the flight altitude. For details, see Fijn et al. (2018).

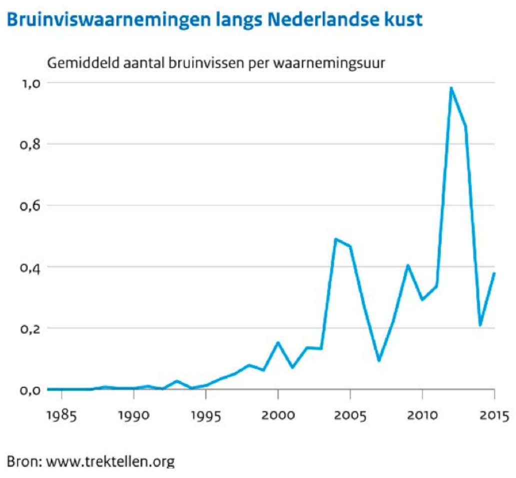
The aerial counts are carried out according to a fixed method along a predetermined route, with marine birds and mammals being counted within transects that are distributed as homogeneously as possible. There are two distinct sub-areas: the coastal zone – from the low water line to the 12-mile line – and the Exclusive Economic Zone (EEZ), the Netherlands' maritime territory beyond the 12-mile zone. In response to the results of a statistical analysis (Soldaat & Poot 2020), the spatial coverage will be expanded from 2020, with a transition to a 'cross-shore' flight pattern. The aerial counts in the EEZ also follow a pattern of transect lines cross-wise to the coast. In the Natura 2000 areas in the EEZ (Frisian Front and (potentially) Bruine Bank), a higher spatial resolution is maintained by flying in a zig-zag pattern.

In response to the results of the aforementioned statistical analysis (see also 5.3.2), two EEZ counts have been added, so starting from 2020 there are six counts a year for both the coastal zone and the EEZ, in: January, February, April, June, August and November.

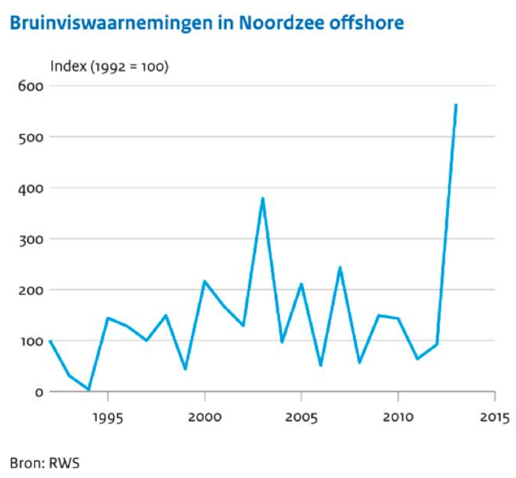
5.3.2 Statistical analysis data

Based on different data sources for harbour porpoise Wageningen University (WUR) and the Dutch Central Bureau for Statistics (CBS) publish trends regularly on the Compendium voor de Leefomgeving:

Land based (Seawatch) counts:



Aerial surveys (MWTL):



Figures 5.7 and 5.8. Trends of harbour porpoise based on land based (seawatch counts, left) and aerial surveys from the MWTL survey, as published in the Compendium voor de Leefomgeving

In both figures an increase seems apparent. However none of these had been statistically assessed. Also, not all visual surveys were taken into account.

CBS performed a statistical analysis on the different datasources that describe harbour porpoise trends. This resulted in input for the update of the MSFD monitoring programme, an additional indicator for the harbour porpoise for the 'Compendium voor de Leefomgeving' and this Harbour Porpoise Conservation Plan. Objective was to optimize the frequency and timing of the SCANS-like aerial surveys, improving the statistical power and where possible, reduce costs. This would also allow for increasing the frequency of the international SCANS surveys to every 6 years without significant overall cost increase (see paragraph 5.3.3).

The analysed data sources were:

- so called "SCANS-like" aerial surveys, which are conducted yearly by Wageningen Marine Research, funded by the Ministry of LNV, since 2009 irregulary and since 2014 in July to harmonise with SCANS;
- "MWTL" aerial surveys, conducted by Bureau Waardenburg / Deltamilieu projecten, funded by the Ministry of I&W , which are conducted 6 times a year since 1991, primarily for seabird monitoring but records of marine mammals are also collected;
- Seawatch counts. Landbased counts along the Dutch coast, of coastal bird migration taking into account cetaceans, which are conducted on a voluntary basis from a fixed number of set locations from land, of which 18 'good' posts were selected based on average effort.

SCANS-like and MWTL data show similar temporal patterns, however only with SCANS-like data absolute abundance estimates can be made. Since MWTL surveys have been conducted every two months annually since 1991, seasonal patterns can be observed (see figure 5.9). These data show a difference in peak occurrence in the coastal zone (Jan/Feb) and offshore (Mar/Apr). The reasons for this difference are unknown. Geelhoed et al. (2013) compared peaks in occurrence among North Sea countries and suggested a northward migration during the summer, which is supported by Gilles et al. (2016). Camphuysen (2011), analysing Seawatch counts, noted the migration away from the coastal zone in spring. He suggested possible causes being a change in food availability or migration to deeper waters because of calving. The difference between coastal zone and offshore supports both explanations, because offshore waters are both deeper and further North. Another possible explanation could be the increased recreational shipping activity in the coastal zone in summer.

Collaboration between countries regarding integration of different datasets (e.g. ferry surveys, acoustic data) is considered valuable and there is ongoing work for example by the Joint Nature Conservation Committee (JNCC)to develop a Joint Cetacean Data Programme (JCDP) to synthesise and collate at-sea observer data for combined use in analyses, which is worth being considered to join forces for a more integrated assessment of data.

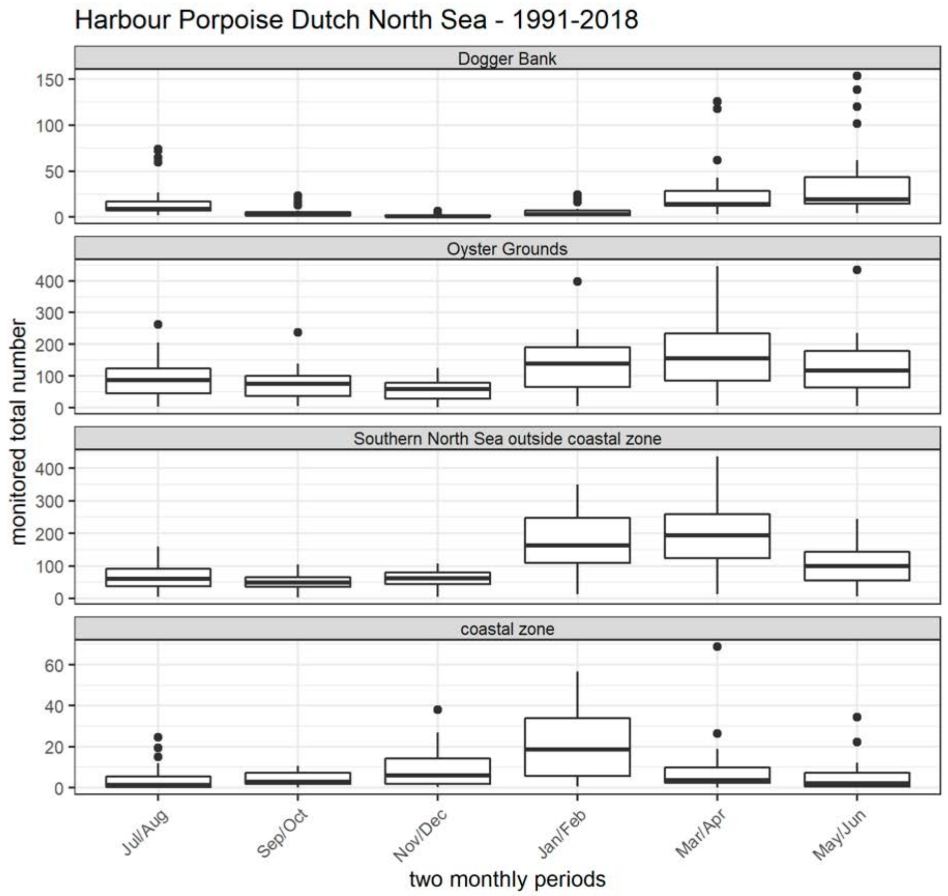


Figure 5.9. Seasonal distribution harbour porpoise in Dutch North Sea (Dogger Bank, Oyster Grounds, Southern North Sea and coastal zone), based on MWTL surveys 1991-2018.

5.3.3 Conclusions CBS analysis

As mentioned earlier, there are several reporting requirements for the protection of the harbour porpoise, stemmed from international legislation or agreements: the Habitats Directive (HD), MSFD, OSPAR, ASCOBANS and the CFP, the latter is addressed in Chapter 3 and 7.

Specifically for population abundance it is required from the Habitats Directive that every six years a best minimum and maximum estimate is reported for the national part of the sea. For highly mobile species it is therefore recommended that this is based as much as possible on regional surveys, such as SCANS, covering all of the North Sea and adjacent waters.

For the MSFD also every six years an abundance estimate is required. As described in Chapter 3, there is a criterium on abundance, D1C2, for which the Netherlands has two indicators, based on OSPAR and on the Habitats Directive.

Regional SCANS surveys are already used for the OSPAR indicator on marine mammal abundance and distribution and the Indicator for the risk of impact from impulsive noise. For the latter, also harbour porpoise distribution maps will be produced. Until now, SCANS surveys were conducted approximately every ten years, but it is desired to increase the frequency to meet the six years MSFD reporting cycle. Besides that, the OSPAR Marine Mammal Expert Group advises that in intermediate years between SCANS more frequent (aerial) surveys on a (sub) regional scale should be conducted to increase the statistical power of the Marine Mammal Indicator.

Furthermore, more effort should be put in integrating data from national and smallscale surveys following standardised methods.

Finally, for the licensing of activities at sea, such as the construction of wind farms, data on (seasonal) distribution is needed that is not older than 5 years.

Based on the results of the CBS analysis (see Soldaat & Poot 2020 for more detail). The following conclusions can be drawn on the different data sources:

- The SCANS-like surveys are most suitable for absolute population abundance estimates and therefore for the HD and MSFD reporting;
- MWTL surveys are suitable for statistically reliable trends in abundance and distribution on DCS- and subarea level;
- MWTL surveys are suitable to determine seasonal difference in abundance between (sub)areas;
- Based on that the peak in abundance offshore is in March/April while minimum numbers offshore are seen in November/December. In the coastal zone the peak is in January/February and minimum numbers are in July/August (see figure XX);
- Voluntary land based surveys are suitable to support the trends in abundance found for harbour porpoises in the MWTL surveys (along the coast).
- For the future survey design, these are the criteria, based on the objectives from a policy perspective:
- A SCANS-like survey minimally 1x in 6 years (HD/MSFD requirement);
- A SCANS-like survey in March for a maximum estimate and one in July which can be used as a minimum estimate and continues the July sequence from previous years for the HD and MSFD;
- A SCANS survey 1x in 6 years (OSPAR/ASCOBANS recommendations);

5.4 Subpopulation within the Netherlands – Eastern Scheldt

In the Eastern Scheldt a unique situation is occurring; a separated group of harbour porpoises can be found in this semi-enclosed tidal bay. Since the closure of the Eastern Scheldt with a storm surge barrier (Construction phase: 1976 - 1986), porpoises have increasingly started inhabiting the Eastern Scheldt, but the numbers of porpoises seem to have stabilized recently. It is unclear what the reason for porpoises is to remain in this area. High mortality of porpoises within the Eastern Scheldt as evidenced by stranding numbers, as compared to the Dutch coastal zone, suggests that the area might act as an 'ecological trap' for these animals (Jansen et al. 2013). The animals stay away from the barrier when the currents are strong. Although it is likely that porpoises do migrate occasionally through the barrier, they do not show the North-South migration as seen for the North Sea population (Zanderink personal communication).

The Rugvin Foundation started to monitor the harbour porpoises in the Eastern Scheldt on a voluntary basis since 2009. At first, the monitoring was focused on yearly scans to count the minimum number of animals in the tidal bay. Since 2015, the focus shifted more and more to an intensive photo-identification project. Through photo-identification the animals can be studied on an individual level and this method has proven to gain important knowledge on many other species of cetaceans (Hammond et al. 1990, Würsig et al. 2018). Using this method on the Eastern Scheldt's porpoises has demonstrated that a considerable part of these animals have been present for a long time (Podt 2020). Some animals have been seen there for up to 10 years without (most likely) leaving the area. In June 2020 two animals have been re-sighted by photo-identification, of which the first records where in 2009, showing an age of at least 11 year and likely older than that (Pers. comm. A. Podt). Photo-identification research indicates that 50 to 60 individual harbour porpoises were present within the Eastern Scheldt on a yearly basis in recent years. It also revealed that porpoises are born in this area and 3 cases are known of calves that were later on re-sighted independently of their mothers. Photo-identification can improve further knowledge about the numbers and distribution of harbour porpoises in the Eastern Scheldt, social and reproductive behaviour, physical condition, chances of survival and attacks by grey seals.


Eastern Scheldt Photo: Annemieke Podt, Stichting Rugvin

Acoustic research has been and still is conducted in the Eastern Scheldt as well. Rugvin Foundation used C-pods to study migration through the storm surge barrier (2010-2013). Research from 2010-2011 led to harbour porpoise presence being observed and recorded by C-pods in all months (March 2010- January 2011). On average, clicks were recorded near the storm surge barrier in 20.6 % of all ten-minute time intervals. The highest peak was seen in March 2011. The lowest in November – December 2010. Evidence is provided for migration between the North Sea and the Eastern Scheldt, but the results suggest that this does not occur very frequently, a couple of times per month, but in each month this research was conducted. The tidal currents passing through the storm surge barrier have a significant effect: the stronger the currents, the less presence of harbour porpoises (pers. comm. L. Korpelshoek, 2011).

This group also developed and installed Studio Porpoise near Zierikzee in 2016. Studio Porpoise serves two purposes: research to learn more about the species itself and informing the general public. With Studio Porpoise, visitors in Zierikzee can experience not only the sight of porpoises at the jetty, but can also listen live to the animals.

The Rugvin Foundation has increased the knowledge about these animals. However, outcomes of the Eastern Scheldt cannot be considered representative for the North Sea population, because the circumstances are different. For example, the food supply in the Eastern Scheldt is considerably lower and different in fish species than in the North Sea, however, once within the Eastern Scheldt, the porpoises often stay there year round and for a longer period of time (months to years) and must therefore also obtain their food locally.

Van Dam et al. 2017 demonstrate that harbour porpoises that stay in the Eastern Scheldt for a longer period of time may develop specialized feeding skills, to cope with the relatively poor prey base. Their study comparing stomach content of stranded dead harbour porpoises found in the Eastern Scheldt with those of porpoises found along the shores of the North Sea, reveals that there are no big differences between biological or stranding parameters, but some differences in diet were found. Still, despite the low fish biomass in the Eastern Scheldt, no evidence of excessive harbour porpoise starvation was found.

The harbour porpoise has been added to the Standard data Form (SDF) for the Eastern Scheldt (as the Western Scheldt and Wadden Sea area) Natura-2000 areas, although the occurrence of the part of the national population is classified as category C (<2 %). Recently the harbour porpoise was added to these areas and a conservation objective is set to maintain the population in all those Delta areas.

In conclusion, the situation in the Eastern Scheldt is unique with a small number of porpoises that occur here year-round. It is possible that they form a separate resident group, although it is unknown if and to what extent there is exchange with animals from the North Sea. The Easter Scheldt forms an exceptional location for research as well as providing opportunities for outreach and public education.

5.5 Technical monitoring and research methodologies

There are several technological tools that can add to the current methods to study the abundance, distribution and behaviour of the harbour porpoise. These include the (combined) use of tags to track animals and using passive acoustic monitoring (PAM) and high definition (HiDef) cameras. All of these have different merits and can build on the knowledge and understanding of the species, however their use still needs further development and considerations.

5.5.1 Tagging

Tagging and tracking harbour porpoises, allows researchers to obtain data on the behaviour and ecology of this species. As mentioned in the section on harbour porpoise ecology, recent tagging data have yielded insightful and detailed information on habitat use, (diving) behaviour, dive depth, and the timing of movements, including individual specific behavioural changes.

Tracking tagged animals can also be a valuable tool to investigate the impact of human activities on individuals, which can be used to inform models such as the iPCoD model (King et al. 2015, Pirotta et al. 2018) and the DEPONS models (Nabe-Nielsen et al. 2014, 2018). A number of recent publications have highlighted that for porpoises in Dutch waters this knowledge is still scarce (see Scheidat et al. 2016 for an overview). There are three types of tags: positioning tags, time-depth recorders and acoustic tags. The use of the different tags depends on the research question. Position tags are always needed, since they provide information on the location of the tagged animal. Time-depth recorders and acoustic tags (that can record both the animals behaviour and movement and the received sounds) have proven to be valuable to determind response fuctions for other (larger) animals (see e.g. Lam et al. 2015-Controlled sonar exposure experiments on cetaceans in Norwegian waters: overview of the 3S-project) and when smaller tags become available these can be valuable for use on porpoises.

Despite the value of it, tagging also impacts the animals. A review by Scheidat et al. (2016) provided an 1) overview of the technical status and the different types of tags; 2) how tags have been used in other areas on porpoises; 3) how tags can be attached to porpoises, 4) how porpoises can be obtained for tagging, and 5) what the legal framework for tagging in the Netherlands is.

Tagging marine mammals in the Netherlands involves a permitting procedure according to the Nature Protection Act, ensuring the animals welfare. When considering tagging porpoises to answer a well-defined research question, a number of important points need to be taken into account: sample size and representativeness of the sample, impact on the natural behaviour of the tagged porpoise as well as the ethics of using a wild animal for research. If the sample of animals has to be representative of the population, this means that a considerable number of animals is required, covering different sex, age and life stages. Nevertheless, because we know so little of harbour porpoise behaviour in the wild, even tagging just one animal could provide substantial new information, although it is recognised interpreting a sample size of one is rather difficult. Ideally animals should be investigated that show completely undisturbed natural behaviour. Often research methods have some impact on the animal, even with shipboard surveys. The potential impact on the animals varies between the different attachment methods, as well as between the condition and life-stage of the animal itself. When considering tagging as a research method, the potential positive effect for the larger population has to be weighed against the potential negative effect on the individual.

Scheidat et al. (2016) proposed a step by step approach. Basic questions need to be addressed first, before tagging can start such as how to obtain animals, while considering the welfare of the caught animal and how to ensure that the attachment and use of any tag poses as little impact as possible for the individual animal? The best way forward is to start with and learn from less invasive tagging methods (small trailing edge tag, detachable tag) with exploring the best possible way to obtain animals (captive-cared, weir fishery, suction-cup attachments) first. This will provide a valuable insight into which methods could best work in the Netherlands, whilst also providing the first data on the behaviour of individual harbour porpoises in Dutch waters. Although recognized that other countries, such as Denmark, have a lot of experience in tagging, the Netherlands differs, e.g. in type of fisheries,

but also in public awareness around animal welfare issues. This all needs to be taken into consideration when designing similar studies. Any kind of tagging project should involve (international) research groups that have expertise in tracking studies of small cetaceans, particularly harbour porpoises. Scheidat et al. (2016) emphasise that different research questions need different tagging studies and that careful consideration is needed about the aim and design of a study beforehand.
As shown by several studies (Linnenschmidt et al. 2013, Teilmann et al. 2004, 2007, Nielsen et al. 2018), a well-designed tracking study could reveal data on regular movements, diving depths, and other important behavioural aspects for harbour porpoises in the Southern Bight. It is therefore recommended to explore different tagging methods, building on the work by Scheidat et al. (2016) and investing in dialogue with stakeholders, and to make use of existing expertise from available tracking studies.

5.5.2 Passive acoustic monitoring (PAM)

Passive acoustic monitoring (PAM) is based on detecting and recording the acoustic signal of the species. Since harbour porpoises use echolocation almost continuously, passive acoustic monitoring (PAM) could be instrumental to assess temporal patterns in overall relative abundance - as reiterated by the HPAC - and could indicate the (ir-)regularities in the use of certain areas and reveal patterns in feeding activity as referred to in the section on ecological studies in offshore waters (Fisher et al. 2003, Carstensen et al. 2006, Thomsen & Piper 2006, Verfuß et al. 2007, Gallus et al. 2012, Buyse 2018). An analysis of the porpoise echolocation-click trains received during such monitoring studies could reveal e.g. diurnal, tidal or seasonal patterns in feeding activity (Todd et al. 2009, Geelhoed et al 2018c & 2015, Nuuttila et al. 2013, Berges et al. 2019).

The Static Acoustic Monitoring of the Baltic Sea Harbour Porpoise (SAMBAH) project – an inter-national project involving all EU countries around the Baltic Sea from 2010-2015, with the ultimate goal to secure the conservation of the Baltic Sea harbour porpoise estimated the Baltic Sea harbour porpoise population to approximately 450 animals by using PAM. The estimate is based on a two-year long data collection, 2011-2013, of harbour porpoise echolocation signals by this project (SAMBAH 2016). The successful project showed the added value of using PAM in order to gain valuable information on distribution and abundance (Carlén et al. 2018).

Scheidat et al. (2019) assessed the feasibility of using such a PAM network on the DCS to monitor harbour porpoises. The study describes what PAM is currently able to do, including the technical and logistical requirements and the analytical limitations when using PAM. To illustrate the steps needed to monitor harbour porpoises with PAM, Scheidat et al. (2019) presented two case studies for setting up a PAM network covering the DCS and respectively an operating offshore wind farm. These case studies include different options and associated costs. The authors came to the following conclusions:

- Deriving absolute abundance from passive acoustic monitoring is still in its infancy and while *theoretically* possible the needed information to do this is still not available
- The primary advantages of PAM are the continuous monitoring, allowing insights in changes in behaviour and habitat use on short (hours) and long (years) temporal scales
- PAM networks have shown to be a useful tool to provide a measure of relative abundance, long-term and of continuous habitat use, in particular in smaller areas or for populations that occur in numbers that are too low to be assessed by visual survey methods
- For the aim of obtaining relative abundance estimates, the costs for PAM networks are relatively high compared to visual line transect surveys
- Some options are available to derive some of the missing parameters needed so that PAM networks may provide absolute abundance estimates
- Before a PAM network is to be established in Dutch waters it is important to clearly define the goals of such a network, and assess the feasibility of realistically achieving these
- A step by step approach could start with testing, developing and improving PAM network to assess harbour porpoise abundance in small-scale areas, such as offshore wind parks. Once the methodology is tested it can be further extended to a larger-scale (e.g. DCS-wide) monitoring

PAM devices can be divided in static and towed hydrophones. The latter are in general towed behind a ship, or in arrays of several devices that need to be synchronized to detections (Scheidat et al. 2019). Despite of the challenges to use PAM as a tool to derive absolute abundance, PAM is widely used in offshore wind farm impact studies abroad and on the DCS. During the construction of the Borssele wind farms in 2019/2020 both underwater noise produced by pile driving, as well as harbour porpoise clicks have been recorded using PAM devices (Soundtraps and CPODs) at multiple locations in and around the construction sites during different parts of construction. This to gain more insight into frequency weighted (see Chapter 8) responses of harbour porpoises to mitigated piling noise (see for more detail 8.2.2).

For a more extensive overview of available devices they refer to Lucke (2014) and Sousa Lima et al. (2013). Using an array (towed or static) with multiple hydrophones can improve the knowledge from specific (dive- and foraging) behaviour nearby the sensor (pers. comm. FPA Lam). An example of observing and tracking porpoises with multiple towed hydrophones is provided by Macauly et al. (2017). The practical implications of PAM, should not be ignored, as PAM devices need to be moored at sea, with an anchoring and marker system to prevent or limit device loss. Scheidat et al. (2019) refer to two main systems, moorings with surface markers and with acoustic release systems (e.g. Wilson et al. 2018). Exploring cost-effective mooring systems might add to the feasibility of future PAM studies.

5.5.3 Aerial surveys – High definition

More and more seabird and marine mammal surveys are performed using so-called high definition (HiDef) digital imagery techniques (Thaxter & Burton 2009; Buckland et al. 2012. As explained in Scheidat et al. (2013), similarly to visual ship-based and aerial surveys, predefined transects are flown over the study area. The sea surface is either photographed or filmed with multiple cameras, providing images of a predefined sector along the transect. All footage is stored digitally to be analysed afterwards by observers, for now.

Collected images can be stored for future reference and for automated digital processing. Automated Image Recognition (IR) is still under development, but offers many advantages in the long run, that it is the preferred way forward. HiDef systems cannot yet estimate absolute density. This is the next step to take after automatic ID of marine mammals. Advantages over traditional aerial surveys are safety (e.g. survey height well above the rotor swept area of wind mills), less disturbance, less observer or weather biases and more precise estimations. However, HiDef is still under development and costly, especially in the initial phase, when video data still needs to be fully analysed afterwards by people. Once an automated identification process is realized it can be used both for density estimation and for the estimation of general animal health using a body condition index (from e.g. length/width ratios). Also, before implementing HiDef for structural monitoring, an overlap period with parallel conducted high definition and conventional surveys is needed for validation and quality control to minimize trend breach risks.

There are important developments in this field. Countries around the North Sea, besides the Netherlands, and further afield (e.g. USA) consider transitioning from aerial surveys with human observers, to aerial surveys using HiDef digital cameras. In the UK HiDef digital imagery (from airplanes is widely used to survey seabirds and marine mammals. In the Netherlands preparatory steps are made to implement the use of HiDef. Currently an algorithm for IR is being developed and simultaneously an image database by means of various pilot surveys is built. A next step is to validate the algorithm and refine where needed. In needs to be recognized that although its advantages, as with conventional aerial surveys, automated processes are limited in yielding all the needed information.

5.6 An integrated approach for ecology research

In conclusion, none of the types of studies mentioned in the paragraphs above would work in isolation. What is needed is the production of on overview of existing data, an analysis of strengths and shortcomings of existing datasets, a meta-analysis to sketch an ecological context of harbour porpoises now and in the past in the Southern Bight. Such a comprehensive analysis of currently available data on spatial and temporal patterns in abundance plus aspects of reproduction and resources should point at the prime study areas for further, dedicated offshore observations. Tagging studies become particularly more insightful if combined with offshore surveys in which species communities, animal behaviour and their interactions are quantified. A further step could be to sample the prey resources (often non-commercial prey fish stocks) with dedicated surveys focussing on previously identified areas and season, found to be important for porpoises in Dutch waters. A meta-analysis would also provide further and more specific recommendations for future studies, including a more efficient expenditure of scarce financial means to obtain more useful results. It is recognised that this goes beyond the scope of this conservation plan, as it does not follow from specific legal or policy requirements. However, when designing research projects, it is encouraged to take these conclusions into account.

Mating behaviour *Photo: Annemieke Podt, Stichting Rugvin*

5.7 Recommendations on population ecology, abundance & distribution

5.7.1 Recommendations population ecology:

- When designing harbour porpoise ecology studies:
  - Use cross border, multidisciplinary and multi-methodology approaches to investigate harbour porpoises and their prey within their ecosystem.
  - Take steps to analyse the harbour porpoise food web and the health of the eco-system and habitats by:
  - Integrating harbour porpoise diet studies, both inshore and offshore, and from stomach content and stable isotope and fatty acids analysis, with studies and DCF data on key prey fish distributions, seasonal movements and abundances at least at DCS level but preferably at an international level in collaboration with North Sea countries.
  - Investigating life history parameters (pregnancy rates, (foetal) growth rate and mortality) of harbour porpoises, which can directly influence population numbers, in combination with other parameters such as contaminants.
  - A meta-analysis providing an overview of existing data, an analysis of strengths and shortcomings of existing datasets is recommended to sketch an ecological context of harbour porpoises now and in the past in the Southern Bight.
- Investigate what can be learned from current population models and identify which information is still needed as input to optimize and validate these models especially with regard to assessing the cumulative impact of anthropogenic activities; the needs for improvement and validation of population models (iPCoD and DEPONS) must be addressed (see 8.1.4).
- Explore whether information on diet, pregnancy rates and foetal growth and prey species distribution can be captured in an indicator for either habitat quality or food webs in the Habitats Directive or MSFD.
- Genetic research can add to knowledge on distribution and could also assess whether there are any (or how many) subpopulations. Investigate possibilities for using genomic techniques in policy and management, such as for population abundances (past and present), adaptation to climate change or other stressors or specific management actions relating to management units.
- Support ongoing work by adding more genomic resources, including porpoises from Dutch waters.

5.7.2 Recommendations population abundance and distribution

- Implement the new sampling schedule as concluded from the CBS analysis. The recommendation following this analysis is to not have yearly national SCANS like surveys in July as was done until 2020, but instead have a nationale SCANS like survey every three years in March and July. Ideally, the national surveys would follow after a six-yearly SCANS survey, looking as follows:

1	2	3	4	5	6	7	8	9	10	11	12
March			March			March			March		
July		SCANS	July			July		SCANS	July		

- Integrate different data collection methods, in particular aerial survey data, nationally, but also on a regional North Sea wide scale, such as the Joint Cetacean Data Programme. Possibly in time the statistical link can be made between MWTL and SCANS like counts and then a comparison could be made. However, this would only be possible after 10+ years of data collection in the current proposed set-up.
- Seasonal maps can be produced for licensing and management based on combining different data sets. Participate in and stimulate an international population abundance and distribution survey (SCANS), preferably every six years.
- Programme the aerial surveys, including SCANS, for the longer term, such as 12 years, so that there is flexibility around the planning of these surveys, with the funding secured. As SCANS is a joint international effort, secured longterm funding should be organised internationally as well. Timing of the Article 17 Habitats Directive reporting and MSFD reporting is ideally two years after SCANS.
- Integrate data from other relevant (international) networks such as voluntary land based offshore visual migration surveys ('Sea Watch') or long term ferry surveys that also report sightings of harbour porpoises (and expand with a potential new line) or other initiatives, with the aim to monitor trends. This data is also being analysed.
- Continue the voluntary photo-identification project in the Eastern Scheldt to gain more general knowledge of the species and to monitor the number of porpoises to assure that the conservation objective to maintain the population in this Natura-2000 area is obtained.
- Consider the Eastern Scheldt for suggested research topics such as acoustic monitoring or tagging, since it offers advantages over the North Sea (e.g. overall environmental conditions, known individuals). Research within the Eastern Scheldt should include analysis of data on migration (in or out) the Eastern Scheldt and mortality.

5.7.3 Recommendations technical monitoring and research methodologies

- Explore different tagging methods and make use of existing expertise from available tagging studies and invest in dialogue with stakeholders on this topic.
- Gain more insight in behaviour and occurrence and changes herein in relation to habitat use and anthropogenic activities by Passive acoustic monitoring (PAM) and estimate (relative) densities in a higher temporal resolution compared to aerial surveys, including developing cost-effective mooring methods.
- Further develop and implement high definition (HiDef) monitoring to assess population abundance and distribution and consider the statistical impact of switching of method, combining with other visual surveying, such as for birds. Also taking into account the limitations of increasing number of windfarms on possibilities for visual surveys.

6 Stranding events & stranding research

The harbour porpoise is the most frequently encountered cetacean in the North Sea and on the Dutch coast. Hundreds of porpoises strand along the Dutch coastline every year, most of them are found dead but occasionally live-stranding events are reported. All animals that are reported, for the most part by voluntary stranding networks, are documented in a central registration database walvisstrandingen.nl. Since 2006, a selection of these are post-mortem investigated and approximately 50 animals per year are selected for necropsy, leading to investigation of cause of death, diet (Chapter 5) and contaminants research, among others. Information on stranding numbers and causes of death is also submitted in national reports for ASCOBANS and the IWC. Stranded animals can be used as specimens for necropsy as the number of offshore porpoises available for necropsy is very limited.

Photo: Utrecht University

6.1 Registration

The harbour porpoise stranding data is collected following a standardized reporting form on the platform Walvisstrandingen.nl (hosted by Naturalis Biodiversity Center, Keijl et al. 2016, see figure 6.1). Information on species, date, and location is the minimum data recorded. This data is validated before being entered in the database. Not from all animals that strand the cause of death is investigated.

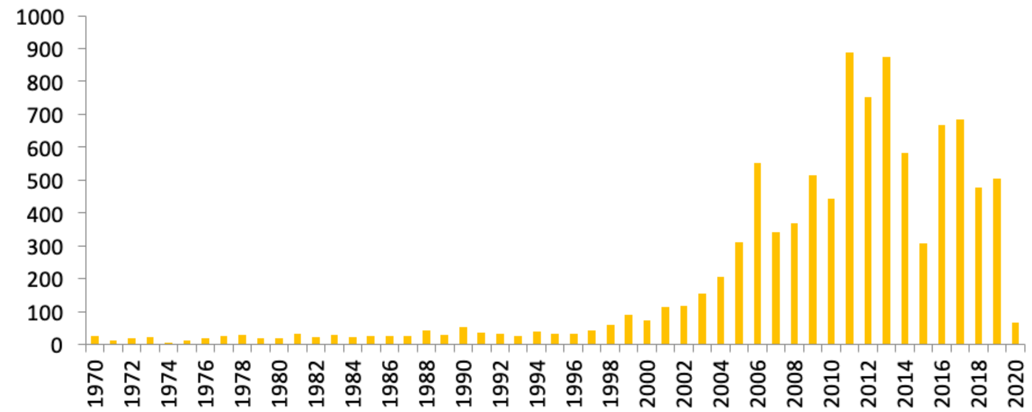


Figure 6.1: Harbour porpoise strandings 1970-2019. Overview of reported strandings in the Netherlands, 1970-2019 (n=9760). Source: Naturalis Biodiversity Center

Currently (2016-2020), only a fraction of stranded porpoises (ca 10 %) is necropsied, existing predominately of fresh carcasses. The vast majority of stranded harbour porpoises is either left at (remote) stranding locations, buried or transported to destruction. Basic information – relatively easy to gather - on these animals is not recorded. To improve the scientific usability of strandings data, it is recommended that information will also be collected on the discarded animals as much as possible, and preferably using a standard protocol. The collection of information on discarded animals can be done by trained volunteers or through citizen science by encouraging the use of a clear website connected to a central database, that is easily accessible and by using an app on smartphones. It should be encouraged that people take standard photographs of stranded animals they find, to confirm the species identification, and other data of the individual like: length, sex, body condition, etc. The increased value of stranding research by engaging the general public to report data has been reiterated by the HPAC as well as analysis of this data by an expert panel.

Standardized and continuous registration of all stranded harbour porpoises is important for management action and scientific research. The combination of improved central registration and digital Image Recognition (IR) of marine mammals is currently being developed by Naturalis & Waarneming.nl. This development will facilitate both the identification and the collection of biometry data for further research and reporting. Waarneming.nl is a well-known and widely used platform, with extensive scientific back-up, and as such a suitable platform.

To include the latest technological developments, it is required to update and improve the current platform www.walvisstrandingen.nl. A new version of the platform, stranding.nl, ideally includes all marine mammals, birds and fish species found stranded in the Netherlands. In order to achieve this, the data entry and validation will be merged with the Waarneming.nl entry and validation. The data entry apps for smartphones are already widely used to report stranded animals. With the integration, strandings that are reported on waarneming.nl are directly linked to the stranding.nl database.

It is also recommended to integrate this database or collaborate with other North Sea countries to share knowledge with similar programmes, to increase consistency and reduce effort in developing this. This should be done in coordination with ASCOBANS, where work is already underway to establish an international database for strandings. Waarneming.nl is part of the global platform observation.org and therefore also a suitable international partner. An advantage of Waarneming.nl/Observation.org is that data are validated by experienced species validators. In the specific case of cetaceans, Naturalis as the stranding database manager and species specialist is added to the validator team. Validated strandings will be added to the stranding.nl database and checked by the Naturalis stranding database manager. The database manager will also facilitate the publication of yearly reports on strandings.

Photo: Utrecht University

Besides the validators' human eye, waarneming.nl also validates using digital IR and rule based autovalidation (see also High Definition, Chapter 5, paragraph 5.5). The IR software helps to identify stranded animals, and integrated rule based validation algorithms will help to assess the credibility of records. An added advantage of these algorithms is that 'alert e-mail messages' can be generated directly after a stranding is reported via the app or the website. These can be used in case of animals stranding alive, that might need to be rescued, in case of rare species that might have special value for research or musea, or in case of animals that appear particularly suitable for post-mortem research, which should be collected quickly. In case of extra-ordinary strandings, such as a mass stranding event[15] (MSE) or an Unusual Mortality Event[16] (UME) , action can be initiated immediately.

6.2 Pathological investigation of stranded Harbour Porpoises

Post-mortem research on stranded animals is conducted at the Faculty of Veterinary Medicine of Utrecht University since 2008, after stranding numbers started increasing. In the earlier years almost all animals were examined. Since 2016 a subset of 50 relatively fresh cadavers are investigated. The main aim of the post-mortem investigations is to determine an animal's most likely cause of death. Additionally, data is collected on potential zoonotic diseases of these animals, as they are in close contact with beach visitors when they strand. Also, samples for other research purposes are gathered during the necropsies. These include, but are not limited to, samples for diet studies, contaminant analysis and life history studies. The collection of samples over time creates the opportunity to assess and trace back in time, e.g. when a certain event (e.g. viral outbreak, new types of contaminants) calls for this. Another major goal of the post-mortem examinations and subsequent additional studies, is to assess the health status of harbour porpoises in the southern North Sea. An additional reason for the post-mortem examinations is to inform the general public about the reasons behind strandings of this charismatic species. In 2020 the IWC endorsed the Joint ACCOBAMS/ASCOBANS Best Practice on Cetacean Post-mortem Investigation and Tissue Sampling, which was developed internationally under the lead of Utrecht University among others (IJsseldijk, Bronlow and Mazzariol, 2019).

[15] Strandings of multiple animals, excluding cetacean cow/calf pairs simultaneously within a defined area often are referred to as mass strandings or mass mortality events. Source: https://www.fisheries.noaa.gov/insight/understanding-marine-wildlife-stranding-and-response, assessed 13/2/2020.

[16] Unusual Mortality Event (UME): a stranding event that is unexpected, involves a significant die-off of any marine mammal population, and demands immediate response. Source: https://www.fisheries.noaa.gov/insight/understanding-marine-mammal-unusual-mortality-events#what_criteria_define_an_ume? Assessed 5/3/2020

Currently, over 1700 necropsies have been conducted (see www.uu.nl/strandingsonderzoek). Several studies have been performed based on these since. Examples include the exposure of the grey seal as a major predator of harbour porpoises (Van Bleijswijk et al. 2014, Leopold et al. 2014, 2015, Podt & IJsseldijk 2017); several studies on prevelence, new and/or emerging diseases, such as *Aspergillus spp.*, *Brucella spp.*, *Herpes and Adeno viruses*, *Toxoplasma gondii*, *and Neisseria spp.* (Maio et al. 2014, Van Beurden 2015,2017, Van de Velde et al. 2016, Foster et al. 2019, Kapetenou et al. 2020); prevalence of marine debris ingestion (Van Franeker et al. 2018) and extensive information on diet analyses (Leopold 2015); bacterial transmission from grey seals to harbour porpoises by biting with zoonotic potential (Foster et al. 2019, Gilbert et al. 2020); scavenging by a fox on a live stranded harbour porpoise (Haelters et al. 2016) and studies towards the assessment of acoustic trauma and hearing damage (Morell et al. 2015,2017, in review, IJsseldijk & Gröne 2016).

The causes of death of the porpoises investigated in the period 2008-2013 (hereinafter: period 1) with those of the period 2016-2019 (hereinafter: period 2) have been compared because of a shift in focus. This was due to the change in sample size (period 1: n= 963 and period 2: n= 234). (IJsseldijk et al. 2020). For the comparison of causes of death between period 1 and period 2 (in period 2 only the DCC1-3[17] (freshest) animals had been selected) a number of differences became apparent. Comparing both periods, the percentage of infectious diseases has increased; the percentage of bycatches decreased and the percentage of grey seal attacks remained fairly constant, but with a shift in acute mortality towards mortality from bite wounds (IJsseldijk et al. 2020). The main causes of death of death remained the same, with infectious disease as main cause, followed by grey seal attacks, bycatch, emaciation and starvation. These are preliminary findings that need to be verified by a multivariable, temporal analysis to confirm the possible presence of age-, season- and/or location specific causes of death. Such an analysis should take into account the representativeness of the sample of collected animals taken annually and varied over time and, where possible, correct for annual differences. More details can be found in the yearly reports.

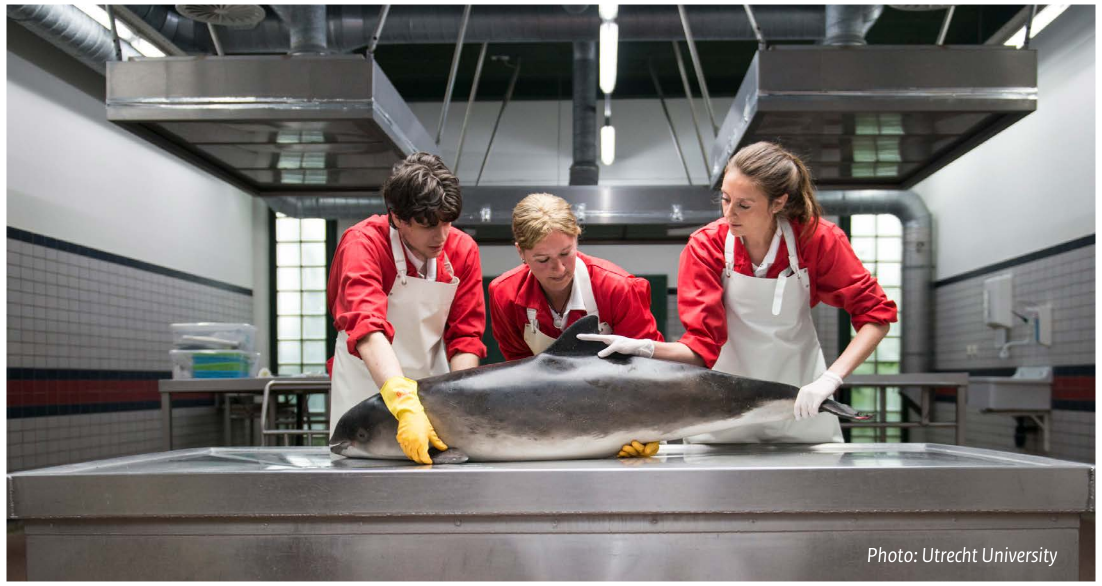


Photo: Utrecht University

The representativeness of the sampled stranded animals for the entire population remains unclear. Animals in the bycatch category are often labeled as a good 'control' group, because it concerns acute mortality and the chances are therefore higher that these are mostly healthier animals compared to the stranded animals (Siebert et al. 2006). However, in the Netherlands this is certainly not always the case and a further subdivision between healthy and sick animals within the bycatch category is necessary. For example, bycaught diagnosed porpoises examined in 2019 were found to have abnormalities, e.g. porpoises with a chronic jaw fracture and associated inflammation

[17] Decomposition Condition Code (DCC) is a code for the state of decomposition: from 1 (freshest) to 5 (rotten)

or severe parasitic and bacterial pneumonia. Investigation of 12 landed bycaught animals showed that two-thirds of the animals had abnormalities, which were severe in 40 % (IJsseldijk et al. In review). These abnormalities were thought to have negative effects on the health of these animals, and may therefore have indirectly contributed to the cause of death. However, the number of animals available for this study was small (n = 12), demonstrating that bycaught porpoises landed by fishermen are rarely accessible in the Netherlands. Validating the health status of porpoise bycatch is very important before this group is referred to as a control group.

It seems increasingly important to generate an answer not only to the question how an animal eventually died, but also to determine the health status of animals, bycaught or not. This gains more insight in the cumulative effects of threats that are often extrinsic and intangible, such as climate change or disturbance.

It is recommended to start collecting more data from stranded animals that will not be post-mortem examined. It is worth noting that through detailed photographs bycatch or predation as a likely cause of death could be diagnosed. However, this needs to be concluded with some degree of uncertainty, as underlying diseases or other abnormalities can only be discovered by post-mortem examination. With the foreseen start of collecting more data from stranded animals that will not be post-mortem examined, it is worth noting that although through the characteristic net imprints and mutilations on the outside bycatch or predation can be diagnosed, it is nevertheless important to determine the role of any underlying diseases or other abnormalities in these animals as well. Firstly, these can play a role in the chance of being (by)caught, but the histological examination also makes the difference in determining whether the incident was pre- or post-mortem. After all, dead porpoises can also be eaten by seals or end up in a fishing net.

The HPAC also reiterated that a knowledge gap in de current design of stranding research is the representativity of stranded animals compared with the population. The selected animals investigated since 2016 are all relatively fresh animals and presumably died nearshore. The HPAC therefore recommended to continue the (post-mortem) stranding research, nevertheless with several critical notes about the current design. The aim and purpose of the research should be clearly formulated and animals from offshore (e.g. caught in fishing nets) should be included. Therefore, in 2019, a pilot was initiated with three fishermen to land harbour porpoises that had been found in fishing nets. By the end of 2020 this project and its feasibility will be reviewed. The committee also encourages an integrated and internationally coordinated reporting of the strandings.

6.2.1 Analysis of North Sea wide stranded Harbour Porpoises

Under the lead of Utrecht University, strandings data from 1990-2017 from all countries bordering the western, southern and eastern North Sea were analysed, to investigate spatio-temporal trends and variation in biological characteristics (IJsseldijk et al. in review). In total, 16181 individual strandings were recorded. Analyses showed that strandings generally increased annually since 1990, with a notably steeper increase in incidence after 2004/2005 particularly in the Southern North Sea (see figure 6.2).

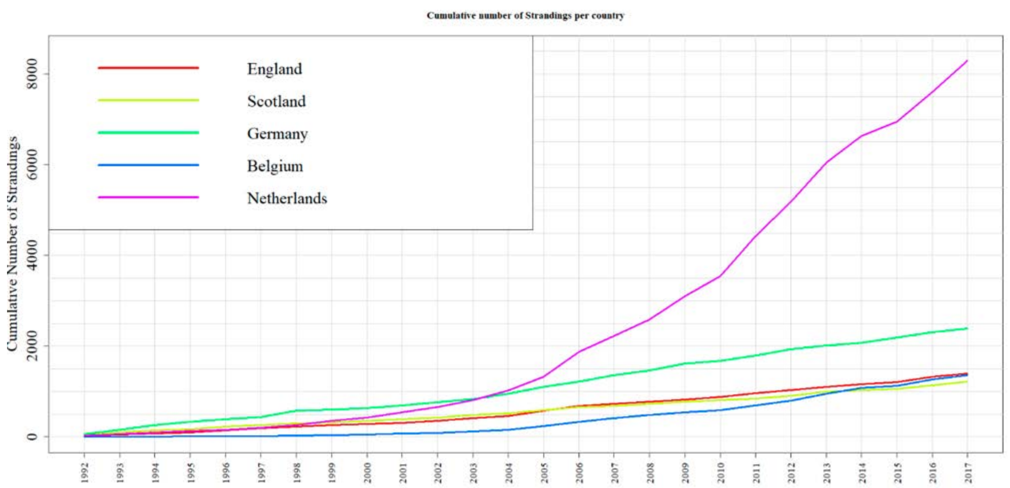


Figure 6.2. Cumulative number of strandings North Sea countries, as analysed by IJsseldijk et al. 2020

In the Netherlands specifically, annual strandings numbers have always been <100 prior to the year 2000, but a distinct increase in stranding numbers has been noted since 2004. Peak years were 2011 and 2013: both counting almost 900 individual harbour porpoise strandings on the Dutch coast alone (data from: www.walvisstrandingen.nl). The general increase in reported stranding numbers correspond with an increase in visual observations of harbour porpoises from land based counts (www.zeetrektellingen.nl), and aerial surveys (MWTL). See also Chapter 5 on the different data sources.

A strong seasonal variation across the North Sea regions was detected in the North Sea wide stranding analysis, as well as a clear southward shift (see figure 6.3; IJsseldijk & ten Doeschate et al. 2020). Heterogeneity in age-specific sex ratio was also detected, with a significantly higher incidence of juvenile male mortality in the southern regions and neonate strandings in the east. The outcomes of this study can be used to inform conservation management, although the significance of this higher incidence of juvenile male mortality for the harbour porpoise population in the North Sea is still unknown. By showing where higher numbers of potentially vulnerable population groups occur specific conservation measures such as the noise threshold, or time-area closures for certain activities can be imposed. This study also highlights the value of a transboundary approach to data analysis of a highly mobile marine species.

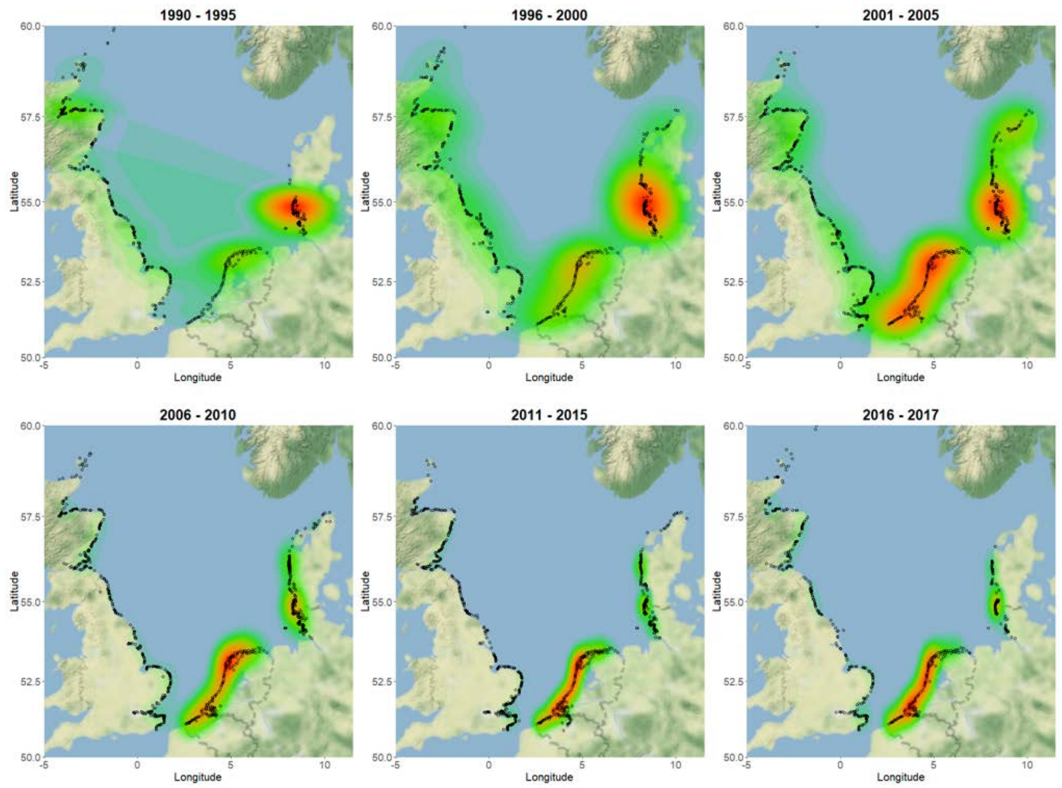


Figure 6.3 Spatio-temporal analysis stranding records North Sea coastlines, showing harbour porpoise strandings (black dots) and density from low (green) to high (red) (IJsseldijk & ten Doeschate et al. 2020)

IJsseldijk & Aarts (2020) used 29 years of sighting and stranding data (1990-2018) to assess which months based on coastal sightings, best explaining the observed variation in stranding numbers. The main goal was to assess if stranding frequencies along the Dutch coast could be explained by local sighting rates (porpoises/hr) as proxy for present numbers. When accounting the stranding for the sighting rate, the temporal patterns in the residuals show that in the early 1990's (when porpoise sightings were still rare) and after 2010, the number of stranded porpoises exceeded the number expected based on the sightings. Especially in the summer of 2011, the number of dead porpoises found ashore was excessively high. The possible cause for the perceived elevated mortality rate in the last decade might be natural, like redistribution of porpoises relative to the coast or increased mortality due to increased density dependent competition of a population near carrying capacity. Alternatively, the cause of the perceived elevated mortalities might be human-related, like increased anthropogenic activities at sea, and warrants further in-depth investigations into the causes of mortality. Follow-up studies should also focus on understanding what the fluctuating strandings numbers mean. Also, spatio-temporal analysis of causes of death or health parameters, like nutritional condition, are recommended in order to understand what (local) threats exist, also aiming at understanding what drives harbour porpoise distribution in the North Sea.

6.3 Marine pollution

There are two types of marine pollution recognized, chemical pollution and marine litter. Chemical pollution is a long-known threat, the impact of marine litter is an emerging threat and recognised as a global problem for the marine environment.

6.3.1 Chemical pollution

A number of chemical pollutant studies are currently ongoing in several countries in western European waters (ICES 2019c). The primary purpose of current contaminant research is to signal trends in identified contaminants and to identify new developments. Jepson et al. (2005) showed a relationship between PCBs and increased infectious disease mortality in harbour porpoises. And chemical pollution, PCBs in particular, is still considered to be a significant threat to marine mammals (Williams et al. 2019, Jepson et al. 2016, Murphy et al. 2015, 2018). It is known to suppress mammal immune and hormone function, which may result in increased susceptibility to infectious disease and impact the reproductivity. Harbour porpoises accumulate some of the highest amounts of PCBs in the North Sea, because they are long-lived mammals that feed at a high trophic level (Williams et al. 2019). Despite regulations and mitigation measures to reduce PCB pollution, their persistence and biomagnification in marine food webs continues to cause severe impacts among cetacean top predators in European seas (Jepson et al. 2016). Williams et al. 2019 show a decreasing trend of PCBs in harbour porpoises to levels below the proposed thresholds for toxic effects. However, even levels below this threshold were associated with increased rates of infectious disease mortality. They found that an increase in PCB blubber concentrations of 1 mg/k lipid was associated with a 5 % increase in risk of infectious disease mortality. This study also showed that juvenile harbour porpoises in the UK are exposed to a more neurotoxic mixture of PCBs than adults, likely as a consequence of pollutant offloading between mothers and calves during lactation. An ongoing study on contaminants in harbour porpoises that have stranded along the Dutch coast shows contaminant loads comparable to animals in the UK (Van den Heuvel Greve et al. in prep).

Several studies (Murphy et al. 2015, 2018) indicate that there is a link between contaminants (PCBs) and reduced reproductive success in porpoises. Lactating females appear to have lower concentrations of PCB compared to resting females, likely as a result of offloading through the lipid rich milk.

A study by Van den Heuvel Greve et al. (in prep.) is aiming to increase the knowledge on contaminants in harbour porpoises that have stranded along the Dutch coast. The study focuses on the concentrations of PCBs, brominated compounds (such as Polybrominated Diphenylethers – PBDEs), and Hexachlorobenzene (HCB) in all age groups and examines the transfer of these contaminants from adult female harbour porpoises to their fetuses. It also assesses potential effects of these contaminants on the immune system and reproduction. A manuscript discussing these results is currently in preparation. A follow up study has recently started on concentrations and potential effects of PFAS (per- and polyfluoroalkyl substances) in harbour porpoises that are stranded along the Dutch coast. These studies contribute to the understanding of generational cycling of contaminants in cetaceans and on the health status of harbour porpoises in the southern North Sea. Stuart-Smith et al. (2017) advocate renewed action in Europe to reduce PCB contamination and the establishment of an enforceable, effective and robust compliance mechanism, along with capacity building support for developing countries.

This together with the persistency of PCBs warranted work on a toxicity indicator for PCBs in blubber of marine mammals, that was proposed to OSPAR by the ICES WGMME in 2013, for inclusion as a biodiversity common indicator within the MSFD (ICES 2013). In 2019, the OSPAR Marine Mammal Expert Group (OMMEG) under COBAM further developed this indicator for inclusion within EU MSFD Descriptors 1 (Biodiversity) and D8 (Contaminant effects).

The advice of OMMEG to BDC and HASEC stated: (1) “For both assessments of trends and status, arbitrary numbers of 30, 50 or 100 animals will be assessed per assessment unit within each MSFD reporting period. Sample sizes vary as it depends on the species in question and the size of the assessment unit. Work will be followed up with statistical analysis to determine appropriate sample sizes for the species concerned.” And (2) “A European-based risk list of priority pollutants for monitoring specifically in marine mammals should be devised (Murphy et al. accepted). This would be aided by screening marine mammals for contaminants of concern listed on the EU watchlist for emerging pollutants (Commission Implementing Decision (EU) 2015/495) particularly those pollutants identified as endocrine disrupting chemicals (Murphy et al. 2019). Research should continue into monitoring effects from exposure to pollutants on health and reproductive status, including the effects from exposure to multiple pollutants, as required by Commission Decision (EU) 2017/848 on the MSFD. This work will then enable the further development of the mammal PCB indicator and the evaluation and development of other mammal pollutant indicators for the MSFD.” The process to develop and adopt PCB burdens in marine mammals as OSPAR indicator for contaminants and habitat quality started in 2019. Implementation of a fully developed PCB indicator will take some years, but the Netherlands has committed to its delivery, which is in line with the HPAC advice to join the international efforts in developing this.

6.3.2 Marine litter

The direct and indirect effects of marine litter on cetacean health are unknown. Van Franeker et al. (2018) investigated stomach content of harbour porpoises collected in the Netherlands between 2003 and 2013 for the presence of plastic and other man-made litter. In 654 stomach samples the frequency of occurrence of plastic litter was 7 % with less than 0.5 % additional presence of nonsynthetic man-made litter. The study compared using a non dedicated litter protocol with a dedicated protocol. This showed that when a dedicated standard protocol for the detection of litter is followed, a considerably higher percentage (15 % of 81 harbour porpoise stomachs from the period 2010–2013) contained marine debris. Results thus strongly depended on methods used and time period considered. Occurrence of litter in the stomach was correlated to the presence of other non-food remains like stones, shells, bog-wood, etc., suggesting that litter was often ingested accidentally when the animals foraged close to the bottom. Most items were small, none were associated to the causes of death of these animals and were not considered to have had a major health impact. No evident differences in ingestion were found between sexes or age groups, with the exception that neonates contained no litter. Polyethylene and polypropylene were the most common plastic types encountered. Compared to earlier literature on litter ingestion in harbour porpoise and related species, their results suggest higher levels of ingestion of litter. This is largely due to the lack of dedicated protocols to investigate marine litter ingestion in previous studies. The IWC organised a third workshop on marine debris in 2019 (IWC, 2020), in which the Dutch methodology was discussed and it was recommended that, with respect to marine debris, standardised approaches for post-mortems should be used, such as the abovementioned Joint ACCOBAMS/ASCOBANS Best Practice on Cetacean Post-mortem Investigation and Tissue Sampling (see 6.2). The workshop further recommended that zero values for marine debris ingestion or entanglement should be recorded in necropsy reports, so that a more reliable estimation can be made of the occurrence of marine debris. The IWC recommendations are also endorsed in this plan and the Netherlands will also support and follow-up on the recommendations made during the IWC workshop. It should be acknowledged that porpoises are not considered suitable as an indicator for marine litter, nor are they heavily affected.

6.4 Recommendations on stranding events and stranding research

6.4.1 Recommendations registration of stranded harbour porpoises on the Dutch coast

- Continuation and expansion of the functionallity of the current central registration of harbour porpoises strandings by integrating walvisstrandingen.nl and waarneming.nl into the new portal stranding.nl.
- Continuation of a coordinated voluntary stranding network.
  - Recognize the effort of the voluntary stranding network by network events, support their work with facilitation of permits and communication.
  - Optimize the functionallity and use of the stranding alert options that will be integrated in stranding.nl
  - Increase the data quality from stranded dead porpoises that are not selected for post-morten investigation, by engaging both the general public and the voluntary stranding network.
    - Encourage the general public and the stranding network (possibly via posters or signs near beaches) to use the proposed app and new portal, including to add pictures according to a standardized protocol.

  - Encourage the general public and the stranding network to continue providing information by reporting the results of the analysis at a regular interval. This can be done through a meeting or an attractive report. A website or digital application could be a useful tool as well.
- Establish or contribute to an international North Sea strandings database to be able to signal potential issues (based on accurate/up to date data). Such a database can facilitate analysing whether there are differences, similarities between regions. Include aspects such as grey seal predation, bycatch, age (length), sex. Stranding.nl can represent a basis for an stranding. EU international database. This should be done in coordination with ASCOBANS, where work is already underway to establish an international database for strandings. Efforts should be complementary in this regard.
- When a mass stranding event (MSE) or an Unusual Mortality Event (UME) is signalled:
  - An investigation of anthropogenic activities prior to and during the MSE should be investigated.
  - Necropsy of stranded animals should be facilitated, including analysis of the hearing organs to assess hearing damage. The latter should be prioritized given the limited time window for this.
- Assess social biases of the stranding network (such as regional differences) by communicating with and learning from other stranding networks (e.g. other countries or other species as birds).

6.4.2 Recommendations pathological investigation of stranded harbour porpoises

- As an international obligation, the (continued) facilitation of post-mortem research on a representative selection of animals, stimulating the replenishment of the tissue bank as well as its use for scientific research, is recommended.
  - Facilitate collecting samples for future analysis on e.g. genetics, age determination, contaminants and reproduction.
  - The collection of samples (e.g. tissue-bank) is recommended, which is important for temporal trends and to address sources of problems. The collection and preservation of samples ideally would be a shared task with other EU member states.
- The integration of various studies and the internationalization of monitoring are important steps to continue in the future, potentially leading to an international assessment on (spatio-temporal) analyses of health status and causes of death.
  - It is also recommended to conduct a spatio-temporal analyses of harbour porpoises diagnosed with likely bycatch as cause of death.
  - In addition to this, to address the coastal/offshore issue, it is recommended to develop and validate drift models for the Netherlands as from work by Peltier et al. This could also be very valuable in identifying where bycatch is occurring and to aquire more reliable estimates of bycatch from strandings.
- As the representativity of stranded animals compared with the population is an acknowledged knowledge gap, more pathological, and ecological research (see Chapter 5) on animals from further offshore is recommended to get a better insight in the general health status of the population, as well as drift modelling studies, which could also be very valuable in identifying where bycatch is occurring and estimates of bycatch from strandings.
- Signal and track (unusual) developments with post-mortem research, acknowledging that a selection of a selected subset is investigated. This is because only fresh cadavers of stranded animals can be thoroughly examined. This should be conducted especially in combination with the (increases in) data collected from non-necropsied individuals.

6.4.3 Recommendations chemical pollution

- Current Dutch research on contaminants in harbour porpoises is focused on assessing generational transfer and potential effects of several contaminant groups. It may in future also serve as monitoring assessing the development of trends and signaling new developments. In order to do this it is recommended to enlarge the Dutch effort by joining the OSPAR initiative to include the harbour porpoise as an indicator species in the monitoring of contaminants.
- It is also recommend to continue screening and monitoring marine mammals for contaminants of concern, as listed on the EU list for emerging pollutants, both for individual and population health status, following the OSPAR working group OMMEG advice.

6.4.4 Recommendations marine litter

- Assessment of marine litter in cetaceans is not a legal obligation, however can be incorporated relatively easily in post-mortem exams, depending on the level of detail required, as is stated in the Best Practice on Cetacean Post-mortem Investigation and Tissue Sampling, which has been adopted by the IWC and ASCOBANS. When executed, such harmonised protocols should be used.
- Furthermore, zero values for marine litter presence should be recorded in the necropsy report.
- The Netherlands will also support and follow-up on the recommendations made during the third IWC Workshop on Marine Debris (December 2019) in an international context.

7 Incidental bycatch

One of the main threats to the conservation of the harbour porpoise in the North East Atlantic is incidental bycatch in gillnet fisheries (Bjørge & Moan 2017, Dolman et al. 2016, Peltier et al. 2016, ICES 2015, Reeves et al. 2013). It involves a fisheries community that is, certainly for the Netherlands, based on often small single manned vessels. This makes it difficult to use traditional means of monitoring such as on-board observers. Bycatch events on small vessels also have a negative impact on fishermen, causing net damage and loss in time to disentangle animals.

Concerns about the sustainability of bycatch of harbour porpoise in European waters has led to a number of agreements aimed to monitor and reduce bycatch. Bycatch numbers vary between regions, and the underlying reasons for bycatch events are wide ranging and complex (Northridge et al. 2017), including fishing effort, net types used, animal distribution and behaviour.

Although it has been recognized as a problem by numerous organizations and groups for decades, there has been little success in tackling bycatch as well as accurate monitoring of the gillnet fisheries in ICES area 4.c (Southern North Sea). The HPAC emphasises the need for accurate obligated monitoring in this area given the porpoise density and gillnet fisheries effort. Incomplete or inaccurate monitoring data on both fishing effort and bycatch events causes low confidence in bycatch estimates. There is a lack of comprehensive information from all member states on the bycatch of cetaceans in EU waters and without a reliable understanding of the problem, mitigation is not as straightforward as it might appear at first sight.

Photo: René van Rossum Puffin dtp & fotografie

From 2013-2017 the bycatch of harbour porpoise in the Dutch commercial bottom-set gillnet fishery has been assessed using a Remote Electronic Monitoring system (REM, Scheidat et al. 2018). Applying the estimated bycatch numbers for the study period (2013-2017) to the average number of porpoises occurring in Dutch waters results in a bycatch percentage that is clearly below the 1 % threshold value advised by ASCOBANS (see Chapter 3). However, the project concluded that as fishing effort had been low (compared to 2003-2012 effort was low in 2013-2017, but much higher compared to 2018-2020) during this time it is not advisable to assume that these values are constant. This project has provided valuable insights, but also highlighted what gaps future monitoring needs to address.

This chapter offers insight in recent developments in incidental bycatch monitoring and assessment, and also in efforts of the Netherlands for a crossborder, multidisciplinary project on bycatch.

7.1 Bycatch assessment

Monitoring of smaller vessels (<15m) in the European fishing fleet has to date generally been poor, although sampling designs under the EU-Multi Annual Programmes (EU-MAP) need to ensure representative coverage of relevant fishing activities (métiers) for protected species bycatch (ICES 2019a). As mentioned in Chapter 3, there is an MSFD indicator for bycatch of harbour porpoise, which is based on ICES and OSPAR work. Within the OSPAR Maritime area bycatch is estimated to be a major cause of human-induced mortality of harbour porpoises. The abundance estimate for the total population in the OSPAR assessment area (see figure 7.2) is greater than 490,000 (OSPAR IA 2017). The estimates of annual bycatch are around 4000 but there is low confidence in the bycatch estimates due to incomplete monitoring data of fishing effort. These bycatch estimates are derived from observing only 0.28 % of the fishing effort for the fishing gear types classified as 'nets' (see OSPAR harbour porpoise bycatch factsheet 2017 IA).

In its advice of 2019 (ICES 2019b), ICES estimated that the percentage mortality of the harbour porpoise population in 2017 in nets in the Greater North Sea (see figures 7.1 and 7.2) was between 0.33 % and 0.59 % (corresponding to 1175–2126 individuals per annum). ICES, in its most recent review, reported a bycatch rate of 0,056 % for harbour porpoise in the Greater North Sea in 2018 (ICES, 2020a). This estimate does not exceed the 1 % limit for bycatch mortality as advised by ASCOBANS (ASCOBANS, 2016). However, ICES notes in its latest advice of 2020 that the current state of knowledge, together with data collection schemes and reporting formats, does not allow for robust assessment of Protected, Endangered, and Threatened Species (PETS) bycatch and evaluation of fishing effects (ICES 2020b). When setting limits for bycatch, it is recommended by the HPAC to take seasonal variations in the number of animals (that occur in Dutch waters) into account. ICES (2020) furthermore noted that effort metrics other than the currently used one "days-at-sea" may provide more accurate information on bycatch rates of PETS. Therefore, ICES suggests to investigate the possibility to obtain fishing effort in different metrics to perform comparative analysis on the effect of different fishing effort metrics on bycatch mortality estimates. Furthermore, in order to raise bycatch rates to fleet level, an accurate record of fishing effort is needed. In 2017 and 2018 there were discrepancies in total fishing effort between the WGBYC database and the ICES Regional DataBase (RDB). When RDBES is operational (2022), ICES should carry out comparisons of fishing effort, monitoring effort, and bycatch data before any decisions on full transition to RDBES as the sole data source. Finally, ICES noted that in general, there has been little progress on the mitigation of cetacean bycatch. ICES continues to have insufficient data to examine bycatch rates according to pinger use within their database. A recent study carried out in the Bay of Biscay on three midwater pair trawls in winter 2018 indicate a reduction of 65 % of bycaught common dolphins with the use of pingers DDD-03 (ICES, 2020b).

Scheidat et al. (2018) assessed the bycatch of harbour porpoise in the Dutch commercial bottom-set gillnet fishery (see paragraph 7.2 for details on the project). Bycatch numbers were estimated by applying the bycatch rate (porpoises/net length km) to the effort of the complete fleet. Results showed that bycatches occur in both single walled gillnets (GNS) as well as trammel nets (GTR) and that the average annual bycatch of harbour porpoise for this fleet was 23 (95 % C.I. 2-44) during the study period. This translates to an annual mortality of between 0.05 and 0.07 % of the Dutch harbour porpoise population (with a maximum worst case value of 0.3 %). Bycatch rate was different between net types, with a higher bycatch rate (0.004) for trammel nets and a lower bycatch rate

(0.0006) for single walled gillnets. This study did not include mortality caused by other fishing fleets operating in Dutch waters.

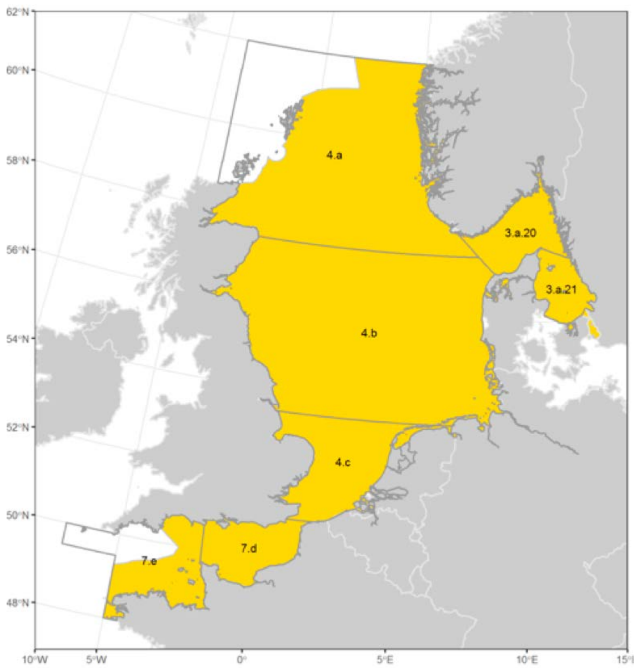


Figure 7.1. The Greater North Sea ecoregion (in yellow) as defined by ICES. Source: ICES Fisheries overview 2017

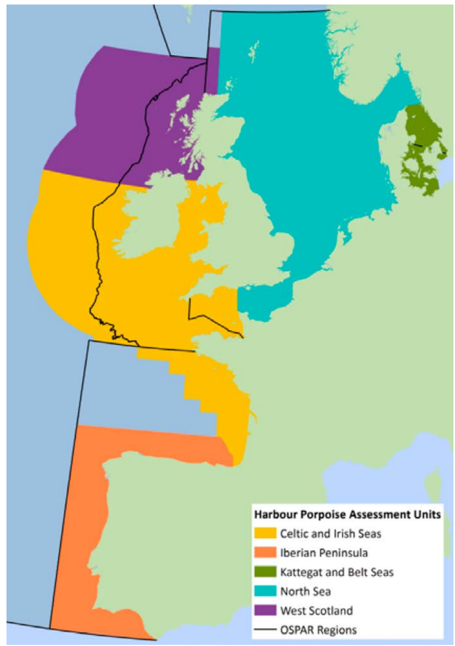


Figure 7.2. Assessment Units OSPAR bycatch assessment. Source: OSPAR Intermediate Assessment 2017

As the bycatch risk for harbour porpoises and other species is generally evaluated at a spatial scale that may or may not be representative of population structure, population-level impacts may not be adequately estimated. ICES suggests that, where possible, any bycatch risk on Protected, Endangered and Threatened Species should be evaluated based on natural population units (ICES 2019b).

7.1.1 Threshold values

A joint OSPAR-HELCOM-ICES workshop[18] in September 2019 examined possibilities for developing threshold values for incidental bycatch on birds and marine mammals. A conservation objective was proposed for the three bodies "*Minimise and where possible eliminate incidental catches of all species such that they do not represent a threat to the conservation status of these species*". The definition of the objective implies the need for a threshold to identify the point at which bycatch threatens the conservation status of a species. The OSPAR-HELCOM workshop proposed that this point would be when the mortality rate from incidental capture exceeds levels that result in a reduction of median population size below 80 % of carrying capacity within a 100-year period. The implication of this is that it is accepted that the interim objective set by ASCOBANS of maintaining populations at 80 % of carrying capacity may fail to be met 50 % of the time.

The approach to determine mortality limits originally stems from the development of the Revised Management Procedure by the International Whaling Commission (IWC) which at its core has the Catch Limit Algorithm (CLA). The method was originally developed to provide sustainable catch limits for large whales, but is also applied to incidental causes of cetacean mortality (Removals Limit Algorithm, RLA). In contrast to using a simple percentage of estimated population size these approaches do account for uncertainties surrounding the estimates of abundance and mortality and consider additional information about the population (e.g. past abundance and mortality estimates).

Having considered the outputs of the OSPAR-HELCOM workshop, OSPAR Working Group OMMEG proposes to use the RLA approach for Quality Status Report 2023 for harbour porpoise in the Greater North Sea.

[18] This workshop was a valuable platform for discussion. It is recognised that the workshop outcomes are suggestions which will be further considered in OSPAR and are in no way binding until Parties agree so.

This was recently done by Hammond et al. (2019) whose implementation of the RLA for harbour porpoises in the Greater North Sea (see figure 7.1 (ICES 2014)) resulted in a threshold bycatch of 1,800 animals i.e. ~ 0.5 % of the 2016 abundance estimate for the North Sea harbour porpoise.

Scheidat et al. (2013) implemented the CLA approach for porpoises in Dutch waters. Their input parameters differed from the OSPAR-HELCOM approach in that they interpreted the intent of the ASCOBANS objective as requiring a high probability (95 %) (vs 50 %) that the ASCOBANS aim would be met. The resulting mortality limits (including bycatch) calculated for Dutch waters were 183 animals per year (Scheidat et al. 2013).

It is important to keep in mind that the output of the RLA is entirely dependent on the definition of a quantitative conservation objective which is a policy decision. The abovementioned objective is currently being discussed within OSPAR. The results also depend on the accuracy of the input parameters and time series of bycatch and abundance estimates (Hammond et al. 2019).

7.2 REM monitoring in the Netherlands

The quantification of marine mammal bycatch is important in the context of conservation and management of protected species. Different methods of obtaining data on bycatch events during fishing operations are available. The most commonly used are on-board observer programs. However, observer programs can be expensive and monitoring of the Dutch commercial gillnet fleet with observers is challenging, primarily due to the small size of some of the vessels which are often run with only one crew member, thus providing very limited space on board. An alternative approach is the use of Remote Electronic Monitoring.

Comparisons between REM results and fishers' logbooks by Kindt-Larsen et al. (2012b) showed that the REM system gave more reliable results, since fishers, in many cases, did not observe the bycatch while working on the deck because the bycatch had already dropped out of the net before coming on board. These dropouts formed a significant part of the actual bycatch, 18 %. The REM system provides bycatch data that are much closer to the actual bycatch, and allows a better assessment of the impact of bycatch on the population. Furthermore, very high coverage percentages at low cost, compared to on-board observers, could be obtained with REM. In the Danish study also alternative means of conducting the video analysis were tested; they were, however, not found to be very efficient.

In the Netherlands a pilot study was done in 2011 on one gillnet vessel to investigate the efficacy of remote electronic monitoring (REM) on Dutch gillnet fishing vessels (Van Helmond & Couperus 2012). Based on the promising results from this pilot study, as well as the priorities outlined in the Harbour Porpoise Conservation Plan (Camphuysen & Siemensma 2011) and results of similar Danish studies (e.g. Kindt-Larsen et al. 2012a) it was decided to conduct a REM study with the goal to sample 5 to 10 % of the Dutch gillnet fleet fishing effort in the time period from June 2013 to March 2017.

A total of fourteen fishing vessels of the Dutch commercial bottom-set gillnet fleet were equipped with remote electronic monitoring (REM) systems. Closed-circuit television cameras (CCTV) in combination with sensors were used to obtain video footage, time and position of all net hauls. Video footage was analysed for porpoise bycatch events and correction factors were applied to account for video quality. Part of the video footage was analysed a second time and a correction factor was added to the bycatch rate to account for animals missed during the first video analyses (Scheidat et al. 2018). In total 900 fishing days of the bottom-set gillnet fleet (of a total of 8133 fishing days) were analysed (11 %). The effort value "net length km" were considered the most suitable to calculate bycatch rates, as the results based on this metric had a lower variability than "ton landed" and were a more realistic reflection of effort than "fishing days". As in the Danish study, Scheidat et al. (2018) also found that two out of six cases within the REM analysed days where bycaught porpoises dropped out of the net unseen by fishermen.

Bycatch landed by fisherman
Photo: Marije Siemensma, MS&C

The REM project estimated the annual bycatch mortality (Scheidat et al. 2013) of harbour porpoises in the Dutch gillnet fishery as 23 (95 % C.I. 2-44), this translates to a maximum worst case annual mortality value of the Dutch harbour porpoise population of 0.3 % (Scheidat et al. 2018). While the bycatch numbers for that time period are within the mortality limits consistent with the ASCOBANS aims (both using the CLA approach or the 1 % threshold), it is important to interpret this with caution. The fishing effort does not include foreign fisheries and recreational fisheries with gillnets (see 7.3.2 and 7.3.3). And finally, the dynamic nature of both fishing activity and porpoise occurrence make it likely that bycatch numbers change between years.

A number of key recommendations were formulated by Scheidat et al. (2018) which will be reflected in the recommendations of this conservation plan. These include the development of a cost-effective mobile REM system (see also Scheidat & Königson 2016), continuation of REM within the Data Collection Framework (Council Regulation EU 2017/1004), facilitation of permits to land animals, assessment of factors causing bycatch in Dutch waters and the improvement of the data collection methodology of fishing effort on an international level. Investing in the cooperation with the fisheries sector has been recommended as a key factor for successful monitoring of bycatch. When using REM monitoring, one should realize that it involves a method that may result in concerns over privacy making an agreement on the use of data and confidentiallity with all parties involved before the start of data collection essential. The HPAC reiterates the importance of a representative project set-up and emphasizes the added value for a REM project in an international context, to allow comparing results and reliable bycatch assessments at population level.

7.3 Main sources of bycatch in the Netherlands

7.3.1 Commercial bottom-set gillnet fisheries

The Dutch bottom-set gillnet fleet consists of 70-100 vessels. Most of them are operated by part time fishermen, who only fish for a limited time per year and most of them are below 12m. The latter means they are not required to complete EU logbooks. The net type used during fishing operations varies and depends on the target species of the fishermen at the time. Within the EU definition (Appendix IV of the 2010/93/EC) two net categories are considered: single walled bottom set gillnets (GNS) (figure 7.3) and the three-walled trammel net, which is categorized as trammel net (GTR) (figure 7.4). “Sole nets” (GNS) are the most commonly used gillnets in the Dutch fisheries.

Sole is by far the primary target species of the commercial Dutch gillnet fishers. It is normally fished upon from March till October. From October till March, some fishermen (5-10 vessels, depending on the catches and the market) switch to cod, turbot and brill – using three walled trammel nets - and to a much lesser extent to plaice and flounder. A few gillnet fishers target mullet in the Delta area and the Wadden Sea, some (the exact number is unknown) gillnet fishers fish at wrecks with single walled gillnets for cod or near dams for bass.

However, it should be noted that even within one net type mesh sizes and net height can vary considerably. What type of net is actually deployed highly depends on the fish availability (e.g. also the size) and fishermen routinely switch between net types. Since most vessels are very small, trip duration is normally one day. Approximately five vessels are larger than 12m and may stay at sea overnight.

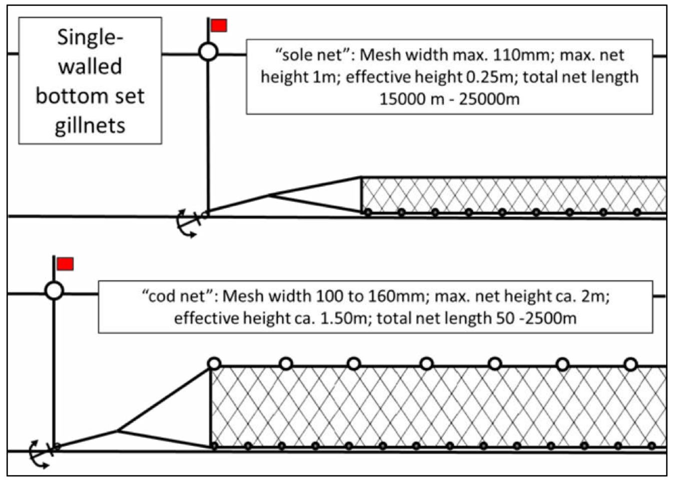


Figure 7.3. Schematic description of the most commonly used single walled bottom set gillnets (GNS) in the Dutch fishery. Credit: Meike Scheidat

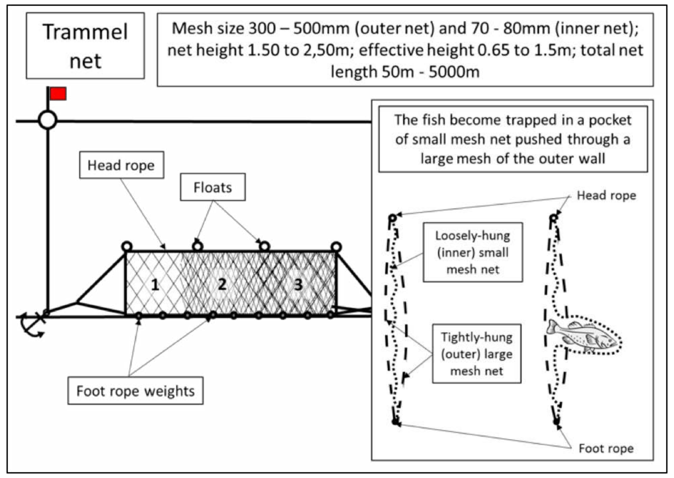


Figure 7.4. Schematic description of trammel nets (GTR) used in the Dutch fishery. 1: one outer net, 2: one outer net with the inner net and 3: the two outer nets with the inner net inside. Credit: Meike Scheidat

The aim of the REM study by Scheidat et al. (2018), was to quantify bycatch of harbour porpoise in the Dutch commercial bottom-set gillnet fleet. In addition, other sources of bycatch in gillnets occur in Dutch waters that are not always well quantified.

7.3.2 Foreign vessels

Other countries also fish in Dutch waters and those activities are likely to contribute to the bycatch of porpoise in Dutch waters. While not within the objectives of the REM study, Scheidat et al. (2018) explored the data available through the Joint Research Centre database (stecf.jrc.ec.europa.eu) to get an indication of the scale of the non-Dutch fishing effort in the study area. Trammel nets (GTR) are used in Dutch waters pretty much exclusively by vessels operating under the Dutch flag, and all effort of these is in the coastal areas. For single walled gillnets (GNS) the Dutch fleet lands about 60 % of all fish based on fishing effort data from 2014, 2015 and 2016, the rest is primarily landed by vessels operating under Danish and German flags (Scheidat et al. 2018).

Interpretation of this data in terms of overall bycatch estimates for the Dutch waters combining all vessels is difficult as it is not known if the estimated bycatch rates for the REM project can be extrapolated to vessels from other countries. Also, the fishing effort information provided is not entered consistently between countries and does not have a spatial resolution that would allow calculation of effort for Dutch waters only. One conclusion however is that any additional bycatch from non-Dutch vessels would primarily come from single walled gillnets. A joint effort of multiple Member States is required for a more accurate bycatch assessment.

7.3.3 Recreational bottom-set gillnet fishery

As mentioned in Chapter 3 recreational bottom-set gillnet fishery in the Netherlands is granted under certain criteria (see 3.6) in 25 coastal municipalities. Catches in the recreational fishery don't have to be registered and logbooks are not required. The EU Data Collection Framework (Council Regulation EU 2017/1004 and Commission Decision EU 1251/2016) obliges the Netherlands to report on recreational catches of certain fish species. Since 2014 a recreational gillnet survey is executed every two years, aiming to provide insight into this activity. The latest result of this survey (van der Hammen & de Bruin 2020) indicated that 61 % of participants fished 1-5 times per year and 10 % indicated that they fished more than 50 times per year. Most fishing trips were made in the months of March, April and May.

Bycatches of dead porpoises have not been formally registered in this fishery, but there is a record of a live catch on 23 February 2011 close to Katwijk (Jongbloed et al. 2013) and a second one on 5 April 2014 close to Noordwijk (Scheidat et al. 2016). Even though these nets are bottom-set, because of the shallow coastal waters, the porpoises were able to reach the surface to breathe. On May 27 2019 an animal was observed swimming in a gillnet close to the coast near Scheveningen, and died after it could not be released on time (IJsseldijk 2020).

Fishing effort (as net length) in recreational fishery is low compared to the commercial fishery. However, as there is a lack of reliable data on the number of bycatches (dead or alive), the Dutch recreational fishery is a hitherto unquantified source of potential bycatch, where additional monitoring and quantification of effort is needed. This is also a recurring topic by the HPAC. In discussions, other recommendations have been suggested such as sharing experiences with other countries, such as Belgium, on recreational fisheries and bycatch or promoting outreach to recreational fisheries, e.g. with a flyer when the fishermen come to notify their fishing activity which is obligatory every year.

7.4 Bycatch information gained from necropsies

Stranding networks in combination with necropsies can provide useful data on bycatch occurrence, and are the only source of information in cases where dedicated programs to monitor bycatch are lacking (ICES 2017ab). Any bycatch information derived from necropsied stranded porpoises need to be considered with caution as they are based on a potentially biased sample. Scheidat et al. (2018) compared the results from the REM study with bycatch numbers based on necropsied stranded animals and these are in the same range, which did not point to any obvious incongruities between the two data sources (see table 12 in Scheidat et al. 2018).

Peltier et al. (2016) used strandings data on harbour porpoises to reconstruct the trajectory of every stranded harbour porpoise from its stranding location to its likely area of death at sea, aiming to obtain reliable information on bycatch occurrence. The analyses show that between 1990-2014, in the North Sea, predicted densities of harbour porpoise bycatch mortality increased and distribution of mortality areas moved to the south eastern North Sea.

In the Dutch situation, there is an example that a drift model seemed to have successfully predicted the location and time of a stranding. Van Helmond & Couperus (2012) mention a porpoise, bycaught in a set gillnet 1 km off the coast of Rotterdam on 16 February 2011. The drift model used by the maritime police predicted that it would strand after 5 days near Scheveningen. Indeed, on 21 February a fresh carcass of the approximate estimated length and with clear imprints of netting stranded within the predicted area, although there was no hard evidence that it was the same specimen. During the REM-project, four bycaught porpoises were not brought ashore. Plastic labels to be used on carcasses that would be released had been provided to the fishermen, but none of these animals were labeled within the project. Most of the animals were considered to rotten to label or dropped from the net before being hauled on-board. Collection of this type of data would be very valuable to improving the understanding of the drifting behaviour of porpoise carcasses and potentially sheds light on the chance of bycaught animals that are stranding ashore.

7.5 Bycatch mitigation

There is not a single panacea to solve fisheries bycatch in. Investing in a diverse, adaptive portfolio of tools and approaches to best match ecological, sociocultural, and economic contexts offers the best path forward to address global bycatch and support sustainable fisheries into the future (Komoroske & Lewison 2015). Although this seems rather logical, there has been little progress in the mitigation of bycatch of cetacean and other marine mammals (ICES 2019b). The effectiveness of bycatch mitigation measures varies among fishing métiers, geographical areas, and species, but in general very few measures have been put in place to reduce harbour porpoise bycatch in European waters. Where mitigation using pingers has been required in legislation the reductions in porpoise bycatch have been relatively small compared to the total bycatch (e.g. Northridge et al. 2018). It should be noted that the effect of pinger use has been small, because of the requirement for pingers only covers a small part of the static gillnet fleet. (i.e. ~25 larger vessels in the UK for example, compared to hundreds of small vessels <12m). ICES advices to further develop mitigation measures and trials to test their effectiveness, and research to identify bycatch hotspots, that are still needed to reduce the bycatch of protected species in many fisheries (ICES 2019b).

With regard to finding effective mitigation methods for reducing the bycatch of harbour porpoises, there is still limited understanding of modifications that could be made to gillnets to encourage harbour porpoises to avoid them (ICES 2019a). An assumption in terms of risk would be that risk is proportional to soak time and net length. However, this has not been demonstrated for most cetacean bycatch problems. In addition, measures of soak time (e.g. the time the nets are set into the water) are rarely available.

Investigating the spatial and temporal overlap of harbour porpoise presence and fishing effort can allow to predict areas of potential high and low bycatch risk for porpoises (Kindt-Larsen et al. 2016). High risk areas are areas where fisheries with a high risk of bycatch coincide with areas which are important for the species. Provided that high-resolution information is available, overlaying distribution patterns and static gillnet fishing effort can be used to inform when and where to focus monitoring and mitigation actions (ICES 2019a). One should be cautious as local circumstances can differ and might require a different approach, depending on type of fisheries, net type, abiotic factors, nevertheless it is worth further developing methods to better understand the risk of bycatch.

Leaper & Calderan (2018) summarized mitigation methods that have been undertaken with the objective of reducing bycatch, and asses their efficacy and future potential. These include methods for reducing risk of contact between cetaceans and fishing gear, such as effort reduction, fishing bans, acoustic alarm or 'pingers', gear modifications and alternative gear. The review focusses on specific technical measures but these need to be considered as part of overall strategies involving all stakeholders. Leaper & Calderan (2018) emphasize there are rather few examples of implemented mitigation measures substantially reducing cetacean bycatch. Enforcement and compliance are key to the success of any measures and the lack thereof has been the cause of many mitigation programmes' failure to meet their objectives. Successfully implementing any measures does require extensive stakeholder collaboration and appropriate incentives or enforcement (Scheidat et al. 2018, Komoroske & Lewison 2015).

7.5.1 Pingers

While numerous bycatch mitigation strategies exist, acoustic alarms or deterrent devices, or 'pingers', are the most widely adopted mitigation strategy to reduce bycatch for small cetaceans (Omeyer et al. 2020). Although pingers have been shown to be an effective measure for numerous species, their effectiveness varies between areas and species and some limitations need to be taken into account. It is important that the use of pingers is done correctly, otherwise bycatch rates can even increase. This includes the correct spacing and deployment on nets and that the pingers are regularly checked whether they are still functioning (defect, battery empty, incorrect mounting, loss, etc.) (Palka et al. 2008, Kingston & Northridge 2011, Bjørge et al. 2013, Dawson et al. 2013, Larsen 2013). There are some concerns about their long-term use, causing habitat exclusion or habituations. This in addition to other environmental welfare and behavioral impacts such as the introduction of noise into the marine environment (Dawson et al. 2013, Larsen 2013) as the review by Leaper & Calderan (2018) concludes.

A review of 14 controlled experiments using pingers in Europe and North America by Dawson et al. (2013) also shows substantial reductions in bycatch and no habituation. Efforts have been taken to study habituation or habitat displacement in UK waters by Omeyer et al. (2020). Although the authors state that they did not find evidence of habituation or substantial habitat displacement over their study period, the results should be interpreted with caution as this particular study was based on one pinger.

In a study in Iceland in 2017 testing a pinger device, six cetaceans (five harbour porpoises and one white beaked dolphin) were caught in the sets equipped with pingers, while five animals (four harbour porpoises and one white beaked dolphin) were caught in the control sets. No significant difference was therefore observed between the pinger and control nets. There was similar size and gender composition of the bycaught animals between the nets with pingers and the controls, and there was no difference in catch or species composition of fish (ICES 2018). Porpoise alert devices (PALs) that were tested in April 2018 in the Icelandic cod gillnet fishery were also unsuccessful (ICES 2018). A total of 23 porpoises were caught in the trial. Twelve of those animals were caught in the sets with PALs, and eleven in the control sets. No significant difference was therefore observed between the PAL and control sets. Interestingly, almost all the by- caught porpoises in the PAL sets (eleven out of twelve) were large adult males, while the gender ratio was seven males and four females in the control sets. Interestingly, eight of the twelve porpoises caught in the PAL sets were found right by the PAL device, suggesting possible attraction of adult males towards the PAL devices (ICES 2018). Leaper & Calderan (2018) also mention contradicting results of an alerting device, Porpoise Alarm (PAL) (Culik et al. 2015, 2016).


Bananapinger
Photo: Vereniging Kust en Zee

In a European Fisheries Fund study coordinated by the Coastal & Marine Union (Siemensma 2014), a pinger has been tested by a group of Dutch commercial bottom-set gillnet fishermen. There were no significant results as bycatch rates where to low. In contrast to the use of other types of pinger, the practical use of this device was considered positive. In collaboration with the manufacturer of the device and based on practical recommendations from the fishermen, adjustments have been made to the housing to prevent damage to the nets and to improve the attachment on the headrope of the nets. This was a good example of which the practical features of a mitigation tool have been optimized in close cooperation with the sector

Pinger research in Europe seems to lack a joint coordinated approach, which is needed, as reiterated by the HPAC. The use of pingers should be assessed case-by-case if considered the most effective measure for the particular fisheries and area and to evaluate the impact of potential habitat loss for porpoises. For the Dutch situation, considering the low number of bycatch events, and the potential of the sounds emitted by pingers leading to habitat degradation, Scheidat et al. (2018) currently do not consider the implementation of the wide use of pingers for the Dutch gillnet fleet an effective measure. The voluntary use of pingers however is possible and their use should be facilitated and monitored.

7.5.2 Alternative gear and or gear modifications
As stated previously, all types of gillnets have been shown to catch porpoises and even if bycatch is considered low in one point of time, as soon as fishing effort and/or porpoise occurrence changes bycatch rates can increase (Leaper & Calderan 2018; Northridge & Hammond 1999).

The development of alternatives in gear or modifications in gillnets that can lower or eliminate the risk of bycatch is thus an important consideration for long-term mitigation. Leaper & Calderan (2018) refer to trials with cod pots as an alternative to gillnets to lessen catch losses and damage to fishing gear by grey seals (Königson et al. 2015). This damage is also the case for Dutch fisheries. The work by Königson et al. (2015) showed that pots can viably replace gillnets in some fisheries and are worth exploring in areas where large whale entanglement is not likely to be an issue.

Switching from gillnets to alternative gear requires effort and investment from the fisheries sector. Questions like what does it involve in terms of logistics, safety and also income are obvious questions that need to be addressed diligently. Incentivising (partially) switching to other gear types, could encourage fishermen. A review by Calderan & Leaper (2019) on UK bycatch recommended that all UK gillnet fisheries should be assessed for potential use of alternative gears. Suitable candidates for shifts to alternative gear are primarily hooks (long and hand lines), but also potentially pots/traps.

Leaper & Calderan (2018) also refer to attempts that have been made to alter the mechanical and acoustic properties of nylon gillnets, aiming at improved detection, and thus avoidance of nets and reduced risk of entanglement. Larsen et al. (2007) show a significantly lower harbour porpoise bycatch testing iron-oxide gillnets, but also a reduced catch to such an extent that they could not be considered a viable mitigation option.

Within the Netherlands, no alternative fishing methods or gear adaptation for bottom-set gillnet fisheries are being investigated actively. A seminar on the viability of fish traps for lobster, cuttlefish, crab, sea bass, cod and sole in the North Sea in 2011 concluded that the industry is interested and curious about the options, however there are still questions about how this gear type functions in Dutch waters (such as the influence of the tidal current for example). A change of gear also involves practical alternations on board, which might not always be feasible on smaller vessels of the fleet or involves high costs without a guaranteed success. Trials in offshore wind parks to test the practical design or the behaviour of fish (bait, stimuli) were considered a potential for future cooperation, although no progress on this has been made yet and fisheries in offshore wind farms is currently prohibited.

7.5.3 Cooperation with fisheries
One of the biggest challenges is involving the fisheries sector. If it is not made clear what the benefits of reducing bycatch is, in combination with bycatch often being penalised, it is not difficult to imagine why fishermen are not always willing to cooperate in these projects.
In the long run, this leads to unreliable monitoring and measures not being implemented in the field.

The REM-project in the Netherlands is a good example of how important mutual trust, good working arrangements and positive incentives are to be successful. REM provides valuable data for bycatch monitoring, particularly on smaller vessels. However, the limitations of space mean it intrudes on the privacy of the crew and installation options are restricted. During the REM-study technical and non-technical challenges continuously emerged, leading to a critical project stage within the first year. However, through a number of interventions these difficulties could be resolved and over the next five years the project turned into an example of a successful cooperation between scientists, fishermen and the government. Fishermen could apply for a so called science quotum to compensate for their time and effort in the project. Initially this was refused by the Ministry, but at a later stage it was allowed, and although not all fishermen were able to benefit from this, it altered the attitude of the participating fishermen positively. Analyses of the project procedure highlighted that the main issues were not logistical challenges but instead intrinsic (traditional believes) and extrinsic (changes in policy) factors that influenced the perspectives of the stakeholders in combination with inadequate communication and an atmosphere of distrust. A successful cooperation is only possible when each other's perspectives are understood and respected. Planning an REM project with a small scale fishing community needs to include as much effort and attention to ensure effective communication as much as the challenges of collecting and analysing the data.

For bycatch, mutual benefits of reducing bycatch are evident; from prevention of damage to fishing nets, to not having to spend time on non-commercially interesting species, to, of course, less fatalities of harbour porpoise. A way forward is to consider ways to incentivise cooperation as done within the agricultural sector. Under the European Green Deal farmers will be paid for the environmetal services. A workshop on incentivising consistent data collection and transparent reporting of marine mammal bycatch in fisheries was held at the World Marine Mammal Conference (WMCC) in 2019 in Barcelona, organised by the Marine Stewardship Council (MSC). The aim of the workshop was to (1) understand 'minimum viable' and 'best practice' information that should be recorded when fishing gear interacts with marine mammals and (2) to create a clear picture of best practice approaches to incentivising collection and sharing of transparent, consistent information on marine mammal bycatch. In general it was shared by the participants that investing in both cooperation with the sector and in understanding the perspective of the sector should be a priority as well as exploring creative solutions to incentivise the sector (pers. comm. M.L. Siemensma). No report is publicly available yet.

7.5.4 Need for international cooperation
Bycatch has been on the international agenda for some time now. It is more and more recognized that it is a multidisciplinary issue, not solvable if only approached from one perspective, be it nature conservation or fisheries. The time seems ripe for appropriate action.

This was also emphasized by European Commissioner for Environment Oceans and Fisheries, Virginijus Sinkevičius, when he sent a letter to all European Fisheries and Environment Ministers on 25 February 2020 calling for action on this issue. The letter followed after a complaint was filed in July 2019 by 25 NGOs at the European

Commission against 15 European Member States[19], including the Netherlands, because they, among others "have systematically failed to implement conservation measures that ensure that bycatch does not have a significant impact on these species." Recent developments in international legislation and policy seem to pave the way for action as well, as is explained in Chapter 3.

Almost all relevant biodiversity and fisheries related treaties and bodies have a specific bycatch group or specific task on bycatch. Groups under ICES, ASCOBANS and OSPAR/HELCOM have been mentioned. However there are more, but not a complete list: the International Whaling Commission (IWC) has its Bycatch mitigation Initiative (BMI), the Convention on Migratory Species (CMS) has a COP Appointed Councilor for Bycatch and the Food and Agriculture Organization (FAO) is about to release Technical Guidelines to reduce bycatch of marine mammals. All these groups have a similar aim: to be able to reliably assess the level of impact of bycatch and to find suitable and appropriate mitigation measures. All groups bring something valuable to the table but do not necessarily join efforts in the most efficient way. Therefore, it is crucial to find a way to collaborate and optimally use the best capacities of all different parties.

7.5.5 Multi-disciplinary bycatch initiative by the Netherlands

As accurate bycatch monitoring is lacking in many European waters, in particular in vessels below 12m, the Netherlands aims to set up an international bycatch project[20], jointly with other member states, which can contribute to an international approach and possibly be a basis for joint recommendations as requested by the European Commission. As incidental bycatch is a cross-border problem in the field of fisheries and environment, it aims to achieve a multi-disciplinary approach with strong stakeholder involvement, involving fishermen from the start as is recommended by several studies (Read 2013, Komoroske & Lewison, 2015, Scheidat et al. 2018).
This proposal intends to:

- Achieve successful cross-border and cross-agency cooperation with fishermen and among countries on bycatch monitoring and mitigation, building on ICES advice (ICES 2020)
- Set up an experimental design for robust monitoring of bycatch and mitigation measures that, can result in statistically reliable bycatch rates across all participating regions, focusing on small scale fisheries
- The experimental design should encompass fishing effort, small scale fishing vessels and different methods for monitoring and mitigation
- Set up funding mechanisms for monitoring and mitigation (e.g. incentivizing alternative gear) across participating regions
- Deliver (advice for) joint recommendations for high risk areas and species.

7.6 Recommendations incidental bycatch

7.6.1 Recommendations cooperation with fisheries

- Cooperation with the industry is the key to reduce bycatch, therefore it is recommended to prioritise this in any project.
- Invest in building and keeping a good working relationship between parties and (international) groups involved based on trust, respect and mutual perspectives.
- Explore together with fishers the advantages of fishing in ways that reduce bycatch, e.g. higher quality of catch from hook and line fisheries, as well as other incentives to reduce bycatch.

7.6.2 Recommendations monitoring

- Obtain statistically robust bycatch assessments at population level by continuing and expanding (REM) monitoring, requiring international collaboration and effort of all stakeholders involved.
- Specify what sufficient levels of monitoring are in order to obtain estimates of bycatch of harbour porpoise.
- Monitoring should include non-Dutch fishing vessels and vessels smaller than 15 meters.
- Make use of a more cost-effective and mobile Remote Electronic Monitoring (REM) system to allow a representative and effective coverage of the fleet

[19] Belgium, Denmark, Estonia, Finland, France, Germany, Ireland, Latvia, Lithuania, Netherlands, Poland, Portugal, Spain, Sweden, and the United Kingdom

[20] Funding has not yet been granted

- Improve data collection of fishing effort of bottom-set gillnet fisheries
- Quantify the fishing activity on the Netherlands part of the North Sea by the commercial bottom-set gillnet fleet (Dutch and foreign).
- Develop a system (based on an Automatic Identification System (AIS) or an adapted REM system) to facilitate the collection of accurate and complete information on fishing effort, including fishing location, net type (single walled gillnets or trammel nets), net specifications (net length, height and mesh size) and soak time.
- Improve the data collection of fishing effort of bottom-set gill net fisheries at international level
- Standardize reporting formats, to be able to extrapolate data across fleets.
- Implement and facilitate landing and registration of harbour porpoise bycatch for research.
- Work with fishermen to, if not landed, release bycaught dead porpoises with a tag to allow further research into stranded or drift porpoises.

Harbour porpoise in a gully close to the beach. *Photo: Marije Siemensma, MS&C*

7.6.3 Recommendations international cooperation

- Set up Dutch initiative for a cross-border project on bycatch, involving the fisheries sector from the start and experts from multiple disciplines.
  - Such a project, can contribute to developing joint recommendations on monitoring and mitigation to the European Commission (see recommendations Chapter 3).
- Explore funding programmes enhancing cooperation with fisheries sector at international level for future projects.
- Focus on knowledge and expertise exchange in relevant fora on international level (e.g. IWC, ASCOBANS, ICES, OSPAR and fisheries organisatons, such as NEAFC and the North Sea Advisory Council (NSAC)).

7.6.4 Recommendations mitigation

- Investigate and encourage the use of alternative gear (e.g. fish traps or line fisheries for cod) other than bottom-set gillnets and/or investigate modification of bottom-set gillnets to reduce bycatch.
- Investigate the development and testing of other bycatch mitigation methods, such as pingers, but also area closures in high risk areas.

7.6.5 Recommendations recreational fisheries

- Continue to quantify fishing effort and control compliance (ongoing), and in addition to this, investigate the frequency and with that the impact of incidental bycatch in recreational fisheries.
- Share experiences with other countries on recreational fisheries and bycatch.
- Promote outreach to recreational fisheries, e.g. with a flyer during yearly notification of fishing activity which is obligatory.

8 Underwater noise

Due to all human activities in the Southern North Sea the emission of anthropogenic noise is a growing concern. Marine mammals rely on sound for fundamental biological and ecological aspects. Sound propagates well under water, which makes it so important for cetaceans (e.g. for foraging and communication) and also for several human technology such as sonar and seismic exploration. Anthropogenic underwater noise may impact marine mammals and underwater noise is formally defined as a source of pollution in the EU Marine Strategy Framework Directive (MSFD, 2008). The directive requires underwater noise to be addressed as separate descriptor (D11) to determine Good Environmental Status (GES): “Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.” The MSFD distinguishes two types of underwater noise: anthropogenic impulsive sound in water and anthropogenic continuous low-frequency sound in water. The MSFD requires international cooperation for its implementation. Underwater noise is a typical transnational problem and therefore cooperation is found on various ways. For this report the term “noise” is used when discussing sound that has the potential to cause negative impacts on marine life. The more neutral term “sound” is used to refer to the acoustic energy radiated from a vibrating object, with no particular reference for its function or

Photo: Ernst Schrijver, Stichting Rugvin potential effect. “Sounds” include both meaningful signals and “noise” which may have either no particular impact or may have a range of adverse effects (Towards thresholds for underwater noise, TG Noise in preparation, 2020).

The MSFD also requires monitoring of underwater noise. Regional sea conventions will be used for the actual implementation of underwater noise monitoring. For the Netherlands this is the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) (see also Chapter 3).

Cooperation at EU level and within OSPAR ensures consistency between methodologies and terminology used in regional and sub-regional scale ‘joint’ monitoring programs- joint meaning monitoring at regional level and not at national level. The Netherlands has the lead in action 29 (under human activities and pressures) *Develop guidelines on how to minimise the disturbing and/or harmful acoustic effects to harbour porpoises especially from seismic surveys, pile driving, shipping traffic, military activities and underwater explosions* in the OSPAR Roadmap for implementing collective actions and is committed in delivering this action.

The Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS, see Chapter 3) adopted a large number of resolutions that are relevant for the conservation of the harbour porpoise, including those dealing with adverse effects of underwater noise on marine mammals.

An international Underwater Noise Working Group is comprised of members and observers of the scientific and advisory bodies of the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS), ASCOBANS and the Convention on the Conservation of Migratory Species of Wild Animals.

Underwater sound can be divided into two major categories: impulsive – loud - underwater sound and continuous sound. The sources of impulsive sound are (Ainslie et al. 2009):
- Pile-driving activities during the installation of offshore wind farms
- Seismic exploration using air guns by mainly the oil and gas industries
- Geophysical exploration (e.g. sub-bottom profiling)
- Underwater explosions (Unexploded Ordnance (UXO) and other explosions)
- Acoustic deterrent devices (ADD) and
- (Naval) sonar systems

The main source of continuous underwater noise is:
- Shipping. The North Sea has one of the highest shipping densities worldwide

Different types of effects of underwater noise (on the harbour porpoise) can be distinguished.
The effects can be hearing damage (for explosions also direct blast damage or death), avoidance behaviour and masking.

Harbour porpoise hearing is very sensitive and vulnerable and loud sounds may affect their hearing capabilities. This reduced sensitivity (threshold shift) can be a temporary (TTS) or a permanent threshold shift (PTS). Threshold shifts caused by anthropogenic noise can elevate the hearing thresholds by several dB. With TTS this elevation of the hearing threshold will return to normal with time, with PTS the hearing threshold remains elevated and the hearing abilities of the animals are changed permanently; PTS is considered to be hearing damage. This shift in hearing capacities can have negative consequences on an animals functioning; this can affect animals fitness or even lead to mortality (Kastelein et al. 2015, 2016, 2017).

Over the last few years more insight was gained into the hearing curve/sensitivity and the effects hereon of different frequencies of impulsive noise. Frequency weighting (differences in sensitivity for specific frequencies or parts of the frequency spectrum for different species) is becoming more apparent and the role hereof on the impact of impulsive sounds on porpoises is under investigation. This topic is addressed by the Offshore Wind Ecological Programme WOZEP (see 8.2.2), to assess the impact of all sound sources on hearing.

Also behavioural impacts can take place. Noise can cause harbour porpoises to flee (displacement), which means that they swim away from the sound to avoid it and potentially cannot forage or socialise at that moment. Research has shown that animals do often return after the disturbance has stopped although it is not yet clear if these are the same individuals or ‘new’ ones (Tougaard et al. 2009, Thompson et al. 2013, Pirotta et al. 2015).

Additionally, sounds can disturb foraging, resting or socializing events by masking particular biologically important sounds or harbour porpoise communication (Hermannsen et al. 2014).

For impulsive sounds the Netherlands Marine Strategy has developed an indicator for the number of harbour porpoise disturbance days[21] in order to prevent adverse effects on populations of the species.

Underwater noise caused by pile-driving for offshore wind farms is assessed and authorized in the Netherlands in the procedure for the adoption of site decisions under the Offshore Wind Energy Act, which provides the possibility to issue a derogation from the prohibition to disturb strictly protected species such as the harbour porpoise (see paragraph 3.1.3).

8.1 Offshore wind energy

The number of offshore wind farms is increasing rapidly in the entire North Sea. In the Dutch part of the North Sea, there are now (2020) five Offshore wind farms in operation: Egmond aan Zee (OWEZ), Prinses Amalia Wind farm (PAWP), offshore wind farm Luchterduinen (LUD) and the two Gemini-wind farms Buitengaats and ZeeEnergie, in total 289 turbines, 957 Megawatt.

A Roadmap has been agreed for the development of offshore wind energy, consisting of different phases. The first phase aims to generate a total of 4 450 MW of electricity by 2023 (figure 8.1). The second phase outlines the main features for the period 2024 - 2030 to arrive at a joint additional capacity of approximately 7 000 MW of offshore wind energy. The second phase concerns the areas Hollandse Kust (west), North of the Wadden Islands and IJmuiden Ver. A third phase is now being developed for 2030-2040.

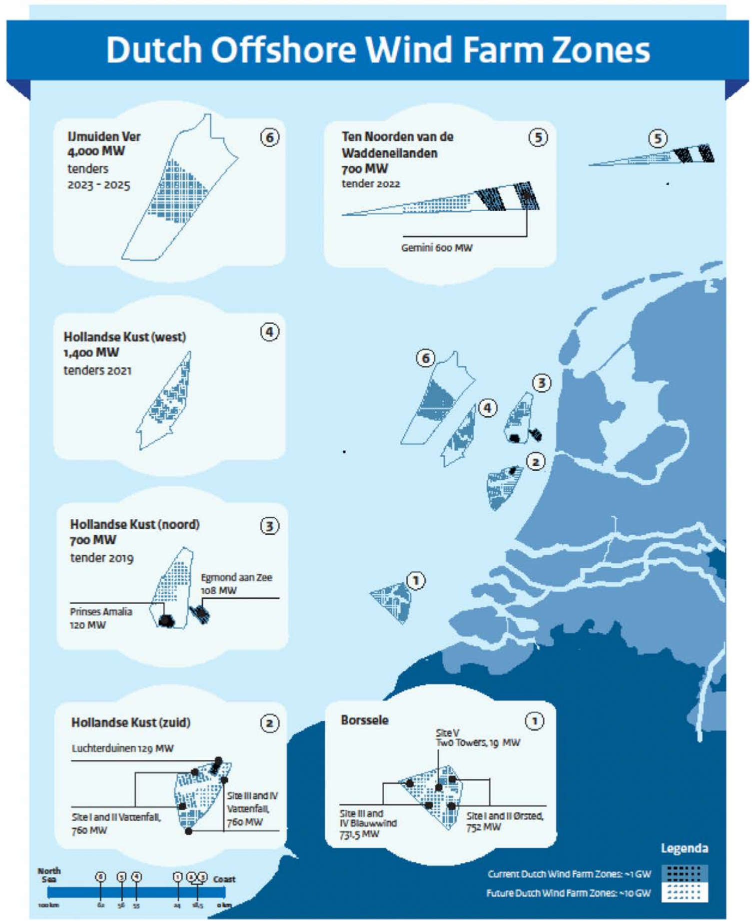


Fig 8.1. Roadmap 2023 for Offshore wind on the DCS. Ministry of EZK

[21] The harbour porpoise disturbance days are the cumulative (over the population) number of days harbour porpoises are disturbed (level of noise exceeds the threshold for disturbance) by impulsive noise.

Offshore Wind Farm *Photo: Marije Siemensma, MS&C*

8.1.1 Impacts of construction of offshore wind farms

There is abundant evidence that the construction of wind farms by pile driving triggers avoidance behaviour of harbour porpoises (see IAMMWG et al. 2015 for an overview) and that the construction sounds may potentially cause temporary or permanent hearing loss (Kastelein et al. 2016, Southall et al. 2019). Because of the planned scale of activities for the construction of offshore wind farms, and the uncertainties around effects of construction, it could not yet be determined that the Favourable Conservation Status (as required in the Habitat Directive) or Good Environmental Status (as required in the Marine Strategy Framework Directive) can be achieved without limitations to construction activities. This uncertainty instigated a research programme that led, with other studies, to the conclusions that the construction at this scale would endanger population goals and therefore a noise threshold has been implemented (see 8.2.2).

This research programme, has been commissioned by The Ministry of Economic Affairs and Climate (EZK), called the Offshore Wind Ecological programme (Wind Op Zee Ecologisch Programma, WOZEP), to obtain answers to important questions about the effect construction and operation of wind farms on the North Sea ecosystem. Together with the Ministries of Agriculture, Nature and Food Quality (LNV) and of Infrastructure and Water Management (I&W), the Netherlands Enterprise Agency (RVO) and the governmental agency Rijkswaterstaat (RWS) Sea and Delta, the Ministry of EZK is working to realise the objectives of WOZEP. The wind energy sector, the offshore stakeholders, the coastal government organisations and local residents are all involved in realising the plans. The WOZEP programme follows earlier programmes to study the ecological effects of offshore wind farms. Additional studies were also being conducted on the basis of the monitoring and evaluation programmes (MEP) for existing wind farms and wind farms under construction (MEP obligations incumbent on the wind farm operators). These included studies to address potential hearing damage as result of construction; to assess mitigation efficiency, hearing studies have been conducted with a porpoise in a research facility (Kastelein et al. 2015, 2016, 2017).

In addition to the government-funded research programmes, the operators of the Egmond (OWEZ), Princess Amalia (PAWP), Luchterduinen and Gemini offshore wind farms have a research programme that is mandatory under the conditions of the permit (which includes a monitoring and evaluation programme obligation). For all subsequent wind farms, monitoring and research is coordinated from the government in WOZEP, in order to make research more efficient and obtain more relevant information that can be applied more directly within policies. In all of these programmes, international cooperation has been sought as there is great deal of research in other countries.

The results of these studies from other countries were, amongst others, used for the 'Framework for Assessing Ecological and Cumulative effects' (KEC) that was announced in the North Sea Draft Policy Document 2016-2021 and published in April 2015, and updated in January 2019 (Heinis et al. 2015, 2019). Notably knowledge from Germany was used, where long term research programmes have been executed including observations of porpoise occurrence before, during and after construction (Brandt et al. 2018). The aim of the framework was to make clear how cumulative ecological effects should be described. The aim of the KEC framework was to provide (quantified) information to support decisions about offshore wind energy licensing.

The Political Declaration made by North Sea energy ministers on energy cooperation between North Sea countries (June 2016) included agreements about the development of a common framework for reporting on environmental effects of offshore wind farms (CEAF = Common Environmental Assessment Framework), based on the Dutch 'Framework for Assessing Ecological and Cumulative Effects'.

8.1.2 Mitigation - Disturbance

The conclusions of the KEC studies (Heinis et al. 2015, 2019) led to believe that construction of wind farms at the scale required to achieve the offshore wind energy target would lead to a high level of disturbance of porpoises and this would endanger population goals for the harbour porpoise. Therefore, based on the results of the KEC, for the construction of all offshore wind farms on the Netherlands part of the North Sea there is a Sound Exposure Level (SEL) threshold value at 750 metre from the source for turbines of at least 10 MW, in combination with a 'soft start', described in the Wind Farm Site Decisions. Since 2011 a number of promising new or advanced methodologies and concepts are available for mitigating the impact of noise during the construction of offshore wind parks; the construction companies are free to choose which method they want to use, as long as they adhere to the noise limits for construction.

To demonstrate that threshold values are not exceeded, the industry has to monitor their own noise. RWS monitors these noise levels to assess whether the regulations are being met.

The Netherlands is not the only country requiring threshold values for sound levels for the construction of offshore wind. Germany and Belgium both have set maximum allowable noise levels, but there are still differences between countries: for instance, Belgium applies a limit to the zero-to-peak pressure level where the Dutch noise standard uses Sound Exposure Level (SEL). Through the SEANSE and CEAF projects countries are discussing these threshold values (see Chapter 3).

8.1.3 Mitigation - Hearing damage

The studies into the potential for hearing damages (Kastelein et al. 2016) have shown that the sound level <1 km to the piling location in the start phase of construction may pose a danger to porpoises. Therefore, in addition to the noise threshold, additional mitigation measures (Acoustic Deterrent Devices (ADD), soft start) have to be used to prevent permanent threshold shift (PTS) at harbour porpoises during the start phase of construction.

Acoustic Deterrent Devices (ADD) can be used for mitigation of various activities. ADD in itself is also a sound source and can have an impact on cetacean distribution within several kilometres of active devices (e.g. Olesiuk et al. 2002, Johnston 2002, Northridge et al. 2010, Brandt et al. 2013, Kyhn et al. 2015, Mikkelsen et al. 2017). Before implementing the use of ADDs their potential impact on harbour porpoises and other species needs to be considered. It is recommended to provide an overview based on studies which ADDs in theory/potentially can be a risk and which types can be used safely.

8.1.4 Remaining uncertainties: population models and operational wind farms

In the KEC studies, an assessment was made of the effects on the population of the harbour porpoise; this assessment included the use of population models to quantify cumulative anthropogenic disturbances on the harbour porpoise. The interim Population Consequences of Disturbance model (iPCoD, Harwood et al. 2013, now PCoD) was used in the KEC studies. Other models are available, notably the Disturbance Effects on the Harbour Porpoise Population in the North Sea (DEPONS) model. Models can be filled with scientific knowledge on abundance, distribution, energetics, sound impact, movement patters amongst other things to make calculations of the effects of different disturbances on populations (see also Nabe-Nielsen & Harwood 2016). For both models knowledge gaps still exist which are currently filled in with expert judgement and/or assumptions. Booth et al. (2019) have provided more information on this topic, that was used in the KEC.

As validation of measures needs to continue in the future, these population models will need to improved. These gaps should be filled with more scientific research over time to improve the reliability of these models and optimize the out coming predictions. The development of an energy budget model for the harbour porpoise would allow for the quantification of the effect of decreased foraging on the development of the population (Hin et al. 2019).

8.1.5 Impacts of operational wind farms

The noise impact from operational off shore wind-turbines has not been studied thoroughly. Measurements in Prinses Amalia Wind Park (De Haan et al. 2013; Jansen & de Jong 2014) showed that the operational sound levels hardly exceeded the park boundaries itself. Measurements of operational sound levels from off shore wind-turbines in the Baltic showed sound levels comparable to a large ship (Diederichs et al. 2008). Further study is recommended, also by the HPAC (Van der Meer et al. 2016), because of the size of the turbines and the total covered area and cumulative sound produced by wind farms in the last and coming decades.

Options for further studies on the effects of continuous noise on the harbour porpoise will be discussed in the section on shipping, the major source of continuous noise.

Offshore Installation Vessel Aeolus — Photo: Van Oord

8.2 Seismic surveying

The North Sea is an area from which vast amounts of oil and gas have been extracted for decades. Especially Norway, the United Kingdom and the Netherlands have many offshore oil and gas production sites in their sectors of the North Sea. As production from the large Groningen gas field will be closed by 2022, and in order to reduce the dependency on imports of gas as much as possible (Dutch national energy policy), the Dutch government decided that production from small gas fields, particularly from the offshore, should continue over the next decades (MinEZK, 2018). Nonetheless, the role of the Dutch North Sea is likely to change in the decades ahead, with more emphasis on climate change mitigation activities, including Carbon (CO_2) Capture Storage (CCS) and possibly hydrogen (H_2) storage. These will be needed to support the Dutch contribution to the Paris Agreement goals.

To visualise the subsurface for oil and gas, CCS and hydrogen storage, the geophysical technique of seismic surveying is commonly applied. In seismic surveying an impulsive sound is generated by a towed array of air guns (compressed air that is released in a coordinated way). The size of the air guns and therefore the amount of acoustic energy is designed in such a way that the signals returning from the target formations (echoes) provide sufficient information for interpretation of the data. What makes seismic different from a static sound source as pile-driving is that for seismic surveing the sound source is moving and that it is the aim to produce sound.

The design and deployment of seismic surveys depends on many factors, including the business climate, particularly in high-costs environments as the North Sea. Also, the optimal time to acquire seismic surveys is outside the winter months (winter metocean conditions are most challenging). This not only minimizes the time spent on acquiring the survey (and thus costs), but also minimizes the Health Safety Exposure (HSE) and the required acoustic energy, thereby in turn minimizing the impact on the marine environment.

In general, seismic surveys have been carried out for more than half a century in the Dutch sector of the North Sea. The fluctuations in the size of the population of harbour porpoises of the last decades show no correlation with these seismic activities. The intensity of seismic survey activities does not therefore appear to negatively impact the conservation objectives for harbour porpoises. Establishing a limit on harbour porpoise disturbance days, based on historic and existing levels of activities, supports avoiding potential impact on the population in the future.

The impulsive sound from air gun arrays is comparable to the impact sound of pile driving, but there are some major differences:

- In seismic surveys the aim of the method is to produce sound to generate a returning signal from geological formations at depths of up to 5 kilometres (i.e. sound is the detection mechanism itself), whereas for pile driving sound is an unwanted side effect. Nevertheless, industry, in cooperation with NGOs and authorities, is looking into opportunities to further reduce sound exposure levels for harbour porpoises. Every seismic survey is different in design for source requirements (size, energy, number of "shots"). By carefully matching project objectives to sound levels, the latter can be minimized.
- Seismic surveys and the construction of a wind park both can take more than a month of mostly continuous operation, but pile driving takes a few hours followed by a silent period that normally takes a half to a full day, until all monopoles have been installed, depending on the distance to the next piling location.
- In seismic surveying the acoustic sources are moving while pile driving is stationary.

8.2.1 Impact of seismic surveying

Harbour porpoises respond in a similar way to seismic surveys as to pile-driving sounds. A study executed in the UK on 2D seismic surveying found disturbance effects over a range from 5 to 10 km at comparable exposure levels (Thompson et al. 2013). A study in the North Sea also observed decrease in echo-location of harbour porpoises, used as a proxy for their presence, at distances up to 12 km during a large 3D survey (Sarnocińska 2020), but does not provide clear thresholds for onset of disturbance. Clearly, noise generated by seismic surveys can be disturbing for harbour porpoises, with potential negative effects, although historic activities appear not to have caused significant negative impacts on the population.

8.2.2 Policies addressing seismic surveys

The Dutch mining legislation contains a general requirement to take measures during seismic surveys to prevent disturbing sound effects on marine mammals. It does not specify what those measures are, other than a general soft-start requirement. Organisations like the International Association of Geophysical Contractors (IAGC) suggest measures that could be taken to reduce the effect of seismic surveys on marine mammals. These include monitoring zones, observations protocols and training of observers. Additionally, it describes the soft-start procedure (www.iagc.org). To undertake seismic surveys without effective mitigation measures or a derogation is at odds with the requirements of article 12 of the Habitats Directive and the requirements of the MFSD.

The Nature Conservation Act (2017) stipulates that any plan or project not directly connected with, or necessary to, the management of a nature conservation site, but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. This includes seismic activities, that have therefore to be evaluated, also in cumulation with other activities.

Loud impulsive noise, such as from seismic surveying, is an indicator in the MSFD. This has been translated in criterium D11C1: for harbour porpoises, reduction of population size is prevented by imposing a limit on the number of harbour porpoise disturbance days. However, to date this has only been done for pile driving, based on the above-mentioned KEC. In the 2018 Netherlands Marine Strategy it has been decided that legislation on seismic surveys will be developed to be in line with the legislation for pile driving. Seismic activities are therefore subject to monitoring of impulsive noise and seismic activities are registered in the international impulsive noise register, as set up by OSPAR. The MSFD also requires that seismic surveying is considered every 6 years in the Programme of Measures (art. 11) and in the Evaluation of GES (art. 8). For the Programme of Measures, which is to be updated in

2021, a societal cost benefit analysis is done for seismic surveying until 2030. To calculate the actual levels of seismic sounds in the environment, acoustic models describing source and propagation are available, but there are some differences between these models. Research is underway to benchmark these models (Ainslie et al. 2019) and this should be continued (Von Benda-Beckmann et al. 2017).

The North Sea Agreement (Chapter 3) describes several agreements regarding seismic surveys by governments, industry and NGOs. Seismic surveying will be done, as much as possible, outside of the harbour porpoise reproductive season which lasts from 1 May until 1 September, and the use of high-frequency airguns will be minimised. Any decision to acquire seismic data should be based on specific survey requirements, potential survey designs and their associated risks. Also, a transparent research programme with all involved stakeholders involved throughout the process, will be set up. This programme will investigate how to minimise sound levels of 3D seismic surveys, whilst yielding the necessary results, based on the Best Available Techniques and within the legal framework. As a result the amount of excessive noise levels entering the ecosystem will be reduced.

A sound budget in 'porpoise disturbance days' for seismic surveys, similar to the methodology used in the KEC for pile driving, can be calculated based on the amount of disturbance by the existing activities. The existing information, as well as new information derived from the North Sea Agreement, can be used to develop this framework for seismic surveys.

8.2.3 Mitigation

As proposed in the North Sea Agreement, seismic surveys ought to be carried out, as much as possible, outside of sensitive periods. Each seismic survey is designed individually, in order to achieve its objectives with minimal levels of acoustic energy. For instance, because of the concern on the use of airguns, the seismic industry is researching alternative ways to emit acoustic energy into the subsurface, including development of marine vibroseis techniques which would reduce seismic noise in the water column.

Mitigation measures focus on reducing the impact of the noise pollution by implementing soft-starts and using Acoustic Deterrent Devices (ADDs) which aim to deter any marine mammals. Seismic survey contractors also employ marine biologists as observers to ensure that operations can be halted if mammals are observed in proximity to seismic vessels.

8.3 Explosions

Unexploded Ordnance (UXO) are frequently (several tens of times per year) accidentally encountered by fishermen, dredging vessels and other offshore activities on the entire Dutch part of the North Sea. Out of concern for human safety and to avoid damage to equipment and infrastructure from uncontrolled explosions most reported UXO found are detonated in a controlled way. These underwater detonations produce high amplitude shock waves that may adversely affect marine mammals, including the harbour porpoise.

8.3.1 Impact of explosions

The 2011 harbour porpoise Conservation Plan prompted research into the impact of explosive ordnance clearance in the Netherlands' part of the North Sea (Full report: Von Benda-Beckmann 2015; peer-reviewed publication: Von Benda-Beckmann et al. 2015, Aarts et al. 2016). The 2015 study showed that negative effects could occur on a large scale, although large uncertainties remained. Potentially 1280-5450[22] animals might be at risk of permanent hearing damage (PTS) on a yearly basis. In their assessment Von Benda-Beckmann et al. used the information regarding UXO cleared in the Netherlands' part of the North Sea provided by the Netherlands' Ministry of Defence. Information on the sources was combined with a propagation model to produce sound exposure maps. These were combined with estimates of exposure levels predicted to cause hearing loss in harbour porpoises and survey-based models of harbour porpoise seasonal distribution in the Netherlands' part of the North Sea. Although uncertainties remained, these study results were in line with earlier concerns (Ainslie et al. 2009; Camphuysen & Siemensma 2011) that unmitigated explosions in the North Sea pose a risk to Harbour porpoises.

8.3.2 Implemented mitigation for explosions

Based on the results of the study by Von Benda-Beckmann et al. 2015 the Ministry of Defence decided to take additional mitigation measures to reduce the impact of explosive clearing. The study included an overview of potential mitigation measures, including an evaluation of effectiveness, feasibility and cost of mitigation options. The use of acoustic deterrent devices (ADDs) was assessed to be a viable option, as these were relatively effective (especially for porpoises), use could be relatively easily combined with operational procedures, and costs were considered to be reasonable. An acoustic deterrent device, the Logitech ADD, was chosen by the Royal Netherlands Navy (RNLN) which was originally developed to deter seals away from (a.o.) fish farms; the source level and frequency of this deterrent device make it effective for deterring harbour porpoises at large distances, and confirmation of the effectivity was available in independent scientific publications (e.g. Brandt et al. 2013; for review see Hermanssen et al. 2015). Additional procedural measures and guidance were developed by the Ministry of Defence for clearances of UXO, including the compulsory use of ADDs.

These measures, including the use of the ADD, are currently in use for clearances by the RNLN and they will take up the current guidance in a new formal regulation document, that was not available yet at the time of developing this Updated Conservation Plan for the Harbour Porpoise in the Netherlands, to also include restrictions for clearances in N2000 areas. The large number of animals potentially at risk of PTS was the reason for the Ministry of Defense to implement mitigation measures, namely the use of ADDs. The system that is used now on-board navy vessels is very effective to distance porpoises. Conclusions of Von Benda-Beckmann (2014 are therefore no longer relevant for the current situation. It may be useful to assess whether the reduction of impact can be observed as result of the introduction of the use of Acoustic Deterrent Devices (ADD's) (short term), but it should be realized that it is uncertain that sufficient empirical data will become available to come to clear conclusions.

It is unclear what to expect in the coming years. There have been fewer reports of encounters with ammunition in recent years. The reason for this is unknown, but may be explained by a change in fishing technique towards pulse fishing. However, with the ban on pulse fishing and a likely increase in beam trawl fisheries, an increase in reports and with that clearances might occur. Also, the increase of sand extraction and offshore wind construction may cause an increase in reported UXO.

8.4 Sonar

8.4.1 Military sonar

Mid-frequency (1-10 kHz) active military sonar, an impulsive sound source, is used by the RNLN to detect and localize submarines. As required in the National Marine Strategy, the use of sonar is regulated in a formal regulation of the Ministry of Defence (Commando Zeestrijdkrachten 2015). This regulation requires the navy to carefully plan sonar activities, avoiding sensitive areas; sonar systems can only be used when needed, and there are additional measures to check that the impact is minimized. In practice, the use of mid-frequency active sonar in the Southern North Sea is negligible, because this area is too shallow to be used by submarines. This is reflected in the assessment of sound sources for the Marine Strategy Framework Directive (Ainslie et al. 2009); in the Dutch part of the North Sea military sonar use is not considered to be a threat. As the RNLN also operates in international waters, involving the use of sonar, there is a research programme by the Ministry of Defence, with a wider scope than North Sea species. Because military sonar has been given a lot of attention in the past, a lot of international research on the effects of military sonar has provided a substantial part of our current understanding of the impact underwater sound, including for example the population consequences of disturbance on which the KEC-study is based.

High-frequency systems (>10 kHz) used by the RNLN for other purposes, notably searching and localizing mines and other explosives are similar to non-military sonars (see below).

8.4.2 High-frequency sonar systems

Sonar sources other than military sonar are fish finding sonars, single and multibeam echosounders and subbottom profilers, like pingers and chirp sonars. Also the use of echosounders by recreational vessels is becoming more popular. Because of its frequency band and power these systems are at this moment not considered to be a threat (and they are not in the frequency band of MSFD descriptor 11, that addresses low- and midfrequency impulsive sound sources). If new insights arise, these sonar sources will also be considered.

[22] The 2014 report estimated 800-8000 animals at risk of PTS, however, these figures were amended in 2015.

8.5 Shipping – continuous noise

Continuous sounds are omnipresent in the underwater environment and can be produced by natural (waves, weather, animals) and anthropogenic (shipping, other activities) sources.

Continuous anthropogenic sound is mainly caused by shipping. More than 90 % of all world cargo is transported by ships. The last decades more attention is paid to the pollution by ships, which focuses on carbon, sulphur and ballast waste water. Underwater noise has been given less attention.

Due to the MSFD various initiatives in the EU were taken. Starting with initiating monitoring (BIAS, JOMOPANS and JONAS projects) an assessment framework is nearly completed by OSPAR. At the initiative of Canada in January 2019 an international workshop was held at the IMO headquarters in London and a proposal has been submitted to the MEPC of the IMO to further assess options for reducing noise from shipping and investigate developing future targets.


Photo: Ernst Schrijver, Stichting Rugvin

Recreational vessels (and other vessels without an Automated Identification System (AIS)) are not covered by the current initiatives. Especially in coastal areas these vessels can cause serious problems related to underwater noise (see: Hermannsen et al. 2019).

Although the noise production by recreational vessels is largely unknown, it is expected that most relative slow-moving ships generate not very much noise. A few types of vessels cause the major disturbance, like RHIBs (Rigid Hull Inflatable Boat) and Jet skis.

Recreational shipping is mainly concentrated in shallow coastal areas and nature areas.
In relation to recreational shipping and underwater noise a number of issues are unknown:

- Source levels of these vessels. There is a wide variety of ships. Also frequency spectrum is relevant.
- Shipping activity. There are millions of ships, but it is unknown how much activity there is in hours and distance.
- How does this contribution compare to the underwater noise by professional shipping?

8.5.1 Impact of continuous noise

Continuous noise is regarded to have a masking effect (see Erbe et al. 2015). The primary effect targeted by the criteria for continuous sound is the reduction of listening and communication space of marine organisms, known as masking. Masking is closely related to signal-to-noise ratio (e.g. a measure comparing the level of a desired signal to the level of background noise) and everything else being equal, increasing the ambient sound in the same frequency band as a biologically relevant signal, will affect the signal-to-noise ratio and make this signal harder to be detected (TG Noise 2019). It should be noted that at present there is still a knowledge gap about the effects of continuous noise, like masking or behavioural responses and physical effects. Wright et al (2007) argues that underwater noise causes an increase of stress in marine animals and that this as various effects on them.

Animals can respond to masking in different ways to reduce its effects (partly or completely), for example by increasing the intensity and repetition rate of calls, changing frequency, moving away from the noise source (if it is close by) or orienting to make use of directionality cues (Turnbull, 1994; Kastelein et al. 2005).

Fundamentally, however, this does not change the basic relationship: increasing the ambient sound level (i.e. reducing the signal-to-noise ratio) makes it more difficult for animals to hear a biologically relevant signal, whether intended for them or not.

8.5.2 Monitoring of continuous noise

The joint international monitoring programme for ambient – continuous – noise in the North Sea (JOMOPANS) led by RWS aims to develop a framework for a fully operational joint monitoring programme for ambient sound in the North Sea.

The aim of the project is to deliver the tools necessary for managers, planners and other stakeholders to incorporate the effects of ambient noise in their assessment of the environmental status of the North Sea, and to evaluate measures to improve the environment. JOMOPANS aims to deliver an innovative combination of modelling and high-quality measurements at sea for an operational joint monitoring programme for ambient noise in the North Sea. The use of consistent measurement standards and interpretation tools will enable marine managers, planners and other stakeholders internationally to identify, for the first time, where noise may adversely affect the North Sea. In relation to harbour porpoises, this programme aims to deliver risk impact maps based on spatial and temporal sound and porpoise distribution. These maps will give a first indication of the risk of communication-masking by shipping noise, and give an indication of the uncertainty of that assessment. Results are expected in the end of 2020.

Next, the project aims to explore the effectiveness of various options for reducing these environmental impacts through coordinated management measures across the North Sea basin. The Netherlands Organisation for applied scientific research TNO is also partner in this project, together with institutes and governmental bodies from the United Kingdom, Germany, Denmark, Sweden, Belgium and Norway.

8.5.3 Policy on continuous noise

Underwater noise from commercial shipping falls within the competence of the International Maritime Organization (IMO) and its Marine Environment Protection Committee (MEPC). This issue has not yet been regulated within the framework of the IMO, but the MEPC has approved non-mandatory guidelines for the reduction of underwater noise from commercial shipping to address adverse impacts on marine life (2014). These guidelines deal with underwater noise originating from commercial vessels resulting from their normal operation. They do not address the introduction of noise from naval and war ships and the deliberate introduction of noise for other purposes such as sonar or seismic activities. The guidelines provide general advice about reduction of underwater noise to designers, shipbuilders and ship operators. The recommendations address reducing noise from propellers, hull form and on-board machinery in new ships, as well as certain operational and maintenance aspects.

In 2018 the International Whaling Commission (IWC) adopted a number of resolutions that address threats posed to all cetaceans, including anthropogenic underwater noise.[23] This resolution refers, *inter alia*, to the forementioned IMO guidelines (2014)[24] The IWC will seek to bring forward clear targets for the reduction of underwater noise by shipping and work together with the IMO on this topic. The guidelines are also relevant for the harbour porpoise.

For continuous sound the Netherlands Marine Strategy states that GES is still unknown. It calls for the development of an international monitoring programme to map the level and distribution of continuous sound in the region. JOMOPANS is a first step to achieve this.

8.5.4 Mitigation of continuous noise

Not much is done yet to reduce underwater noise caused by ships, although ship classification societies offer different underwater noise categories. Incentivising to encourage quieter ships is a potential way forward.

[23] IWC Resolutions 2018-3 and 2018-4.

[24] IMO/MEPC.1/Circ.833, 7 April 2014.

In January 2019 Transport Canada organised a workshop at the IMO headquarters in London (see Bahtiarian 2019), that focussed on the technology to reduce the noise radiated by ships.

Incentives to reduce ship noise were first added to the Vancouver port authority's EcoAction Program in 2017, now the Enhancing Cetacean Habitat and Observation (ECHO) Program, making Canada the first country in the world to encourage quieter ships. Since January 1st, 2019, the port authority increased the number of underwater noise-reducing options and updated the air emissions reduction options eligible for discounted harbour fees through its ECHO Program. Ships calling on the Port of Vancouver that use technologies to reduce emissions, underwater noise, and other environmental effects can apply for reduced harbour dues of up to 47 per cent. The EcoAction Program now accepts quiet ship notations from five different ship classification societies (the non-governmental organizations that establish and maintain technical standards for the construction and operation of ships) and five propeller technologies, all of which can help reduce underwater noise emissions. Ships that have one or more of these quiet ship notations or technologies are eligible to apply for the reduced fees. As the Netherlands has a lot of expertise in the field of shipbuilding technology, this can be an opportunity to contribute to reducing underwater noise emissions.

8.6 Recommendations underwater noise

8.6.1 Recommendations on offshore wind

- To improve knowledge for filling population models, it is recommended to investigate the behaviour and movements of (individual) porpoises before, during and after pile-driving activities,
- through exploring different methodologies such as PAM and tagging animals as a potential future tool. See Chapter 5 for more detailed recommendations on this.
- It is also recommended to continue research on harbour porpoise in captivity for dedicated research questions.
- Investigate what can be learned from current population models and identify which information is still needed as input to optimize and validate these models especially with regard to assessing the cumulative impact of anthropogenic activities; the needs for improvement and validation of population models (iPCoD and DEPONS) must be addressed.
- Maintain the Sound Exposure Level (SEL) threshold at 750 meters from the source for piling described in the Wind Farm Site Decisions based on the calculations in the Framework Ecology and Cumulation (KEC) and adjust when significant new information becomes available e.g. new insights, new wind farm scenario. This threshold is based on calculations made in the KEC 3.0 for the wind farms till 2030 (Heinis et al. 2019), and is based on the newest insights from iPCoD (Pirotta et al, 2018).
- The noise impact from operational off shore wind-turbines is recommended to be investigated, including the effect of bottom-vibrations and this should be included in continuous sound-models, also because of the increasing size of the turbines, the substantial vessel traffic associated with servicing wind farms and the total covered area and cumulative sound produced by wind farms in the last and coming decades.
- Also the effects of underwater noise by other activities for offshore wind farms, like geophysical surveys and shipping involved in the maintenance of the turbines, need to be factored in.

8.6.2 Recommendations on seismic surveying

- Seismic survey design and associated mitigation measures cannot be generic, but need to be location and season specific.
- Support benchmarking of acoustic models that describe seismic sources and propagation of the sound and choose a validated model for use in impact assessments.
- Review available information, including new information coming from the North Sea Agreement research programme or other research programmes, and determine an unambiguous onset threshold for disturbance of harbour porpoises, taking into account moving sound sources.
- Provide a framework and guidelines addressing (cumulative) impacts of seismic surveys in line with the current legal framework (Wet Natuurbescherming, MSFD), and international accepted guidelines (www.iagc.org), using similar model approaches as for the Framework Ecology and Cumulation (Kader Ecologie en Cumulatie – KEC), with the aim of keeping the impact of seismic survey within acceptable limits. New technologies (Ocean Bottom Nodes (OBN)) should be considered when designing guidelines and regulation.
- Determine an acceptable budget of 'porpoise disturbance days', based on the average of historic and existing levels of activity (e.g. the amount of surveying days, the area covered by the survey and information on the sources used). This average levels of activity will need to be translated in 'porpoise disturbance days', using the KEC methodology.
- Consider establishing noise budgets for individual industry sectors (wind farms, seismic surveys, etc.). This would provide incentives to each industry to minimise noise and resulting environmental impacts. Enforce that future planned seismic surveys (from the year 2023) remain within such budgets.
- Continue the dialogue with the industry to develop regulation for seismic activities to minimize the impact on harbour porpoises.
- Stimulate the industry to develop and adopt alternative technologies that produce less sound in the marine environment.
- Determine the amount of sound needed to achieve the objective of a survey and minimize the amount (and the frequency band) of sound sent into the water column.

8.6.3 Recommendations on explosions

- Describe measures and guidance for clearances of unexploded ordnance (UXO) in the Defence regulation, including the required use of Acoustic Deterrent Devices (ADD's) for clearances and a restriction for clearances within N2000 areas.
- Restrict the use of explosives for other reasons than clearance of unexploded ordnance (UXO), e.g. for demolition of old platforms, to a minimum.
- Validate effects of mitigation; it may be useful to assess whether a reduction of impact can be observed as result of the introduction of the use of Acoustic Deterrent Devices (ADD's) (short term). However, one should realize that it is uncertain that sufficient empirical data will become available to come to clear conclusions.
- For validation it is needed to monitor the effectivity of mitigation measures by systematically recording details of clearances including time/position, type of explosive, (estimate of) explosive mass, water depth and actual depth of explosive during clearing, type of clearance (e.g. high-order detonation or low-order deflagration), other mitigation measures taken during clearing
- Monitor whether alternative technologies for clearance of munition at sea become available (long term).

8.6.4 Recommendations on sonar

It is recommended to assess the use of sonar sources in relevant frequencies, other than military sonar, to signal a significant increase.

8.6.5 Recommendations on continuous noise

- Implement and further develop MSFD required noise monitoring, including under JOMOPANS to produce and assess risk exposure maps based on sound and HP distribution.
- Discuss and encourage the development of measures (such as noise emission requirements) at both national and international (e.g. IMO) level. These measures can consist of stimulating the use of more quiet ships.
- Improve the knowledge on the effects, mostly masking and stress of continuous noise on harbour porpoises. This should be a joint international approach. The Netherlands will follow international projects (e.g. under the recent Horizon2020 call) closely and contribute to the implementation of possible recommendation into policy.
- Assess the impact of underwater noise by recreational shipping.

8.6.6 General recommendations underwater noise

- Contribute in delivering action 29 in the OSPAR Roadmap.
- Evaluate the need to use frequency weighting to improve assessment of behavioural disturbance.
- Assess and address temporal and spatial cumulative impact of acoustic anthropogenic activities. The need to address cumulative effects is marked in all topics in this Chapter. This may include various activities of the same kind; all impulsive sound sources and include continuous noise.
- Motivate and stimulate the industry, using (legislative) incentives, to continue development, testing and use of mitigation measures, relevant for the activity involved.
- Provide an overview based on studies which ADDs potentially can cause a risk and which types can be used safely.

9 Next steps towards concrete measures for conservation

Altogether, the wide range of information gathered in this conservation plan has led to a number of recommendations for the conservation of harbour porpoise in Dutch waters. This plan has been developed by the Ministry of Agriculture, Nature and Food Quality in collaboration with the Ministry of Defence; Economic Affairs and Climate and Infrastructure and Water Management, as well as scientific experts and stakeholders from NGOs and industry.

Throughout the process of developing this plan, the various consultation phases have contributed to a well-balanced plan that has commitment from the stakeholders at large. Nevertheless, several points of concern have been raised, which are acknowledged and understood from the perspective of the stakeholders involved.

Some parties reported not to support the outcome of the conservation status assessment in the article 17 Habitats Directive report, which reported the overall conservation status as favourable. Population, range and habitat are assessed as favourable and future prospects for habitat and population assessed as unknown. Although the views of these parties are recognized, this is not an issue that can be addressed in this plan. The Conservation Status is part of the 2019 article 17 reporting of the Habitats Directive. It was submitted in 2019 and adopted by the European Commission. It is therefore final. Furthermore, the assessment was based on the latest scientific information and expert judgement.

Photo: Annemieke Podt, Stichting Rugvin

Parties have also expressed their concern regarding the carrying capacity of the North Sea population and food availability in relation to the fishery pressure in the North Sea including the Delta waters. Furthermore, there was a request to elaborate on assessing and addressing the cumulative effects of anthropogenic stressors on harbour porpoises. These aspects were already part of different recommendations, but details were provided to reflect the (international) efforts undertaken. Different programmes, as well as this plan, focus on a multidisciplinary, integral approach - and also on cumulative effects. However, this is extremely complex and research in this field is only just starting to progress. The Framework for Ecological and Cumulative Assessment (KEC) is a good example of this developing field of research which led to policy measures. Within the North Sea Agreement, specific priorities for research and monitoring include cumulative effects and carrying capacity.

Other comments concerned a lack of concrete measures and an overview of actions with deadlines and focal points. A conservation plan indeed involves more than a state-of-the-art overview of knowledge. The recommendations in this plan focus on what is needed to fulfil the (legal) requirements from the perspective of policy and management (Chapter 3), with the overall aim to maintain a Favourable Conservation Status of the species in Dutch waters. The recommendations throughout the plan build up the Harbour Porpoise Conservation Action Plan 2020-2026 (Annex I), which contains policy, management, mitigation, research and/or monitoring conservation measures that have been prioritized following selected criteria; a time scale for implementation has been provided and focal points have been determined, in which the latest advice from the HPAC has been incorporated (Van der Meer et al. 2020). Based on this discussion, a few recommendations and paragraphs were added to the plan, referring to existing legal instruments.

A priority scale has been applied (High; Medium; Low). The following criteria haven been used to assess the priority: Allocated funding (e.g. is funding allocated or does it need to be found), feasibility, data availability, how well it fits within the policy context and whether it is addressing a key threat. A score 4/5 out of 5 = high. 3/4 out of 5 = medium and 1/2 out of 5 = low.

A time-scale (short-term = <3yr; medium-term = <6yr; long-term = >6yr; ongoing) has also been given. This time-scale refers to the start of implementation of the recommended measures. Several recommendations have already been implemented and are therefore listed as 'ongoing'.

Focal points have been determined, along with a focal lead for each point, who/which is mainly responsible for the implementation of the relevant recommendation. In some cases, international or non-governmental organisations are included when considered crucial in the implementation and collaboration needed.

The next steps towards concrete conservation measures will be the implementation of the Action Plan (Annex I) in standing policy, such as the KEC, Netherlands Marine Strategy, N2000 management plans and structural monitoring programmes and aligning this plan as much as possible with relevant work in international fora, such as ASCOBANS, OSPAR and the IWC. To promote and enhance the exchange of expertise and knowledge between policy-makers and experts involved with harbour porpoise conservation in the North East Atlantic, a networking event will be organised in collaboration with the EU Natura 2000 Biogeographical Process, early 2021. Under the umbrella of the North Sea Agreement, an expert group (consisting of stakeholders and scientists) has been established to develop a Monitoring, Research, Nature Restoration and Species Protection (MONS)-programme for publication in early 2021. The preparation of the programme is supported by working groups. The MONS-programme addresses three subjects (pillars): Carrying capacity; Nature enhancement and species protection and Cumulative effects. The Ministries of LNV and I&W facilitate the process. It is evident that the highest priority actions will be be implemented first. The North Sea Agreement has also committed to a process to evaluate species conservation plans every two years. Furthermore, the NSA partners agreed to request a scientific advice from the Royal Netherlands Academy of Sciences on the Action Plan.

The first steps towards cooperation with the Dutch Research Council (NWO) have also been explored by the ministry of LNV. NWO funds top researchers, and steers the course of Dutch science by means of research programmes and by managing the national knowledge infrastructure.

The Ministry of Agriculture, Nature and Food Quality is committed to delivering these actions and working with all partners in this endeavour.

10 Acknowledgements

The Ministry of LNV acknowledges all stakeholders who have provided their input throughout the process of compiling this updated Conservation Plan for the Harbour Porpoise in the Netherlands. The input received was welcomed and considered valuable for a constructive debate and this plan and its Action Plan (Annex I).

This report is a result of an informal expert group, consisting of the following members, whom we all sincerely thank for their input and hard work: Steve Geelhoed, Meike Scheidat, Kees Camphuysen, Lonneke IJsseldijk, Martine van den Heuvel-Greve, Guido Keijl, Hans Verdaat, Mardik Leopold, Frank Zanderink, Annemieke Podt, Martin Poot, Harm Dotinga, Niels Kinneging, René Dekeling, Inger van den Bosch, Martine Graafland, Aylin Erkman, Erik Tichelaar, Laurent Gorissen, Annelies Bobeldijk-Warning, Marije Siemensma and Anne-Marie Svoboda. Furthermore, several international experts have contributed significantly. We express our gratitude to Michael Fontaine and Ralph Tiedemann for writing a chapter on genetics and Eunice Pinn, Russel Leaper and Graham Pierce are sincerely thanked for their input on both bycatch and structure and grammar. Jaap van der Meer, Herman Eijsackers and Jan Haelters are thanked for their advice as Harbour Porpoise Advisory Committee. Martin White is also thanked for his final editing.

To conclude, an honourable acknowledgment is given to Chris Smeenk, who passed away in 2017. Chris was an inspiration for many with his pioneering work on harbour porpoises and with that the conservation of this small whale and, in a wider context, cetaceans in general. His work will live on in all dedicated to do the same.

Photo: Annemieke Podt, Stichting Rugvin

References

Aarefjord H., Bjørge A.J., Kinze C.C. & Lindstedt I. 1995. Diet of the Harbour Porpoise (*Phocoena phocoena*) in Scandinavian waters. In: Bjørge A. & Donovan G.P. (eds) Biology of the Phocoenids: 211-222. SC/45/SM3 Special Issue 16, International Whaling Commission, Cambridge.

Aarts, G., Von Benda-Beckmann, A., Lucke, K., Sertlek, H., Van Bemmelen, R., Geelhoed, S., . . . Kirkwood, R. 2016. Harbour porpoise movement strategy affects cumulative number of animals acoustically exposed to underwater explosions. Marine Ecology Progress Series, 557, 261-275. doi:10.2307/24897410

Ainslie, M., De Jong, C., Dol., H., Blacquière, G. & Marasini, C., 2009, Assessment of natural and anthropogenic sound sources and acoustic propagation in the North Sea, TNO report TNO-DV 2009 C085, February 2009.

Ainslie, M. Michele B. Halvorsen, René P. A. Dekeling, Robert M. Laws, Alec J. Duncan, Adam S. Frankel, Kevin D. Heaney, Elizabeth T. Küsel, Alexander O. MacGillivray, Mark K. Prior, H. Özkan Sertlek, and David G. Zeddies, 2016. Verification of airgun sound field models for environmental impact assessment, Proceedings of Meetings on Acoustics 27:1, 2016.

Andersen S. 1965. L'alimentation du marsouin (Phocoena phocoena) en captivité. Vie Milieu Ser A16: 799-810.

Antunes R, Kvadsheim PH, Lam FPA, Tyack PL, Thomas L, Wensveen PJ, Miller PJO. 2014. High response thresholds for avoidance of sonar by free-ranging long-finned pilot whales (Globicephala melas). Mar. Poll. Bull. 83: 165-180. DOI: 10.1016/j.marpolbul.2014.03.056

Augustijns T. 2018. Harbour porpoises in the Belgian Part of the North Sea: Using passive acoustic monitoring to determine spatio-temporal patterns in distribution and feeding behaviour. MSc Thesis. Faculty of Sciences, Biology Department, Research Group Marine Biology: Gent. 47 pp.

Baines M.E. & Earl S.J. 2001. Do harbour porpoises use favoured habitats around the coast of Wales, UK, for calving and nursing young calves? In: Evans P.G.H., Pitt-Aiken R. & Rogan E. (eds) European Research on Cetaceans - 14: 13. Proc. 14th Ann. Conf. European Cetacean Society, Cork, 2-5 April 2000, ECS, Rome.

Bahtiarian, M. 2019. Quieting Ships to Protect the Marine Environment: Workshop Final Report, Acentech report #481, April 2019.

Begeman, L., IJsseldijk, L.L. en Gröne, A. 2013. Postmortaal onderzoek van Bruinvissen (Phocoena phocoena) uit Nederlandse wateren van 2009 tot 2013. Rapport 2014, Departement Pathobiologie, Faculteit Diergeneeskunde, Universiteit Utrecht.

Berges, B.J.P., Geelhoed, S.C.V., Scheidat, M., Tougaard, J. 2019. Quantifying harbour porpoise foraging behaviour in CPOD data: identification, automatic detection and potential application. Wageningen, Wageningen Marine Research (University & Research centre), Wageningen Marine Research report C039/19 Quantifying harbour porpoise foraging behaviour in CPOD data: identification, automatic detection and potential application, pp. 41

Bjørge A. 2003. The harbour porpoise (Phocoena phocoena) in the North Atlantic: Variability in habitat use, trophic ecology and contaminant exposure. In: Haug T., Desportes G., Víkingsson G.A. & Witting L. (eds) Harbour Porpoises in the North Atlantic. NAMMCO Sci. Publ. 5: 223-228.

Bjørge A. & A. Moan 2017. Revised estimates of harbour porpoise (Phocoena phocoena) bycatches in two Norwegian coastal gillnet fisheries. Paper SC/66b/SM03 presented to IWC Scientific Committee, Bled, Slovenia.

Booth C.G. 2010. Variation in habitat preference and distribution of harbour porpoises west of Scotland. PhD.-thesis, University of St Andrews.

Booth C.G., C. Embling, J. Gordon, S.V. Calderan & P.S. Hammond 2013. Habitat preferences and distribution of the harbour porpoise Phocoena phocoena west of Scotland. Mar. Ecol. Prog. Ser. 478: 273-285.

Booth C.G., Heinis, F. & Harwood, J. 2019, Updating the Interim PCoD Model: Workshop Report New transfer functions for the effects of disturbance on vital rates in marine mammal species, Report Code SMRUC-BEI-2018-011, submitted to the Department for Business, Energy and Industrial Strategy (BEIS), February 2019 (unpublished).

Bowen W.D. & Siniff D.B. 1999. Distribution, population biology, and feeding ecology of marine mammals. In: Reynolds III J.E. & Rommel S.A. (eds). Biology of marine mammals: 423-484. Smithsonian Institution Press, Washington.

Brandt, M.J., Höschle, C., Diederichs, A., Betke, K., Matuschek, R. & Nehls, G. 2013. Seal scarers as a tool to deter Harbour Porpoises from offshore con-struction sites. Marine Ecology Progress Series 475: 291-302.
Brandt, M.J., Dragon, A., Diederichs, A., Schubert, A., Kosarev, V., Nehls, G., Wahl, V., Michalik, A., Braasch, A., Hinz, C., Ketzer, C., Todeskino, D., Gauger, M., Laczny, M., Piper, W. 2016. Effects of offshore pile driving on harbour porpoise abundance in the German Bight -Assessment of Noise Effects- Final Report June 2016, Prepared for Offshore Forum Windenergie.
Brandt, M.J., A-C. Dragon, A. Diederichs, M.A. Bellmann, V. Wahl, W. Piper, J. Nabe-Nielsen & G. Nehls 2018. Disturbance of harbour porpoises during construction of the first seven offshore wind farms in Germany, Mar. Ecol. Prog. Ser. 596: 213 – 232, 2018.
Braulik, G., Minton , G., Amano, M. & Bjørge, A. 2020. Phocoena phocoena. The IUCN Red List of Threatened Species 2020: e.T17027A50369903. https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T17027A50369903.en. Downloaded on 20 August 2020.
Buyse J. 2018. Monitoring of harbour porpoise (Phocoena phocoena) density in the Belgian part of the North Sea using aerial surveys and passive acoustic monitoring. MSc Thesis. Oceans & Lakes, Interuniversity Master in Marine and Lacustrine Science and Management: Antwerpen, Gent and Brussel.
Calderan, S. & R. Leaper 2019. Review of Harbour Porpoise bycatch in UK waters and recommendations for management. Nairobi: United Nations Environment Programme.
Camphuysen C.J. 2004. The return of the harbour porpoise (Phocoena phocoena) in Dutch coastal waters. Lutra 47(2): 113-122.
Camphuysen C.J., B. Scott & S. Wanless 2006. Distribution and foraging interactions of seabirds and marine mammals in the North Sea: multi-species foraging assemblages and habitat-specific feeding strategies. In: Boyd I.J., Wanless S. and Camphuysen C.J. (eds) Top predators in Marine Ecosystems: monitoring change in upper trophic levels: 82-97. Cambridge Univ. Press, Cambridge.
Camphuysen C.J. & M.L. Siemensma 2011. Conservation plan for the Harbour Porpoise Phocoena phocoena in the Netherlands: towards a Favourable Conservation Status. NIOZ Report 2011-07, Royal Netherlands Institute for Sea Research, Texel.
Camphuysen C.J. & C. Smeenk 2016. Bruinvis. In: Broekhuizen S., K. Spoelstra, J.B.M. Thissen, K.J. Canters & J.C. Buys (eds) 2016. Atlas van de Nederlandse Zoogdieren. Natuur van Nederland 12, Naturalis Biodiversity Center, Eis Kenniscentrum insecten en andere ongewervelden, Zoogdiervereniging en KNNV Uitgeverij, Zeist.
Carlén, I., Thomas, L., Carlström, J., Amundin, M., Teilmann, J., Tregenza, N. et al. (2018). Basin-scale distribution of harbour porpoises in the Baltic Sea provides basis for effective conservation actions. Biol. Conserv. 226, 42–53. doi: 10.1016/j.biocon.2018.06.031
Carstensen J., Henriksen O. D. & Teilmann J. 2006. Impacts of offshore wind farm construction on harbour porpoises: acoustic monitoring of echolocation activity using porpoise detectors (T-PODs). Mar. Ecol. Progr. Ser. 321: 295- 308.
Chehida YB, Loughnane R, Thumloup J, Kaschner K, Garilao C, Reyes K, Rosel PE, Fontaine MC 2020. Population genetics, dispersal and phylogeographic history of the North Atlantic harbour porpoise (Phocoena phocoena). Submitted and BioRxiv preprint: doi: TBA.
Commando Zeestrijdkrachten 2015, Voorschrift Commando Zeestrijdkrachten MWC 230 Verantwoord gebruik van actieve sonar.
Cox S., Scott B.E. & C.J. Camphuysen 2013. Combined spatial and tidal processes identify links between pelagic prey species and seabirds. Marine Ecology Progress Series 479: 203-221.
Culik, B., C. von Dorrien, V. Müller & M.Conrad 2015. Synthetic communication signals influence wild harbour porpoise (*Phocoena phocoena*) behaviour. Bioacoustics 24(3): 201-221.
Culik, B., C. von Dorrien & M. Conrad 2016. Porpoise Alerting Device (PAL): synthetic harbour porpoise (*Phocoena phocoena*) communication signals influence behaviour and reduce bycatch. BfN Skripten 451: 150-155.
Dam, van, S., Solé, L., IJsseldijk, L.L., Begeman, L., Leopold, M.F. 2017. The semi-enclosed tidal bay Eastern Scheldt in the Netherlands: porpoise heaven or porpoise prison? Lutra 60 (1): 5-18
Das K., G. Lepoint, Y. Leroy & J.M. Bouquegneau 2003. Marine mammals from the southern North Sea: feeding ecology data from delta 13C and delta 15N measurements. Marine Ecology Progress Series 263: 287-298.
Dawson S.M., S. Northridge, D. Waples, A.J. Read 2013. To ping or not to ping: the use of active acoustic devices in mitigating interactions between small cetaceans and gillnet fisheries. Endang Species Res 19:201-221. https://doi.org/10.3354/esr00464
Deaville, R. (compiler) 2019. UK Cetacean Strandings Investigation Programme Final Contract Report, 2011-2017 http://sciencesearch.defra.gov.uk/Document.aspx?Document=14514_FINALCSIPContractReport2011-2017.pdf
De Haan, D., Burggraaf, Dirk, Van der Wal, Jan Tjalling & Van Hal, Ralf, 2013, Underwater acoustic characteristics of the OWEZ wind farm operation (T1), IMARES report, August 2013
Deinse A.B. van 1925. De bruinvisch. De Levende Natuur 29: 195-203.
Dekeling, R.P.A., Tasker, M.L., Van der Graaf, A.J., Ainslie, M.A, Andersson, M.H., André, M., Borsani, J.F., Brensing, K., Castellote, M., Cronin, D., Dalen, J., Folegot, T., Leaper, R., Pajala, J., Redman, P., Robinson, S.P., Sigray, P., Sutton, G., Thomsen, F., Werner, S., Wittekind, D., Young, J.V. 2014. "Monitoring Guidance for Underwater Noise in European Seas," JRC Scientific and Policy Report EUR 26555 EN, Publications Office of the European Union, Luxembourg, doi: 10.2788/27158.
De Vos, B.I. 2011. Seminar: Fish traps in the North Sea: a viable option? 669, LEI NAT HULPB -Aquatische hulpbronnen. Kenniskringen Visserij. https://library.wur.nl/WebQuery/wurpubs/418669
Diederichs, A., Hennig, V., and Nehls, G. 2008. Investigations of the bird collision risk and the responses of harbour porpoises in the offshore wind farms Horns Rev, North Sea, and Nysted, Baltic Sea, in Denmark Part II: Harbour porpoises (Abschlussbericht), Husum (DEU): Universität Hamburg & BioConsult SH.
Dolman, S.J., Champion, A., Clark, J., Eisfeld-Pierantonio, S., Green, M., Gregerson, S., Hodgins, N., Ritter, F., Tetley, M. & Hoyt, E. 2013. Making space for porpoises, dolphins and whales in UK seas: Harbour Porpoise Special Areas of Conservation as part of a coherent network of marine protected areas for cetaceans. A WDC Report, Whale and Dolphin Conservation (WDC), Brookfield House, 38 St. Paul Street, Chippenham, Wiltshire.
Dolman S., Baulch S, Evans PG, Read F, Ritter F. 2016. Towards an EU action plan on cetacean bycatch. *Mar Policy*. 2016;72:67–75.
Dotinga, H. 2020. Conservation of the Harbour Porpoise in the Netherlands: Recent Legal Developments. Final report April 2020.
Dudok van Heel W.H. 1960. Aanvulling op het walvisnieuws 1958. Lutra 2(1): 11-12.
Elliott, M., Burdon, D., Atkins, J.P., Borja, A., Cormier, R., de Jonge, V.N. and Turner, R.K. (2017) "And DPSIR begat DAPSI(W)R(M)!" - A unifying framework for marine environmental management. Marine Pollution Bulletin 118, 27-40.
Embling C.B., J. Illian, E. Armstrong, J. van der Kooij, J. Sharples, C.J. Camphuysen & B.E. Scott 2012. Investigating fine scale spatio-temporal predator-prey patterns in dynamic marine ecosystems: a functional data analysis approach. J. Appl. Ecol. doi: 10.1111/j.1365-2664.2012.02114.x
Erbe C. 2015. The maskogram: A tool to illustrate zones of masking. Aquatic Mammals. 41 (4): 434–443. https://doi.org/ 10.1578/AM.41.4.2015.434.
European Parliament, Council of the European Union 2008. "Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008, Establishing a framework for community action in the field of marine environmental policy, (Marine Strategy Framework Directive)
Etnier M.A. & Fowler C.W. 2005. Comparison of size selectivity between marine mammals and commercial fisheries with recommendations for structuring management policies. U.S. Dep. Commer., NOAA Tech. Memo. NMFSAFSC-159, 274 p..
Evans P.G.H., 1990. European cetaceans and seabirds in an oceanographical context. Lutra 33: 95-125
Evans P.G.H., Fisher P., Rees I., Wainwright J., Farrell J. & Mayo W. 1993. Foraging ecology of harbour porpoises in Shetland. In: Evans P.G.H. (ed.). Proc. 7th Ann. Conf. ECS, Inverness. European Research on Cetaceans 7: 33-38.
Evans P.G.H., L. Andersen, A. Bjørge, M. Fontaine, A. Galatius, C.C. Kinze, C. Lockyer, C. De Luna, G. Pierce, S. Sveegaard, J. Teilmann, R. Tiedemann & M. Walton 2009. Harbour Porpoise *Phocoena phocoena*. In: Evans P.G.H. & J. Teilmann (eds) Report of the ASCOBANS / HELCOM small cetacean population structure workshop. ASCOBANS Bonn, Germany.
Evans P.G.H., 2020. European Whales, Dolphins and Porpoises, Marine Mammal Conservation in Practice. Academic Press, London & New York. 306pp. DOI: https://doi.org/10.1016/B978-0-12-819053-1.00001-6
Fisher P., Tregenza N., Hanton E., Lomax C. & Evans P.G.H. 2003. Acoustic monitoring and visual observations of Harbour Porpoise Phocoena phocoena in Yell Sound. The Shetland Sea Mammal report 2001 & 2002: 20-25. Shetland Sea Mammal Group, Lerwick.
Fontaine P.-H. 1998. Whales of the North Atlantic: biology and ecology. Multi Mondes, Québec.
Fontaine M.C., K.A. Tolley, U. Siebert, S. Gobert, G. Lepoint, J-M. Bouquegneau & K. Das 2007. Long-term feeding ecology and habitat use in harbour porpoises Phocoena phocoena from Scandinavian waters inferred from trace elements and stable isotopes. BMC Ecology 2007, 7:1 doi:10.1186/1472-6785-7-1.
Fontaine M.C., Roland K, Calves I, Austerlitz F, Palstra FP, Tolley KA, Ryan S, Ferreira M, Jauniaux T, Llavona Á, Öztürk B, Oztürk AA, Ridoux V, Rogan E, Sequeira M, Siebert U, Vikingsson GA, Borrell A, Michaux JR, Aguilar A

2014. Postglacial climate changes and rise of three ecotypes of harbour porpoises, Phocoena phocoena, in western Palearctic waters. Molecular Ecology 23, 3306–21.
Fontaine M.C. 2016 Harbour Porpoises, Phocoena phocoena, in the Mediterranean Sea and Adjacent Regions: Biogeographic Relicts of the Last Glacial Period. Advances in marine biology, 75, 333–358.
Fontaine M.C., Thatcher O, Ray N, Piry S, Brownlow A, Davison NJ, Jepson P, Deaville R, Goodman SJ 2017. Mixing of porpoise ecotypes in southwestern UK waters revealed by genetic profiling. Royal Society Open Science, 4, 160992.
Foster, G., Whatmore, A. M., Dagleish, M. P., Malnick, H., Gilbert, M. J., Begeman, L., ... & IJsseldijk, L. L. 2019. Forensic microbiology reveals that Neisseria animaloris infections in harbour porpoises follow traumatic injuries by grey seals. Scientific Reports, 9(1), 1-8.
Gallus A., M. Dähne, U.K. Verfuß, S. Bräger, S. Adler, U. Siebert & H. Benke 2012. Use of static passive acoustic monitoring to assess the status of the `Critically Endangered' Baltic harbour porpoise in German waters. Endangered Species Research Volume 18: 265-278.
Geelhoed S, Scheidat M, Aarts G, van Bemmelen R, Janinhoff N, Verdaat H & Witte R, 2011. Shortlist Masterplan Wind – Aerial surveys of harbour porpoises on the Dutch Continental Shelf. Research Report IMARES Wageningen UR - Institute for Marine Resources & Ecosystem Studies, Report No. C103/11.
Geelhoed SCV, Scheidat M, van Bemmelen RSA & Aarts G, 2013a. Abundance of harbour porpoises (Phocoena phocoena) on the Dutch Continental Shelf, aerial surveys in July 2010-March 2011. Lutra 56(1): 45-57.
Geelhoed SCV, Scheidat M, & van Bemmelen R, 2013b. Marine mammal surveys in Dutch waters in 2012. Research Report IMARES Wageningen UR - Institute for Marine Resources & Ecosystem Studies, Report No. C038/13.
Geelhoed SCV, Scheidat M, & van Bemmelen RSA, 2014a. Marine mammal surveys in Dutch waters in 2013. Research Report IMARES Wageningen UR - Institute for Marine Resources & Ecosystem Studies, Report No. C027/14.
Geelhoed SCV, Lagerveld S, Verdaat JP & Scheidat M, 2014b. Marine mammal surveys in Dutch waters in 2014. Research Report IMARES Wageningen UR - Institute for Marine Resources & Ecosystem Studies, Report No. C180/14.
Geelhoed, S.C.V.; Friedrich, E.; Joost, M.; Juhre, H.; Kirkwood, R.J.; Leeuwen, P.W. van; Machiels, M.A.M.; Stoeber, N.; Verdaat, J.P. 2015. Gemini T-0: passive acoustic monitoring and aerial surveys of harbour porpoises. Report / IMARES Wageningen UR : C144/15. https://edepot.wur.nl/361579
Geelhoed SCV, Janinhoff N, Lagerveld S, Lehnert LS & Verdaat JP, 2018a. Marine mammal surveys in Dutch North Sea waters in 2017. Wageningen Marine Research (University & Research centre), Wageningen Marine Research report C030/18.
Geelhoed, S. C. V., Janinhoff, N., Lagerveld, S. & Verdaat, H., 2018b. Marine mammal surveys in Dutch North Sea waters in 2018. Den Helder: Wageningen Marine Research. 23 p. (Wageningen Marine Research rapport; no. C098/18)
Geelhoed, S. C. V., Friedrich, E., Joost, M., Machiels, M. A. M., & Stöber, N. 2018c. Gemini T-c: aerial surveys and passive acoustic monitoring of harbour porpoises 2015. (Wageningen Marine Research rapport; No. C020/17). Wageningen Marine Research. https://doi.org/10.18174/410635
Geelhoed S.C.V. & M. Scheidat 2018. Abundance of harbour porpoises (Phocoena phocoena) on the Dutch Continental Shelf, aerial surveys 2012-2017. Lutra 61: 127-136.
Geelhoed, S. C. V., Janinhoff, N., Lagerveld, S., & Verdaat, H. 2020. Marine mammal surveys in Dutch North Sea waters in 2019. (Wageningen Marine Research rapport; No. C016/20). Den Helder: Wageningen Marine Research. https://doi.org/10.18174/515228
Gilbert MJ, IJsseldijk LL, Rubio-García A, Gröne A, Duim B, Rossen J, Zomer AL, Wagenaar JA. 2020 After the bite: bacterial transmission from grey seals (Halichoerus grypus) to harbour porpoises (Phocoena phocoena). R. Soc. Open Sci. 7: 192079. http://dx.doi.org/10.1098/rsos.192079
Gilles A. 2003. Characterisation of harbour porpoise (Phocoena phocoena) habitat in German waters. Diplomarbeit, Christian-Albrechts-Universitat zu Kiel.
Goodwin L. 2008. Diurnal and tidal variations in habitat use of the harbour porpoise (Phocoena phocoena) in Southwest Britain. Aquatic Mammals 34: 44-53.
González A.F., López A., Guerra A. & Barreiro A. 1994. Diets of marine mammals stranded on the northwestern Spanish Atlantic coast with special reference to cephalopoda. Fisheries Research 21: 179-191.
Haelters J. & F. Kerckhof 2004. Hoge bijvangst van bruinvissen in de starndvisserij in het voorjaar van 2004. De Grote Rede (Nieuws over onze kust en zee) 11 (oktober 2004): 6-7.

Haelters J., F. Kerckhof & T. Jauniaux 2004. Bijvangst van bruinvissen Phocoena phocoena vastgesteld bij recreatieve (strand)visserij in het voorjaar van 2004. Nota BMM, 21 april 2004, Beheerseenheid Mathematisch Model van de Noordzee (BMM), Koninklijk Belgisch Instituut voor Natuurwetenschappen (KBIN), 3e en 23e Linieregimentsplein, 8400 Oostende.
Haelters J., F. Kerckhof, E. Toussaint, T. Jauniaux & S. Degraer 2012. The diet of harbour porpoises bycaught or washed ashore in Belgium, and relationship with relevant data from the strandings database. Royal Belgian Institute of Natural Sciences, Management Unit of the North Sea Mathematical Models, Marine Ecosystem Management Section.
Haelters, J, Kerckhof, F, Jauniaux, T and Degraer, S 2012. The grey seal (Halichoerus grypus) as a predator of harbour porpoises (Phocoena phocoena)? Aquatic Mammals 38:343–353
Haelters, J., E. Everaarts, P. Bunskoek, L. Begeman, J.W.J. Hinrichs, L.L. IJsseldijk 2016. A suspect scavenging event by red foxes (Vulpes vulpes) on a live, stranded harbour porpoise (Phocoena phocoena) external link. Aquatic Mammals, DOI 10.1578/AM.42.2.2016.227
Hall A. 2011. Foraging behaviour and reproductive season habitat selection of Northeast Pacific porpoises. Ph.D.-thesis, Univ. British Columbia, Vancouver.
Hammond, P. S., Mizroch, S. A., & Donovan, G. P. 1990. Individual recognition of cetaceans: use of photo-identification and other techniques to estimate population parameters. Reports of the International Whaling Commission, Special Issue, 12.
Hammond, P., Berggren, P., Benke, H., Borchers, D., Collet, .A., Heide-Jørgensen, M., Heimlich, S., Hiby, A., Leopold, M. and Øien, N. 2002. Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. Journal of Applied Ecology, 39: 361-376. doi:10.1046/j.1365-2664.2002.00713.x
Hammond, PS, MacLeod, K, Berggren, P, Borchers, DL, Burt, ML, Cañadas, A, Desportes, G, Donovan, GP, Gilles, A, Gillespie, D, Gordon, J, Hiby, L, Kuklik, I, Leaper, R, Lehnert, K, Leopold, M, Lovell, P, Øien, N, Paxton, CGM, Ridoux, V, Rogan, E, Samarra, F, Scheidat, M, Sequeira, M, Siebert, U, Skov, H, Swift, R, Tasker, ML, Teilmann, J, Van Canneyt, O and Vázquez, JA. 2013. Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. Biological Conservation 164:107–122.
Hammond, PS, Lacey, C, Gilles, A, Viquerat, S, Börjesson, P, Herr, H, Macleod, K, Ridoux, V, Santos, MB, Scheidat, M, Teilmann, J, Vingada, J and Øien, N. 2017. Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. Final Report available at https://synergy.st-andrews.ac.uk/scans3/files/2017/05/SCANS-III-design-based-estimates-2017-05-12-final-revised.pdf
Hammond, P.S., Paradinas, I. & Smout, S.C. 2019. Development of a Removals Limit Algorithm (RLA) to set limits to anthropogenic mortality of small cetaceans to meet specified conservation objectives, with an example implementation for bycatch of harbour porpoise in the North Sea. JNCC Report No. 628, JNCC, Peterborough, ISSN 0963-8091.
Harris, CM, D Sadykova, SL DeRuiter, PL Tyack, PJO Miller, PH Kvadsheim, FPA Lam, and L Thomas 2015. Dose response severity functions for acoustic disturbance in cetaceans using recurrent event survival analysis. Ecosphere 6(11): Article 236.
Harwood, J., King, S., Schick, R., Donovan, C. & Booth, C. 2013, A protocol for implementing the interim population consequences of disturbance (PCOD) approach: quantifying and assessing the effects of UK offshore renewable energy developments on marine mammal populations, Report SMRUL-TCE-2013-014. Scottish Marine and Freshwater Science 5(2) (2013)
Heinis, F., De Jong, C.A.F. & Rijkswaterstaat Underwater Sound Working Group. 2015, Cumulative effects of impulsive underwater sound on marine mammals, TNO 2015 R10335-A, April 2015
Heinis, F., C.A.F. de Jong, S. von Benda-Beckmann & B. Binnerts, 2019. Framework for Assessing Ecological and Cumulative Effects – 2018: Cumulative effects of offshore wind farm construction on harbour porpoises. HWE & TNO. HWE report nr. 18.153RWS_KEC2018. Heinsius H.W. 1914. Langs de Zuiderzee. De Levende Natuur 18: 282-286.
Hermannsen, Line; Beedholm, Kristian; Tougaard, Jakob; Madsen, Professor Peter Teglberg 2014. High frequency components of ship noise in shallow water with a discussion of implications for harbor porpoises (Phocoena phocoena). In: Acoustical Society of America. Journal, Vol. 136, No. 4, 2014, p. 1640-1653.
Hermannsen, L., L. Mikkelsen, J. Tougaard, 2015, Review: Effects of seal scarers on Harbour Porpoises- Research note from Danish Centre for Environment and Energy, Aarhus University, 8 December 2015.
Hermannsen L., L. Mikkelsen, J. Tougaard, K. Beedholm, M. Johnson & P.T. Madsen 2019. Recreational vessels without Automatic Identification System (AiS) dominate anthropogenic noise contributions to a shallow water soundscape. Scientific Reports volume 9, Article number: 15477 (2019). doi:10.1038/s41598-019-51222-9.

Hin, V., J. Harwood, A. M. de Roos, and A. M. Roos. 2019. Bio-energetic modeling of medium-sized cetaceans shows high sensitivity to disturbance in seasons of low resource supply. Ecological Applications 29:e01903.
IAMMWG, Camphuysen, C.J. & Siemensma, M.L. 2015. A Conservation Literature Review for the Harbour Porpoise (Phocoena phocoena). JNCC Report No. 566, Peterborough. 96pp.
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 2015. Report of the Working Group on Bycatch of Protected Species (WGBYC), 2-6 February 2015,
ICES Headquarters, Copenhagen, Denmark. ICES CM 2015\ACOM:26. 82 pp.
ICES 2017a. Report of the Working Group on Bycatch of Protected Species (WGBYC), 12–15 June 2017a, Woods Hole, Massachusetts, USA. ICES CM 2017/ACOM:24. 82 pp.
ICES 2017b. Report of the Working Group on Marine Mammal Ecology (WGMME), 6–9 February 2017b, St Andrews, Scotland, UK. ICES CM 2017/ACOM:27. 102 pp.
ICES 2018. Report from the Working Group on Bycatch of Protected Species (WGBYC), 1–4 May 2018, Reykjavik, Iceland. ICES CM 2018/ACOM:25. 128 pp.
ICES 2019a. Working Group on Bycatch of Protected Species (WGBYC). ICES Scientific Reports. 1:51. 163 pp. http://doi.org/10.17895/ices.pub.5563
ICES 2019b. Advice Ecoregions in the Northeast Atlantic and adjacent seas Published 30 August 2019
ICES 2019c. Working Group on Marine Mammal Ecology (WGMME). ICES Scientific Reports. 1:22. 131 pp. http://doi.org/10.17895/ices.pub.4980
ICES 2020a. Road map for ICES bycatch advice on protected, endangered, and threatened species. In Report of the ICES Advisory Committee, 2020. ICES Advice 2020, section 1.6. https://doi.org/10.17895/ices.advice.6022
ICES 2020b. Advice Ecoregions in the Northeast Atlantic and adjacent areas. Published 22 september 2020.
IJsseldijk L.L., Camphuysen, C.J., Nauw, J.J. & Aarts, G. 2015. Going with the flow: Tidal influence on the occurrence of the harbour porpoise (Phocoena phocoena) in the Marsdiep area, the Netherlands. Journal of Sea Research, 103: 129-137.
IJsseldijk, L. L., & Gröne, A. 2016. Investigation into hearing damage and life history of Dutch stranded harbour porpoises. Utrecht University intern report for WoZEP.
IJsseldijk, L.L., ten Doeschate, M.T.I., Davison, Nicholas, Gröne, A. & Brownlow, Andrew 2018. Crossing boundaries for cetacean conservation: Setting research priorities to guide management of harbour porpoises. Marine Policy, 95:77-84.
IJsseldijk, L.L., Brownlow, A.C., Mazzariol, S. (Eds) 2019. European Best Practice on Cetacean Post-Mortem Investigation and Tissue Sampling. Joint ACCOBAMS/ASCOBANS document. Access at: https://osf.io/zh4ra/, DOI: 10.31219/osf.io/zh4ra
IJsseldijk, L.L., M.J.L. Kik M.J.L, & Gröne, A. 2019. Post-mortem research on porpoises (Phocoena phocoena) from Dutch waters, 2018. Biological data, health status and causes of death. Statutory Research Tasks Unit for Nature & the Environment (WOT Natuur & Milieu), WOt-technical report 150.
IJsseldijk, L.L., M.J.L. Kik, L. van Schalkwijk & A. Gröne 2020. Postmortaal onderzoek van bruinvissen (Phocoena phocoena) uit Nederlandse wateren, 2019. Statutory Research Tasks Unit for Nature & the Environment (WOT Natuur & Milieu), WOt-technical report 184, DOI: 10.18174/523708.
IJsseldijk LL, & ten Doeschate, M.T.I., Brownlow, A., Davison, N., Deaville, R., Galatius, A., ... & Heesterbeek, H. 2020. Spatiotemporal mortality and demographic trends in a small cetacean: Strandings to inform conservation management. Biological Conservation, 249, 108733.
IJsseldijk, L.L. & Aarts, G. 2020. Predicting harbour porpoise strandings based on near shore sightings indicate elevated temporal mortality rates. Utrecht University intern report for WoZEP
IJsseldijk, L.L., Scheidat, M., Siemensma, M.L., Couperus, B., Leopold, M.F., Morell, M., Gröne, A., Kik, M.J.L. Challenges in the assessment of bycatch: Post-mortem findings in harbour porpoises (Phocoena phocoena) retrieved from gillnets. In review at: Veterinary Pathology
IWC 2020. Report of the third IWC workshop on Marine Debris: The Way Forward, 3-5 December, La Garriga, Catalonia, Spain.
Jak R.G., O.G. Bos, R. Witbaard & H.J. Lindeboom 2009. Bijlagenrapport bij Instandhoudingsdoelen Natura 2000-gebieden Noordzee. Bijlage bij rapport C065/09, Wageningen-IMARES, Texel.
Jansen O.E. 2013. Fishing for food: feeding ecology of harbour porpoises Phocoena phocoena and white-beaked dolphins Lagenorhynchus albirostris in Dutch waters. Ph.D.-thesis, Univ. Wageningen.
Jansen H.W. en C.A.F. De Jong, 2014, Underwater noise measurements in the North Sea in and near the Princess Amalia Wind Farm in operation, TNO report TNO 2013 R11916, May 2014
Jepson, P.D., Bennett, P.M., Deaville, R., Allchin, C.R., Baker J.R. & Law, R.J. 2005. Relationships between PCBs and health status in UK-stranded harbour porpoises (Phocoena phocoena). Environmental Toxicology and Chemistry 24: 238–248.
Jepson, P. D., Deaville, R., Barber, J. L., Aguilar, À., Borrell, A., Murphy, S., ... & Cunningham, A. A. 2016. PCB pollution continues to impact populations of orcas and other dolphins in European waters. Scientific reports, 6, 18573.
Johnson, M. P. and P. L. Tyack 2003. "A Digital Acoutic Recording Tag for Measuring the Response of Wild Marine Mammals to Sound." IEEE Journal of Oceanic Engineering 28(1): 3-12.
Johnston D.W., A.J. Westgate & A.J. Read 1997. Effects of fine-scale oceanographic features on the distribution and movements of harbour porpoises Phocoena phocoena in the Bay of Fundy. Mar. Ecol. Progr. Ser. 295: 279-293.
Johnston, D.W. 2002. The effect of acoustic harassment devices on harbour porpoises (Phocoena phocoena) in the Bay of Fundy, Canada. Biological Conservation, Volume 108, Issue 1, 113-118. https://doi.org/10.1016/S0006-3207(02)00099-X.
Jongbloed, R.H, Hintzen, N.T., Machiels, M.A.M., Couperus, A.S. 2013. Nadere effecten analyse staandwantvisserij – bruinvis in Natura 2000 gebied Noordzeekustzone. IMARES Wageningen UR, report nr. C206/13.
Kapetanou, A., IJsseldijk, L. L., Willems, D. S., Broens, E. M., Everaarts, E., Buil, J. B., ... & Gröne, A. (2020). Mycotic infections in Free-ranging Harbour porpoises (Phocoena phocoena). *Frontiers in Marine Science*, 7, 344.
Kastelein R.A., J. Hardeman & H. Boer 1997. Food consumption and body weight of harbour porpoises (Phocoena phocoena). In: Read A.J., P.R. Wiepkema & P.E. Nachtigall (eds) The biology of the Harbour Porpoise: 217-233. De Spil Publ., Woerden.
Kastelein, Ronald & Au, Whitlow & Rippe, H & Schooneman, N. 1999. Target detection by an echolocating harbor porpoise (Phocoena phocoena). The Journal of the Acoustical Society of America. 105. 2493-8. 10.1121/1.426951.
Kastelein R.A, Gransier R, Marijt MA, Hoek L. 2015. Hearing frequency thresholds of harbour porpoises (Phocoena phocoena) temporarily affected by played back offshore pile driving sounds. J Acoust Soc Am. 2015; 137(2):556-564. doi:10.1121/1.4906261;
Kastelein, R. A., Janssen, M., Verboom, W. C., de Haan, D. 2005. "Receiving beam patterns in the horizontal plane of a harbor porpoise (Phocoena phocoena)," J. Acoust. Soc. Am. 118, 1172-1179. DOI: 10.1121/1.1945565.
Turnbull, S.D. (1994). "Changes in masked thresholds of a harbour seal (Phoca vitulina) associated with angular separation of signal and noise sources." Can. J. Zool. 72, 1863-1866.
Kastelein RA, Helder-Hoek L, Covi J, Gransier R. 2016. Pile driving playback sounds and temporary threshold shift in harbour porpoises (Phocoena phocoena): Effect of exposure duration. J Acoust Soc Am. 2016; 139(5):2842. doi:10.1121/1.4948571;
Kastelein R.A, Helder-Hoek L, Van de Voorde S, et al. 2017. Temporary hearing threshold shift in a harbour porpoise (Phocoena phocoena) after exposure to multiple airgun sounds. J Acoust Soc Am. 2017; 142(4):2430. doi:10.1121/1.5007720;
Kastelein, R.A & Helder-Hoek, Lean & Jennings, Nancy & Kester, Ruby & Huisman, Rowanne. 2019. Reduction in Body Mass and Blubber Thickness of Harbor Porpoises (Phocoena phocoena) Due to Near-Fasting for 24 Hours in Four Seasons. Aquatic Mammals. 45. 37-47. 10.1578/AM.45.1.2019.37.
Keijl, G. O., Begeman, L., Hiemstra, S., IJsseldijk, L. L., & Kamminga, P. 2016. Cetaceans stranded in the Netherlands in 2008-2014. *Lutra*, 59(1-2), 75-107.
Kindt-Larsen, L, Dalskov, J, Stage, B and Larsen, F. 2012a. Observing incidental harbour porpoise Phocoena phocoena bycatch by remote electronic monitoring. Endang Species Res 19:75–83
Kindt-Larsen, L, Larsen, F, Stage, B and Dalskov, J. 2012b. Fully documented fishery onboard gillnet vessels <15 m. FINAL REPORT. National Institute of Aquatic Resources Technical University of Denmark. February 2012.
Kindt-Larsen L, Berg CW, Tougaard J, Sørensen TK and others, 2016. Identification of high-risk areas for harbour porpoise Phocoena phocoena bycatch using remote electronic monitoring and satellite telemetry data. Mar Ecol Prog Ser 555:261-271. https://doi.org/10.3354/meps11806
Kingston, A. & Northridge, S. 2011. Extension trial of an acoustic deterrent system to minimise dolphin and porpoise bycatch in gill and tangle net fisheries. Report to the MMO under the Fisheries Challenge Fund. Available from: http://marinemanagement.org.uk/fisheries/funding/documents/fcf-acoustic-deterrent.pdf
Kinze C.C., Kröger R.H.H., Smeenk C. & Evans P.G.H. 1987. The decline of the Harbour Porpoise in the North Sea. Statement of Concern of European Cetacean Society, 17 November 1987.
Komoroske, LM and Lewison, RL 2015. Addressing fisheries bycatch in a changing world. Front. Mar.Sci. 2:83. doi: 10.3389/fmars.2015.00083.

Königson S, Lovgren J, Hjelm J, Ovegard M, Ljunghager F, Lunneryd SG 2015. Seal exclusion devices in cod pots prevent seal bycatch and affect their catchability of cod. Fish Res 167:114–122.
Kristensen I. & K. Willemsen 1949. Journaal VI van het Zoologisch Station Den Helder, 1 Januari - 26 November 1949. Ongepubliceerd logboek, archief Koninklijk Nederlands Instituut voor Onderzoek der Zee, Texel.
Kyhn LA, Jørgensen PB, Carstensen J, Bech NI, Tougaard J, Dabelsteen T, Teilmann J (2015) Pingers cause temporary habitat displacement in the harbour porpoise Phocoena phocoena. Mar Ecol Prog Ser 526:253-265. https://doi.org/10.3354/meps11181
Lah L, Trense D, Benke H, Berggren P, Gunnlaugsson Þ, Lockyer C, Öztürk A, Öztürk B, Pawliczka I, Roos A, Siebert U, Skóra K, Víkingsson G, Tiedemann R. 2016. Spatially explicit analysis of genome-wide SNPs detects subtle population structure in a mobile marine mammal, the Harbour porpoise. PLoS ONE 11, e0162792.
Larsen, F., O.R. Eigaard & J. Tougaard 2007. Reduction of harbour porpoise (Phocoena phocoena) bycatch by iron-oxide gillnets. Fisheries Research (Amsterdam) 85:270-278.
Larsen, F. C. Krog, O.R. Eigaard 2013. Determining optimal pinger spacing for harbour porpoise bycatch mitigation. Endangered Species Research Vol. 20:147-152.
Leaper R. & Calderan S., 2018. Review of methods used to reduce risks of cetacean bycatch and entanglements. UNEP/CMS Secretariat, Bonn, Germany. 76 pages. CMS Technical Series No. 38.
Leopold M.F. 2015. Eat and be eaten - Porpoise diet studies. PhD.-thesis, Wageningen University Research (WUR), Wageningen.
Leopold M.F., L. Begeman, E. Heße, J. van der Hiele, S. Hiemstra, G. Keijl, E.H.Meesters, L. Mielke, D. Verheyen & A. Gröne 2015. Porpoises: From predators to prey. Journal of Sea Research 97: 14-23.
Leopold MF, Begeman L, van Bleijswijk JDL, IJsseldijk LL, Witte HJ, Gröne A. 2015 Exposing the grey seal as a major predator of harbour porpoises. Proc. R. Soc. B 282: 20142429. http://dx.doi.org/10.1098/rspb.2014.2429
Lick R.R. 1991. Nahrungsanalysen mariner Säuger. In: Untersuchungen zu Lebenszyklus (Krebse - Fische - Marine Säuger) und Gefrierresistenz anisakider Nematoden in Nord- und Ostsee. Ber. Inst. Meeresk., Christ.-Albr. Univ., Kiel Nr 218: 122-140.
Linnenschmidt M., J. Teilmann, T. Akamatsu, R. Dietz & A. Miller 2013. Biosonar, dive, and foraging activity of satellite tracked harbour porpoises (Phocoena phocoena). Mar. Mamm. Sc. 29: E77-E97.
Lockyer C., Heide-Jorgensen M.P., Jensen J. & Walton M.J. 2003. Life history and ecology of harbour porpoises (Phocoena phocoena) from West Greenland. In: Haug T., Desportes G., Víkingsson G.A. & Witting L. (eds) Harbour Porpoises in the North Atlantic. NAMMCO Sci. Publ. 5: 177-194.
Lockyer C. & Kinze C. 2003. Status, ecology and life history of harbour porpoise (Phocoena phocoena) in Danish waters. In: Haug T., Desportes G., Víkingsson G.A. & Witting L. (eds) Harbour Porpoises in the North Atlantic. NAMMCO Sci. Publ. 5: 143-176. https://doi.org/10.7557/3.2745.
Macaulay J, J Gordon, D Gillespie, C Malinka, S Northridge 2017. Passive acoustic methods for fine-scale tracking of harbour porpoises in tidal rapids. The Journal of the Acoustical Society of America 141, 1120 (2017); doi: 10.1121/1.4976077
MacLeod C.D., M.B. Santos, A. López, G.J. Pierce 2006. Relative prey size consumption in toothed whales: implications for prey selection and level of specialisation. Mar. Ecol. Progr. Ser. 326: 295-307.
Macfadyen, G, Huntington, T and Cappell, R 2009. Abandoned, lost or otherwise discarded fishing gear. UNEP Regional Seas Reports and Studies, No. 185; FAO Fisheries and Aquaculture Technical Paper, No. 523. Rome, UNEP/FAO. 115p.
Maio, E., Begeman, L., Bisselink, Y., van Tulden, P., Wiersma, L., Hiemstra, S., ... & van der Giessen, J. 2014. Identification and typing of Brucella spp. in stranded harbour porpoises (Phocoena phocoena) on the Dutch coast. Veterinary Microbiology, 173(1-2), 118-124.
Marubini F., A. Gimona, P.G.H. Evans, P.J. Wright & G.J. Pierce 2009. Habitat preferences and interannual variability in occurrence of the harbour porpoise Phocoena phocoena off northwest Scotland. Mar. Ecol. Prog. Ser. 381: 297-310.
Mikkelsen L., L. Hermannsen, K. Beedholm, P.T. Madsen and J. Tougaard 2017. Simulated seal scarer sounds scare porpoises, but not seals: species-specific responses to 12 kHz deterrence soundsR. Soc. open sci.4170286 http://doi.org/10.1098/rsos.170286
Miller PJO, Antunes R, Wensveen P, Samarra FIP, Alves AC, Tyack P, Kvadsheim PH, Kleivane L, Lam FP, Ainslie, M and Thomas L. 2014. Dose-response relationships for the onset of avoidance of sonar by free-ranging killer whales. J. Acoust. Soc Am. 135, 975-993.
Ministerie van EZ 2013: Enquête behorend bij de brief van 29 maart 2013, kenmerk DAD/13053186.
Ministry of Infrastructure and the Environment, 2012. Marine Strategy for the Netherlands part of the North Sea 2012-2020, Part 1.
Ministry of Infrastructure and the Environment, 2014. Marine Strategy for the Dutch part of the North Sea 2012-2020, Part 2, MSFD Monitoring Programme.
Ministry of Infrastructure and the Environment, 2015. Marine Strategy for the Dutch part of the North Sea 2012-2020, Part 3, the MSFD Programme of Measures.
Ministry of Infrastructure and Water Management and Ministry of Agriculture, Nature and Food Quality, 2018. Marine Strategy for the Dutch part of the North Sea, part 1. Update of current environmental status, good environmental status, environmental targets and indicators 2018-2024.
MinEZK 2018. Kamerbrief over gaswinning uit kleine Velden. Kamerstuk: Kamerbrief 30-05-2018.
Morell, M., Lenoir, M., Shadwick, R. E., Jauniaux, T., Dabin, W., Begeman, L., ... & Cazevieille, C. 2015. Ultrastructure of the O dontocete Organ of C orti: Scanning and transmission electron microscopy. Journal of Comparative Neurology, 523(3), 431-448.
Morell, M., Lehnert, K., IJsseldijk, L. L., Raverty, S. A., Wohlsein, P., Gröne, A., ... & Shadwick, R. E. 2017. Parasites in the inner ear of harbour porpoise: cases from the North and Baltic Seas. Diseases of aquatic organisms, 127(1), 57-63.
Morell, M., Vogl, A. W., IJsseldijk, L. L., Piscitelli-Doshkov M., Tong, L., ... & Shadwick, R. E. Echolocating whales and bats express the motor protein prestin in the inner ear: a potential marker for hearing loss. In review at Frontiers in Marine Science.
Morin PA, Hancock-Hanser BL, Robertson KM, Forney KA, Crossman CA, Barrett-Lennard LG, Baird RW, Calambokidis J, Gearin P, Hanson BM, Schumacher C, Harkins T, Forester BR, Fontaine MC, Taylor BL, Parsons K 2020. Data from the dead: genomic SNPs from poor-quality samples detect population structure in North Pacific harbour porpoise. Submitted and preprint available on biorxiv at doi: TBA.
Murphy, S., JL Barber, J.A. Learmonth, F.L. Read, R. Deaville, M.W. Perkins, A. Brownlow, N. Davison, R. Penrose, G. J. Pierce, R. J. Law, P. D. Jepson 2015. Reproductive failure in UK harbour porpoises Phocoena phocoena: legacy of pollutant exposure? PLOS ONE 10(7), e0131085. doi: 10.1371/journal.pone.0131085 2015.
Murphy, S. R.J. Law, R. Deaville, J. Barnett, M.W. Perkins, A. Brownlow, R. Penrose, N.J. Davison, J.L. Barber & P.D. Jepson 2018. Marine Mammal Ecotoxicology. Impacts of Multiple Stressors on Population Health. Chapter 1 - Organochlorine Contaminants and Reproductive Implication in Cetaceans: A Case Study of the Common Dolphin. Academic Press. Pages 3-38. https://doi.org/10.1016/B978-0-12-812144-3.00001-2
Murphy, S, Evans, PGH, Pinn, E, Pierce, GJ. Conservation management of common dolphins: Lessons learned from the North-East Atlantic. Aquatic Conserv: Mar Freshw Ecosyst. 2019; 1– 30. https://doi.org/10.1002/aqc.3212
Nabe-Nielsen, J. & Harwood, J., 2016. Comparison of the iPCoD and DEPONS models for modelling population consequences of noise on Harbour Porpoises, Aarhus University, DCE – Danish Centre for Environment and Energy, 22 pp. Scientific Report from DCE – Danish Centre for Environment and Energy No. 186.
Nielsen, N., J. Teilmann, S. Sveegaard, R. Hansen, M.H. Sinding, R. Dietz & M.P. Heide-Jørgensen 2018. Oceanic movements, site fidelity and deep diving in harbour porpoises from Greenland show limited behavioural similarities to North Sea harbour porpoise population. Marine Ecology Progress Series. 597. 10.3354/meps12588.
Northridge, S. P. and P. S. Hammond 1999. Estimation of porpoise mortality in UK gill and tangle net fisheries in the North Sea and west of Scotland. SC/51/SM42.
Northridge, S.P., Gordon, J.G., Booth, C., Calderan, S., Cargill, A., Coram, A., Gillespie, D., Lonergan, M. and Webb, A. 2010. Assessment of the impacts and utility of acoustic deterrent devices. Final Report to the Scottish Aquaculture Research Forum, Project Code SARF044. 34pp.
Northridge, S., Coram, A., Kingston, A. and Crawford, R. 2017. Disentangling the causes of protected-species bycatch in gillnet fisheries. Conservation Biology, 31: 686-695. doi:10.1111/cobi.12741
North Atlantic Marine Mammal Commission & Norwegian Institute of Marine Research 2019. Report of Joint IMR/NAMMCO International Workshop on the Status of Harbour Porpoises in the North Atlantic. Tromsø, Norway.
Nuuttila, H.K., R. Meier, P.G.H. Evans, J.R. Turner, J.D. Bennell, & J.G. Hiddink 2013. Identifying Foraging Behaviour of Wild Bottlenose Dolphins (Tursiops truncatus) and Harbour Porpoises (Phocoena phocoena) with Static Acoustic Dataloggers. Aquatic Mammals 39: 147-161.
Olesiuk, P.F., Nichol, L.M., Sowden, M.J. and Ford, J.K.B. 2002, Effect of the sound generated by an acoustic harassment device on the relative abundance and distribution of harbor porpoises (Phocoena phocoena) in

retreat passage, British Columbia. Marine Mammal Science, 18: 843-862. doi:10.1111/j.1748-7692.2002.tb01077.x
Palka, D. L., Rossman, M. C., VanAtten, A. S., and Orphanides, C. D. 2008. Effect of pingers on harbour porpoise (Phocoena phocoena) bycatch in the US Northeast gillnet fishery. J. Cetacean Res. Manage. 10, 217–226.
Peltier, H., Authier, M., Deaville, R., Dabin, W., Jepson, P. D., Van Canneyt, O., Daniel, P. and Ridoux, V. 2016. Small cetacean bycatch as estimated from stranding schemes: The common dolphin case in the northeast Atlantic. Environmental Science and Policy 63, 7-18.
Pierrepont J.F. de, B. Dubois, S. Desormonts, M.B. Santos & J.P. Robin 2005. Stomach contents of English Channel cetaceans stranded on the coast of Normandy. J. Mar. Biol. Ass. U.K. 85: 1539-1546.
Pirotta E, Brookes K, Grahamh IM, Thompson PM. 2014 Variation in harbour porpoise activity in response to seismic survey noise. Biol. Lett. 10, 20131090. (doi:10.1098/rsbl.2013.1090)
Pirotta E, Harwood J, Thompson PM, New L, Cheney B, Arso M, Hammond PS, Donovan C, Lusseau D. 2015. Predicting the effects of human developments on individual dolphins to understand potential long-term population consequences. Proc R Soc B 282:2109–2115.
Pirotta, E., Booth, C. G., Costa, D. P., Fleishman, E., Kraus, S. D., Lusseau, D., … Harwood, J. 2018. Understanding the population consequences of disturbance. Ecology and Evolution, 8, 9934–9946.
Podt, A., & IJsseldijk, L. L. 2017. Grey seal attacks on harbour porpoises in the Eastern Scheldt: Cases of survival and mortality. Lutra, 60(2), 105-116.
Podt, A. 2020. Photo-identification catalogue of harbour porpoises (Phocoena phocoena) in the Eastern Scheldt 2015-2019. Rugvin Foundation. https://rugvin.nl/wp-content/uploads/2020/03/catalogus_2015-2019.pdf
Rae B.B. 1965. The food of the common porpoise (Phocoena phocoena). J. Zool., Lond. 146: 114-122.
Rae B.B. 1973. Additional notes on the food of the Common porpoise (Phocoena phocoena). J. Zool., Lond. 169: 127-131.
Ransijn, J.M., Booth, C. & Smout, S.C. 2019. A calorific map of harbour porpoise prey in the North Sea. JNCC Report No. 633. JNCC, Peterborough, ISSN 0963 8091.
Read A. J. & A.J. Westgate 1997. Monitoring the movements of harbour porpoises (Phocoena phocoena) with satellite telemetry. Mar. Biol. 130: 315-322.
Redeke H.C. (ed.) 1936. Flora en fauna der Zuiderzee. Monografie van een brakwatergebied, supplement. Uitgeverij De Boer, Den Helder.
Reeves RR, McClellan K, Werner TB. 2013. Marine mammal bycatch in gillnet and other entangling net fisheries, 1990, 2011, End. Sp. Res. 20, 71–97.
Reijnders PJH, 1992. Harbour porpoises Phocoena phocoena in the North Sea: Numerical responses to changes in environmental conditions. Netherlands Journal of Aquatic Ecology 26(1): 75-85.
Reijnders, P.J.H., Donovan, G.P., Bjørge, A., Kock, K-H., Eisfeld, S., Scheidat, M. & Tasker, M.L., 2009. ASCOBANS Conservation Plan for harbour porpoises (Phocoena phocoena L.) in the North Sea. 6th Meeting of the Parties to ASCOBANS MOP6/Doc.7-02 (AC), UN Campus, Bonn, Germany, 16-18 September 2009.
Robineau D., Duguy R. & Klima M. 1995. Handbuch der Säugetiere Europas, Vol 6: Meeressäuger, Part IB: Wale und Delphine 2. Aula-Verlag, Wiesbaden, Germany, I-XIX, 505-811.
Rogan E.M. 2009. The ecology of harbour porpoise (Phocoena phocoena) in Irish waters: what strandings programmes tell us. In: Berrow S.D. & B. Deegan (eds) Muc Mhara - Ireland's Smallest Whale: 8-14. Proceedings of the 2nd IWDG International Whale Conference, Fitzpatrick Castle Hotel, Killiney, Co Dublin 19th - 21st September 2008; Irish Whale and Dolphin Group (IWDG), Killiney, Co. Dublin.
Rosel P.E, Tiedemann R, Walton M. 1999. Genetic evidence for restricted trans-Atlantic movements of the harbour porpoise, Phocoena phocoena. Marine Biology 133, 583-591.
SAMBAH (2016). Final report for LIFE+ project SAMBAH LIFE08 NAT/S/000261 covering the project activities from 01/01/2010 to 30/09/2015 (No. Reporting date 29/02/2016). http://www.sambah.org/SAMBAH-Final-Report-FINAL-for-website-April-2017.pdf
Santos M.B. & G.J. Pierce 2003. The diet of Harbour Porpoise (Phocoena phocoena) in the Northeast Atlantic. Oceanogr. Mar. Biol. Ann. Rev. 41: 355-390.
Santos M.B. 1998. Feeding ecology of harbour porpoises, common and bottlenose dolphins and sperm whales in the North East Atlantic. PhD thesis, Univ. Aberdeen.
Santos M.B., G.J. Pierce, J.A. Learmonth, R.J. Reid, H.M. Ross, I.A.P. Patterson, D.G. Reid & D. Beare 2004. Variability in the diet of Harbour porpoises (Phocoena phocoena) in Scottish waters 1992-2003. Mar. Mamm. Sc. 20: 1-27.

Sarnocińska J, Teilmann J, Balle JD, van Beest FM, Delefosse M and Tougaard J. 2020. Harbour porpoise (Phocoena phocoena) Reaction to a 3D Seismic Airgun Survey in the North Sea. Front. Mar. Sci. 6:824. doi: 10.3389/fmars.2019.00824
Scheidat, M., H. Verdaat, G. Aarts 2012. Using aerial surveys to estimate density and distribution of harbour porpoises in Dutch waters J. Sea Res., 69, pp. 1-7
Scheidat, M., R. Leaper, M. Van Den Heuvel-Greve and A. Winship 2013. Setting Maximum Mortality Limits for Harbour Porpoises in Dutch Waters to Achieve Conservation Objectives. Open Journal of Marine Science Vol.03No.03: 7
Scheidat, M. & Königson S. 2016. Workshop on Remote Electronic Monitoring with Regards to Bycatch of Small Cetaceans. The Hague, Netherlands, 2 October 2015. Available at: http://www.ascobans.org/sites/default/files/document/ASCOBANS_WS_REM_2015_Report.pdf
Scheidat M, Bos O & Geelhoed S.C.V 2016. The feasibility of tagging harbour porpoises in Dutch waters. IMARES Report [C009/16].
Scheidat, M., Couperus, B., & Siemensma, M. 2018. Electronic monitoring of incidental bycatch of harbour porpoise (Phocoena phocoena) in the Dutch bottom set gillnet fishery (September 2013 to March 2017). (Wageningen Marine Research report; No. C102/18). IJmuiden: Wageningen Marine Research. https://doi.org/10.18174/466450
Scheidat M, Geelhoed S.C.V & Noort, C.A. 2019. The Feasibility of a Passive Acoustic Monitoring (PAM) network for Harbour Porpoises on the Dutch Continental Shelf. Wageningen Marine Research report C095/19. https://doi.org/10.18174/504076
Schulze G. 1987. Die Schweinswale. Neue Brehm-Bücherei No. 583, A. Ziemsen Verlag, Wittenberg Lutherstadt.
Scott B.E., J. Sharples, O.N. Ross & C.J. Camphuysen 2005. Marine top predator foraging habitat predicted from a detailed understanding of temporal and spatial oceanographic processes. ICES CM 2005/ Session O:39.
Scott B.E., J. Sharples, O.N. Ross, J. Wang, G.J. Pierce & C.J. Camphuysen 2010. Sub-surface hotspots in shallow seas: fine scale limited locations of marine top-predator foraging habitat indicated by tidal mixing and sub-surface chlorophyll. Mar. Ecol. Progr. Ser. 408: 207-226.
Senigaglia V, Christiansen F, Bejder L, Gendron D and others 2016. Meta-analyses of whale- watching impact studies: comparisons of cetacean responses to disturbance. Mar Ecol Prog Ser 542:251-263. https://doi.org/10.3354/meps11497
Siebert U, Tolley K, Vikingsson GA, Olafsdottir D, Lehnert K, Weiss R, & Baumgärtner W. 2006. Pathological findings in harbour porpoises (Phocoena phocoena) from Norwegian and Icelandic waters. Journal of Comparative Pathology, 134(2-3), 134-142.
Siemensma, M.L. 2014. Bijvangstmitigatie Bruinvis. Final report of the European Fisheries Fund porpoise bycatch mitigation trial by Vereniging Kust & Zee.
Siemensma, M.L., Scheidat, M. 2015. Stand van zaken soortbeschermingsplan Bruinvis 2014. IMARES Rapport C077/15
Sivle L, PH Kvadsheim, C Curé, S Isojunno, PJ Wensveen, FPA Lam, F Visser, L Kleivane, PL Tyack, C Harris, PJO Miller 2015. Severity of expert-identified behavioural responses of humpback whale, minke whale and northern bottlenose whale to naval sonar. Aquatic Mammals 41(4): 469-502 DOI 10.1578/AM.41.4.2015.469
Skov H. & F. Thomsen 2008. Resolving fine-scale spatio-temporal dynamics in the harbour porpoise Phocoena phocoena. Marine Ecology Progress Series 373: 173-186.
Smith R.J. & Read A.J. 1992. Consumption of euphausiids by Harbour Porpoises (Phocoena phocoena) calves in the Bay of Fundy. Can. J. Zool. 70: 1629-1632.
Soldaat. L & M.Poot 2020. Analyse bruinvisgegevens en evaluatie monitoring Noordzee – Kwaliteitsborging IHM 2019. CBS projectnummer 190220.
Soudijn, F. H., T. van Kooten, H. Slabbekoorn, and A. M. de Roos. 2020. Population-level effects of acoustic disturbance in Atlantic cod: a size-structured analysis based on energy budgets. Proceedings of the Royal Society B: Biological Sciences 287 (10.1098/rspb.2020.0490).
Southall, B.L., Finneran, J.J., Reichmuth, C., Nachtigall, P.E., Ketten, D.R., Bowles, A.E., Ellison, W.T., Nowacek, D.P., and Tyack, P.L. (2019) Marine mammal noise exposure criteria: updated scientific recommendations for residual hearing effects. Aquatic Mammals, 45, 125-232, DOI 10.1578/AM.45.2.2019.125
Staatscourant 2012. Regeling van de Staatssecretaris van Economische Zaken, Landbouw en Innovatie van 27 Juni 2012, nr. 268070, houdende wijzing van de Uitvoeringsregeling visserij ten behoeve van het onder voorwaarden toestaan van recreatief gebruik van staand want in de Visserijzone.

Stuart-Smith, S. J., & Jepson, P. D. 2017. Persistent threats need persistent counteraction: Responding to PCB pollution in marine mammals. Marine Policy, 84, 69-75.)

Sveegaard S., J. Teilmann, P. Berggren, K.N. Mouritsen, D. Gillespie & J. Tougaard 2011. Acoustic surveys confirm the high-density areas of harbour porpoises found by satellite tracking. ICES Journal of Marine Science 68(5): 929-936.

Sveegaard S., H. Andreasen, K.N. Mouritsen, J. Peder Jeppesen, J. Teilmann & C.C. Kinze 2012. Correlation between the seasonal distribution of harbour porpoises and their prey in the Sound, Baltic Sea. Mar Biol. 159: 1029-1037.

Taylor SA, Larson EL, Harrison RG 2015. Hybrid zones: windows on climate change. Trends in Ecology & Evolution 30, 398–406

Teilmann J., R. Dietz, F. Larsen, G. Desportes, B. Molgaard Geertsen, L. Wesley Andersen, P. Aastrup, J. Rye Hansen, L. Buholzer 2004. Satellitsporing af marsvin i danske og tilstodende farvande. Faglig rapport fra DMU, nr. 484, Danmarks Miljoundersogelser Miljoministeriet.

Teilmann J., F. Larsen & G. Desportes 2007. Time allocation and diving behaviour of harbour porpoises (Phocoena phocoena) in Danish waters. J. Cetacean Res. Manage. 9: 201-210.

Ten Doeschate MTI, IJsseldijk LL, Hiemstra S, de Jong EA, Strijkstra A, Gröne A, Begeman L (2017) Quantifying parasite presence in relation to biological parameters of harbour porpoises Phocoena phocoena stranded on the Dutch coast. Dis Aquat Org 127:49-56. https://doi.org/10.3354/dao03182

Tiedemann R, Tiedemann MR, Goto M, Taguchi M, Pastene LA 2017. Finding parent-offspring pairs among western North Pacific common minke whales. Paper SC/67A/SDDNA/01 presented to the IWC Scientific Committee.

TG Noise. In preparation, 2020 Towards thresholds for underwater noise. Common approaches for interpretation of data obtained in (Joint) Monitoring Programmes.

Thomsen F. & Piper W. 2006. Akustisches Monitoring von Schweinswalen (Phocoena phocoena) vor der Küste Ostfrieslands. Natur- und Umweltschutz (Zeitschr. Mellumrat) 5(1): 11-17.

Thompson, P.M., Brookes, K.L., Graham, I.M., Barton, T.R., Needham, K., Bradbury, G. & Merchant, N.D., 2013. Short-term disturbance by a commercial two-dimensional seismic survey does not lead to long-term displacement of Harbour Porpoises, Proc RSoc B 280: 20132001, https://doi.org/10.1098/rspb.2013.2001, November 2013. Jakob Tougaard, Jacob Carstensen, Jonas Teilmann, Henrik Skov and Per Rasmussen, Pile driving zone of responsiveness extends beyond 20 km for harbor porpoises (Phocoena phocoena (L.)) August 2009, The Journal of the Acoustical Society of America 126(1):11-4

Trouwborst, A. 2012. Legal Review of the Netherlands Conservation Plan for the Harbour Porpoise (Phocoena phocoena), Tilburg Law School, March 2012, commissioned by the North Sea Foundation (Stichting De Noordzee).

Turnbull, S.D. (1994). “Changes in masked thresholds of a harbour seal (Phoca vitulina) associated with angular separation of signal and noise sources.” Can. J. Zool. 72, 1863-1866.

Van Beurden, S.J., L.L. IJsseldijk, S.R. Ordonez, C. Förster, G. de Vrieze, A. Gröne. M.H. Verheije, M. Kik. 2015. Identification of a novel gammaherpesvirus associated with (muco)cutaneous lesions in harbour porpoises (Phocoena phocoena). Archives of Virology, DIO:10.1007/s00705-015-2607-8

Van Beurden, S. J., IJsseldijk, L. L., Van de Bildt, M. W., Begeman, L., Wellehan, J. F., Waltzek, T. B., ... & Penzes, J. J. 2017. A novel cetacean adenovirus in stranded harbour porpoises from the North Sea: detection and molecular characterization. *Archives of virology*, *162*(7), 2035-2040.

Van Bleijswijk, J.D.L., L. Begeman, H.J. Witte, L.L. IJsseldijk, S.M.J.M. Brasseur, A. Gröne, M.F. Leopold 2014. Detection of grey seal Halichoerus grypus DNA in attack wounds on stranded harbour porpoises Phocoena phocoena external link. Marine Ecology Progress Series, DIO: 10.3354/meps11004.

Van den Heuvel-Greve, M.J., van den Brink AM, Kotterman M, Kwadijk C, Geelhoed SCV, ... & IJsseldijk LL. Polluted porpoises: Generational transfer of contaminates in harbour porpoises from the southern North Sea. In preparation, pending submission.

Van den Heuvel-Greve, M.J., Kwadijk C & Kotterman M. 2014. Contaminanten in aangespoelde bruinvissen langs de Nederlandse kust; spekkwaliteit, neonaten en chemische profielen. Rapport C113/14.

Van der Hammen, T. and de Graaf, M. 2016. Recreational fisheries in the Netherlands: Analyses of the 2015 screening survey, the 2014 – 2015 logbook survey and the 2014 – 2015 Gillnet survey. CVO report number: 17.005. available at: http://dx.doi.org/10.18174/409681

Van der Hammen, T. and de Bruin, P. 2020. Recreatieve staandwant survey 2018-2019. CVO report number: 20.007. Available at: https://doi.org/10.18174/516509

Van der Meer, J., H. Eijsackers & J. Haelters 2016. Eerste Advies Bruinvisonderzoek (Bac-2016-01) http://edepot.wur.nl/381441; IMARES Wageningen UR.

Van der Meer, J., H. Eijsackers & J. Haelters 2019. Tweede advies Bruinvisonderzoek.

Van der Meer, J., H. Eijsackers & J. Haelters 2020. Derde advies Bruinvisonderzoek.

Van de Velde, N., Devleesschauwer, B., Leopold, M., Begeman, L., IJsseldijk, L., Hiemstra, S., ... & De Craeye, S. 2016. Toxoplasma gondii in stranded marine mammals from the North Sea and Eastern Atlantic Ocean: findings and diagnostic difficulties. Veterinary parasitology, 230, 25-32.

Van Franeker, J.A., Bravo Rebolledo, E.L., Hesse, E. 2018. Plastic ingestion by harbour porpoises Phocoena phocoena in the Netherlands: Establishing a standardised method. Ambio 47, 387–397 2018. https://doi.org/10.1007/s13280-017-1002-y

Van Helmond, A.T.M. and Couperus, A.S. 2012. Elektronische monitoring van kleinschalige staandwantvisserij. IMARES rapport C034.12:25 pp.

Van Laar V. 1961. Faunistische gegevens over zoogdieren in en om Amsterdam. Lutra 3(1): 1-18.

Verfuß U.K., C.G. Honnef, A. Meding, M. Dahne, R. Mundry & H. Benke 2007. Geographical and seasonal variation of harbour porpoise (Phocoena phocoena) presence in the German Baltic Sea revealed by passive acoustic monitoring. J. Mar. Biol. Ass. U.K. 87: 165-176.

Verwey J. 1932. Journaal Zoologisch Station Den Helder van 9 September 1931 tot 31 December 1932. Ongepubliceerd, archief Koninklijk Nederlands Instituut voor Onderzoek der Zee.

Verwey J. 1937. Journaal III van het Zoologisch Station Den Helder, 1 September 1934 - 26 Mei 1937. Ongepubliceerd logboek, archief Koninklijk Nederlands Instituut voor Onderzoek der Zee, Texel.

Verwey J. 1975a. The cetaceans Phocoena phocoena and Tursiops truncatus in the Marsdiep area (Dutch Wadden Sea) in the years 1931-1973, part 1. Publ. & Versl. Nederl. Inst. Onderz. Zee, 17a: 1-98.

Verwey J. 1975b. The cetaceans Phocoena phocoena and Tursiops truncatus in the Marsdiep area (Dutch Wadden Sea) in the years 1931-1973, part 2. Publ. & Versl. Nederl. Inst. Onderz. Zee, 17b: 99-153.

Verwey J., F. Creutzberg & I. Kristensen 1947. Journaal IV van het Zoologisch Station Den Helder, Mei 1937 - Mei 1947. Ongepubliceerd logboek, archief Koninklijk Nederlands Instituut voor Onderzoek der Zee, Texel.

Viergever J. 1940. Van bruinvissen, tuimelaars en dolfijnen. Amoeba 19(12): 184-187.

Viergever J. 1941. Zeedieren in onze binnenwateren. Amoeba 20(9): 128.

Víkingsson G.A., Olafsdóttir D. & Sigurjónsson J. 2003. Diet of harbour porpoises (Phocoena phocoena) in Icelandic coastal waters. NAMMCO Sci. Publ. 5:243-270.

Von Benda-Beckmann, A.M., G. Aarts, K. Lucke, W.C. Verboom, R.A. Kastelein, O. Sertlek, D. Ketten, R. v. Bemmelen, R. v. Wees, S. Giodini, S.C.V. Geelhoed, R. Kirkwood, F.P.A. Lam, M.A. Ainslie. 2015. Assessment of impact of underwater clearance of historical explosives by the Royal Netherlands Navy on harbour porpoises in the North Sea, TNO report 2014 R10916.

Von Benda-Beckmann, A., Geert Aarts, H. Özkan Sertlek, Klaus Lucke, Wim C. Verboom, Ronald A. Kastelein, Darlene R. Ketten, Rob van Bemmelen, Frans-Peter A. Lam, Roger J. Kirkwood, and Michael A. Ainslie, 2015, Assessing the Impact of Underwater Clearance of Unexploded Ordnance on Harbour Porpoises (Phocoena phocoena) in the Southern North Sea, Aquatic Mammals 2015, 41(4), 503-523, DOI 10.1578/AM.41.4.2015.503

Von Benda-Beckmann, A., C. de Jong, M. Ainslie, M. Prior, F.P.A. Lam 2017. Uitgangspunten voor een leidraad voor het inschatten van effecten van onderwatergeluid door seismische airgun arrays op de bruivis. 2017. TNO-rapport R10739 2.1.0.0.

Waggitt J.J., Dunn H.K., Evans P.G.H., Hiddink J.G., Holmes L.J., Keen E. ,Murcott B.D., Piano M., Robins P.E., Scott B.E., Whitmore J. & Veneruso G. 2017. Regional-scale patterns in harbour porpoise occupancy of tidal stream environments. ICES Journal of Marine Science doi:10.1093/icesjms/fsx164.

Weel, S.M.H. 2016. Investigating feeding behaviour of harbour porpoise (Phocoena phocoena) using stationary passive acoustic data (C-POD). M.Sc. Thesis AEW-80430 Aquatic Ecology and Water Quality Management Group Wageningen University. Report No. 2016 M10.

Weel, S.M.H., S.C.V. Geelhoed, I. Tulp & M. Scheidat 2018. Feeding behaviour of harbour porpoises (Phocoena phocoena) in the Ems estuary. Lutra 61 (1): 137-152.

Wenger, D. & Koschinski, S. 2012. Harbour porpoise (Phocoena phocoena Linnaeus, 1758) entering the Weser river after decades of absence, Marine Biology Research, 8:8, 737-745.

Wiemann A, Andersen LW, Berggren P, Siebert U, Benke H, Teilmann J, Lockyer C, Pawliczka I, Skóra K, Roos A, Lyrholm T, Paulus KB, Ketmaier V, Tiedemann R. 2010. Mitochondrial Control Region and microsatellite analyses on Harbour porpoise (Phocoena phocoena) unravel population differentiation in the Baltic Sea and adjacent waters. Conservation Genetics 11, 195-211.

Williams, R.S, D.J. Curnick, J.L. Barber, A. Brownlow, N.J. Davison, R. Deaville, M. Perkins, S. Jobling & P.D. Jepson, 2019. Juvenile harbor porpoises in the UK are exposed to a more neurotoxic mixture of polychlorinated biphenyls than adults. Science of The Total Environment. 134835. 10.1016/j.scitotenv.2019.134835.
Wright, Andrew J., Natacha Aguilar Soto, Ann Linda Baldwin, Melissa Bateson, Colin M. Beale, Charlotte Clark, Terrence Deak, Elizabeth F. Edwards, Antonio Fernández, Ana Godinho, Leila T. Hatch, Antje Kakuschke, David Lusseau, Daniel Martineau, L. Michael Romero, Linda S. Weilgart, Brendan A. Wintle, , Giuseppe Notarbartolo-di-Sciara, Vidal Martin, 2007, Do marine mammals experience stress related to anthropogenic noise?, International Journal of Comparative Psychology, 2007, 20, 274-316
Würsig, B., J. G. M. Thewissen and K. M. Kovacs, eds. Encyclopedia of Marine Mammals. 3rd edition. ISBN 13: 978-0-12-804327-1. Academic Press, London, U.K. 2018. 1,157 pp.
Zein B., B. Woelfing, M. Dåhne, T. Schaffeld, S. Ludwig, J.H. Rye, J. Baltzer, A. Ruser & U. Siebert 2019. Time and tide: Seasonal, diel and tidal rhythms in Wadden Sea Harbour porpoises (Phocoena phocoena). Plos One https://doi.org/10.1371/journal.pone.0213348.

Annex I
Harbour Porpoise Conservation Action Plan 2020-2026

Photo: Annemieke Podt, Stichting Rugvin

Harbour Porpoise Conservation Action Plan 2020-2026

Recommendation *summary*	**Category** *research, monitoring, management, mitigation or policy measure*	**Priority*** *High, Medium, Low*	**Time scale** *short-term = <3yr, medium-term = <6yr, long-term = >6yr, ongoing*	**Focal point** *in bold is lead*
General				
Assess and address temporal and spatial cumulative impact of anthropogenic activities	All	High	<6yr	Ministries of **I&W**, LNV, Def, EZK, European Commission, OSPAR & ASCOBANS
Legislative & policy context				
Pursue a cross-sectoral and transboundary approach for bycatch. When joint protocols for monitoring and research are established and followed, comparison of effort is possible, leading to ideally robust information at population level	All	High	<3 yr	**Ministry of LNV, I&W (for relevant MSFD topics)**, Def, EZK, European Commission, OSPAR, ASCOBANS, IWC
Develop and submit joint recommendations to the European Commission for additional bycatch- monitoring and mitigation	Management	High	<6 yr	**Ministry of LNV** in cooperation with North Sea member states
Pursue streamlining this plan with the ASCOBANS North Sea Harbour Porpoise Conservation plan	Policy	High	<3 yr	**Ministry of LNV** in cooperation with ASCOBANS
Consistent application and enforcement of the general species protection requirements	Management	High	Ongoing	Ministries of **LNV**, I&W, Def and EZK
Consistent application and enforcement of the legal requirements for all Natura 2000 sites designated for the harbour porpoise.	Management	High	Ongoing	Ministries of **LNV**, I&W, Def and EZK
Agree suitable measures for the next phase of Natura 2000 management plans relevant for the harbour porpoise.	Management	High	<3 yr	Ministries of **LNV**, I&W, Def and EZK
Stakeholder consultation & engagement				
Continue the work of the Harbour Porpoise Advisory Committee	Policy	High	Ongoing	**Ministry of LNV**
Encourage communication and education initiatives	Management	Medium	Ongoing	**Ministry of LNV** at national level in cooperation with NGOs and at international level with ASCOBANS
Keep informing and interacting with all relevant stakeholders, amongst other within the North Sea Agreement platform	Policy	High	Ongoing	All Ministries
Organise a networking event in collaboration with the EU Natura 2000 Biogeographical Process	Policy	High	<3 yr	**Ministry of LNV** in cooperation with ASCOBANS
Population ecology & status				
Population ecology				
When designing harbour porpoise ecology studies:				
Use cross border, multidisciplinary and multi-methodology approaches to investigate harbour porpoise ecology	Research	Medium	<6yr	**Research institutes**, Ministry of LNV also at an international level

**Criteria used to assess priority: allocated funding, feasibility, data availability, policy context, key threat; score 4/5 out of 5 = High; 3/4 out of 5 = Medium; 1/2 out of 5 = Low*

Harbour Porpoise Conservation Action Plan 2020-2026

Recommendation *summary*	**Category** *research, monitoring, management, mitigation or policy measure*	**Priority*** *High, Medium, Low*	**Time scale** *short-term = <3yr, medium-term = <6yr, long-term = >6yr, ongoing*	**Focal point** *in bold is lead*
Take steps to analyse the harbour porpoise food web and the health of the eco-system and habitats by:	Research	Medium	<6yr	**Research institutes**, Ministry of LNV in collaboration with North Sea countries
Integrating harbour porpoise in- and offshore diet studies and from stomach content and stable isotope and fatty acid analysis with studies and DCF data on key prey fish distributions, seasonal movements and abundances	Research	Low	<6yr	**Research institutes**, Ministry of LNV in collaboration with North Sea countries
Investigating life history parameters (pregnancy rates, (foetal) growth rate and mortality) of harbour porpoises in combination with parameters such as contaminants	Research	Medium	<3yr	**Research institutes**, Ministry of LNV
Developing a meta-analysis to provide an overview of existing data and strenghts and shortcomings of existing datasets	Research	Low	<3yr	**Research institutes**
Investigate what can be learned from current population models and identify which information is still needed as input to optimize and validate these models	Research and management	High	<6yr	**Ministry of LNV**, **EZK**, I&W and Def
Explore whether information, such as on diet, pregnancy rates, foetal growth and prey species distribution can be captured in an indicator for habitat quality or food webs in the Habitats Directive or MSFD	Research and policy	High	<3yr	**Ministry of LNV**
Genetics				
Investigate using genomic techniques for population abundance, adaptation to climate change or other stressors or specific management actions related to management units	Research	Medium	>6yr	**Ministry of LNV**
Support ongoing work by adding more genomic resources, including porpoises from Dutch waters	Research	Medium	>6yr	**UU** in cooperation with other research institutes
Population status: abundance and distribution				
Implement new sampling schedule, every three years a national survey in March and July, following an international SCANS survey which would ideally take place every 6 years	Monitoring	High	<3 yr	**Ministry of LNV**
Integrate and analyse data from different aerial survey collection methods at national and regional scale, and integrate data from other networks (land based or ferry surveys)	Research	High	ongoing	**Ministry of LNV** & I&W in cooperation at national and international level with research institutes, OSPAR, ASCOBANS and North sea countries
Produce seasonal abundance and distribution maps based on combined data sets	Management	Medium	<6yr	**Ministry of I&W** & LNV and at international level with North Sea countries
Participate in and stimulate an international population abundance and distribution survey (SCANS), preferably every six years	Monitoring	High	<3yr	**Ministry of LNV** & I&W in cooperation with other OSPAR and ASCOBANS countries

**Criteria used to assess priority: allocated funding, feasibility, data availability, policy context, key threat; score 4/5 out of 5 = High; 3/4 out of 5 = Medium; 1/2 out of 5 = Low*

Harbour Porpoise Conservation Action Plan 2020-2026

Recommendation *summary*	**Category** *research, monitoring, management, mitigation or policy measure*	**Priority*** *High, Medium, Low*	**Time scale** *short-term = <3yr, medium-term = <6yr, long-term = >6yr, ongoing*	**Focal point** *in bold is lead*
Programme abundance and distribution aerial survey monitoring for 12 years	Monitoring	High	<6yr	**Ministry of LNV** & I&W in cooperation with other North Sea countries
Continue the voluntary Eastern Scheldt photo-identification project	Research	Low	<3yr	**Rugvin Foundation**
Consider the Eastern Scheldt for suggested research topics	Research	Low	<6yr	**Research institutes**
Technical monitoring and research methodologies				
Explore different tagging methods and make use of existing expertise from available tagging studies and invest in dialogue with stakeholders on this topic	Research and monitoring	High	<6yr	**Ministry of LNV,** EZK and I&W in cooperation with NGOs;
Passive acoustic monitoring (PAM): gain insight in behaviour and occurrene and changes herein in relation to habitat use and densities in a higher temporal resolution compared to aerial surveys and develop cost-effective mooring methods	Research and monitoring	Medium	<6yr	**Ministry of LNV**, **EZK** and I&W
Further implement HiDef and consider statistical impact of switching methods, taking into account limiting possibilities for visual surveys from increasing wind farms	Research and monitoring	Medium	<3yr	**Ministry of LNV**, **EZK** and I&W
Stranding events & stranding research				
Registration of stranded harbour porpoises on the Dutch Coast				
Continue and expand functionality of central registration of harbour porpoises strandings by integrating walvisstrandingen.nl and waarneming.nl into new portal stranding.nl	Monitoring	Medium	<3yr	**Ministry of LNV**
Continuation of a coordinated voluntary stranding network	Monitoring	High	Ongoing	**Stranding networks**
Recognize effort of voluntary stranding network by network events, support their work with facilitation of permits and communication	Management	High	<6yr	**Ministry of LNV, municipalities**
Optimize functionality and use of stranding alert options that will be integrated in stranding.nl	Management	Medium	<3yr	**Ministry of LNV**
Increase data quality stranded dead porpoises not selected for post-mortem investigation by encouraging general public and stranding network to: (1) use the proposed app and new portal, including adding pictures according to a standardized protocol (such as posters or signs near beaches); (2) report results of stranding data analysis at regular interval (meeting or attractive report, website or digital application)	Monitoring	High	<3yr	**Ministry of LNV**, municipalities
Establish or contribute to an international North Sea strandings database to be able to signal potential issues (based on accurate/up to date data)	Policy	Medium	<6yr	**Ministry of LNV** and I&W in coordination with ASCOBANS and OSPAR

**Criteria used to assess priority: allocated funding, feasibility, data availability, policy context, key threat; score 4/5 out of 5 = High; 3/4 out of 5 = Medium; 1/2 out of 5 = Low*

Harbour Porpoise Conservation Action Plan 2020-2026

Recommendation *summary*	Category *research, monitoring, management, mitigation or policy measure*	Priority* *High, Medium, Low*	Time scale *short-term = <3yr, medium-term = <6yr, long-term = >6yr, ongoing*	Focal point *in bold is lead*
If a mass stranding event (MSE) or unusual mortality event (UME) is signalled: (1) An investigation of anthropogenic activities prior to and during the MSE and (2) prioritize analysis of hearing organs when a MSE is signalled	Research and policy	Medium	When MSE or UME occurs	**Ministry of LNV**, EZK, I&W and Def
Assess social biases of stranding network, comparing with other stranding networks (e.g. other countries or other species as birds)	Research	Low	<3yr	**Ministry of LNV** and I&W
Pathological investigation of stranded harbour porpoises				
Faciliate (continued) international, representative post-mortem research and integrate data to work towards an international assessment on (spatiotemporal) analyses of health status and causes of death	Monitoring and research	Medium	<6yr	**Ministry of LNV**
Pursue post-mortem and ecological research on animals from further offshore, as well as drift modelling studies	Research and monitoring	High	<3yr	**Ministry of LNV**
Apply a "nested approach" with regard to pathological research acknowledging that a selection of a selected subset is investigated to signal and track (unusual) developments, in combination with data collected from non-necropsied individuals	Monitoring	Medium	<3yr	**Ministry of LNV**
Facilitate collecting samples for future analysis on e.g. genetics, age determination, contaminants and reproduction	Research and monitoring	Medium	<6yr	**Ministry of LNV** and UU in collaboration with other research institutes at an international level
Conduct a spatiotemporal analyses of harbour porpoises diagnosed with likely bycatch as cause of death and develop and validate drift models for the Netherlands to address the coastal/ offshore issue	Research	Medium	<3yr	**Ministry of LNV** and UU in collaboration with other research institutes at an international level
Chemical pollution				
Enlarge the Dutch effort by joining the OSPAR initiative to include the harbour porpoise as an indicator species in the monitoring of contaminants	Monitoring and policy	High	<3yr	**Ministry of LNV**, I&W
Continue screening and monitoring marine mammals for contaminants of concern (EU list) following OMMEG advice	Monitoring and policy	Medium	<6yr	**Ministry of LNV**, I&W
Marine litter				
Incorporate assessment of marine litter in post-mortem exams and use harmonised protocols, including reporting zero values for marine litter in necropsy reports	Monitoring	High	<3yr	**Ministry of LNV** and UU
Support and follow-up on IWC recommendations on marine litter	Policy	Medium	<3yr	**Ministry of LNV**

**Criteria used to assess priority: allocated funding, feasibility, data availability, policy context, key threat; score 4/5 out of 5 = High; 3/4 out of 5 = Medium; 1/2 out of 5 = Low*

Harbour Porpoise Conservation Action Plan 2020-2026

Recommendation *summary*	Category *research, monitoring, management, mitigation or policy measure*	Priority* *High, Medium, Low*	Time scale *short-term = <3yr, medium-term = <6yr, long-term = >6yr, ongoing*	Focal point *in bold is lead*
Incidental bycatch				
Cooperation with fisheries				
Cooperation with the industry is the key to reduce bycatch, therefore it is recommended to prioritise this in any project	All	High	<3yr	**Ministry of LNV** and other partners in bycatch projects
Invest in building and keeping a good relationship with all parties involved based on trust, respect and mutual perspectives	Policy	High	<3yr	**Ministry of LNV**
Explore together with fishers the advantages of fishing in ways that reduce bycatch	Policy and research	High	<3yr	**Ministry of LNV**
Monitoring				
Obtain statistically robust bycatch assessments at population level by continuing and expanding (REM) monitoring, requiring international collaboration and effort of all stakeholders involved, including non-Dutch fishing vessels and vessels smaller than 15 meters	Monitoring and policy	High	<6yr	**Ministry of LNV** in cooperation with fisheries industry and other North Sea countries
Specify what sufficient levels of monitoring are in order to obtain estimates of bycatch of harbour porpoise	Monitoring and policy	High	<6yr	**Ministry of LNV** in cooperation with fisheries industry and other North Sea countries
Make use of a more cost-effective and mobile Remote Electronic Monitoring (REM) system for a representative and effective fleet coverage	Monitoring	High	<3yr and continuous	**Ministry of LNV** in cooperation with fisheries industry and other North Sea countries
Quantify fishing activity (fish location, net specifications and soak time) of commercial bottom-set gillnet fleet (Dutch and foreign) by developing a system (based on AIS, adapted REM system)	Monitoring	High	<6yr	**Ministry of LNV** in cooperation with other North Sea countries
Improve data collection of fishing effort of bottom-set gillnet fisheries at international level (soak time, net length, height and mesh size) and standardize reporting formats, to extrapolate data across fleets	Monitoring	High	<6yr	**Ministry of LNV** in cooperation with fisheries industry and other North Sea countries
Implement and facilitate landing and registration of harbour porpoise bycatch for research	Management	High	<3yr	**Ministry of LNV** in cooperation with UU and other research institutes
Work with fishermen to, if not landed, release bycaught dead porpoises with a tag to allow further research into stranded or drift porpoises	Research and policy	High	<3yr	**Ministry of LNV** in cooperation with research institutes and fishing industry
International cooperation				
Set up initiative for a cross-border bycatch project, involving fisheries sector from the start and experts from multiple disciplines	All	High	<3yr	**Ministry of LNV** in cooperation with fishing industry, NSAC and other relevant stakeholders
Explore funding programmes enhancing cooperation with fisheries sector at international level for future projects	Policy	High	<3yr	**Ministry of LNV**

**Criteria used to assess priority: allocated funding, feasibility, data availability, policy context, key threat; score 4/5 out of 5 = High; 3/4 out of 5 = Medium; 1/2 out of 5 = Low*

Harbour Porpoise Conservation Action Plan 2020-2026

Recommendation *summary*	Category *research, monitoring, management, mitigation or policy measure*	Priority* *High, Medium, Low*	Time scale *short-term = <3yr, medium-term = <6yr, long-term = >6yr, ongoing*	Focal point *in bold is lead*
Focus on knowledge and expertise exchange in relevant fora on international level	Policy and research	High	<3yr	**Ministry of LNV** in cooperation with relevant fora including NSAC, OSPAR, ASCOBANS, ICES, IWC and regional fisheries organisations
Mitigation				
Investigate and encourage alternative gear use (e.g. fish traps or line fisheries for cod) other than bottom-set gillnets and/or investigate modification of bottom-set gillnets to reduce bycatch	Research and mitigation	High	<6yr	**Ministry of LNV** in cooperation with the fisheries industry, research institutes and technical companies and other North Sea countries
Investigate development and testing of other bycatch mitigation methods, such as pingers, but also area closures in high risk areas	Research and mitigation	Medium	<6yr	**Ministry of LNV** in cooperation with fisheries industry and other North Sea countries
Recreational fisheries				
Continue quantifying fishing effort and controlling compliance, and in addition, investigate the frequency and impact of incidental bycatch of recreational fisheries	Research and monitoring	High	<6yr	**Ministry of LNV, municipalities responsible for controlling and compliance**
Share experiences with other countries on recreational fisheries and bycatch	Policy	High	<6yr	**Ministry of LNV, municipalities responsible for controlling and compliance**
Promote outreach to recreational fishers	Mitigation	Low	<6yr	**Ministry of LNV, municipalities responsible for controlling and compliance**
Underwater noise				
Offshore wind				
Investigate movements of (individual) porpoises before, during and after pile-driving activities to improve population models by exploring different methodologies as potential tools (see population ecology)	Research and mitigation	Medium	<6yr	**Ministry of EZK**, LNV and I&W
It is also recommended to continue research on harbour porpoise in captivity for dedicated research questions	Research	Medium	<6yr	**Ministry of EZK**, LNV and I&W
Maintain the Sound Exposure Level (SEL) threshold for piling based on the calculations in the Framework Ecology and Cumulation (KEC) and adjust when significant new information becomes available	Management, mitigation and research	High	<6yr	**Ministry of EZK**, LNV and I&W
Investigate the noise impact from operational offshore wind-turbines, including the effect of bottom-vibrations and include in continuous sound-models	Research and mitigation	High	<6yr	**Ministry of EZK**, LNV and I&W

**Criteria used to assess priority: allocated funding, feasibility, data availability, policy context, key threat; score 4/5 out of 5 = High; 3/4 out of 5 = Medium; 1/2 out of 5 = Low*

Harbour Porpoise Conservation Action Plan 2020-2026

Recommendation *summary*	Category *research, monitoring, management, mitigation or policy measure*	Priority* *High, Medium, Low*	Time scale *short-term = <3yr, medium-term = <6yr, long-term = >6yr, ongoing*	Focal point *in bold is lead*
Include the cumulative effects of underwater noise by other activities for offshore wind farms, like geophysical surveys and shipping involved in the maintenance of the turbines, in impact assessments	Management and research	Medium	ongoing	**Ministry of EZK**, LNV and I&W
Seismic surveying				
Seismic survey design and associated mitigation measures cannot be generic, but need to be location and season specific.	Management, mitigation and research	Medium	Ongoing	**Ministry of LNV**, EZK and I&W, oil&gas industry
Support benchmarking of acoustic models that describe seismic sources and propagation of the sound and choose a validated model for use in impact assessments	Management and research	High	<3yr	**Ministry of LNV**, EZK and I&W, oil&gas industry
Review available information, including new information coming from the North Sea Agreement or other research programmes and determine an unambiguous onset threshold for disturbance of harbour porpoises, taking into account moving sound sources.	Policy, management and research	High	<3yr	**Ministry of LNV**, EZK and I&W, NSA stakeholders
Provide a framework and guidelines addressing (cumulative) impacts of seismic surveys using similar model approaches as for the Framework Ecology and Cumulation (KEC)	Policy, management and research	High	<3yr	**Ministry of LNV**, EZK and I&W, NSA stakeholders
Determine an acceptable budget of 'porpoise disturbance days' by seismic surveys, based on the average of historic and existing levels of activity	Policy, management and mitigation	High	<3yr	**Ministry of LNV**, EZK and I&W
Consider establishing noise budgets for individual industry sectors (windfarms, seismic surveys, etc.)	Policy, management and mitigation	Medium	<6yr	**Ministry of LNV**, EZK and I&W
Continue the dialogue with the industry to develop regulation for seismic activities to minimize the impact on harbour porpoises	Policy and mitigation	High	<3yr	**Ministry of LNV**, EZK and I&W, oil&gas industry
Stimulate the industry to develop and adopt alternative technologies that produce less sound in the marine environment	Policy, research and mitigation	High	<6yr	**Ministry of LNV**, EZK and I&W, oil&gas industry
Determine the amount of sound needed to achieve the objective of a survey and minimize the amount (and the frequency band) of sound sent into the water column	Research and mitigation	High	<6yr	**Oil&gas industry**, ministry of LNV, EZK, I&W
Explosions				
Describe measures and guidance for clearances of unexploded ordnance (UXO) in the Defence regulation, including the required use of ADD's for clearances and a restriction for clearances within N2000 areas	Policy, management and mitigation	High	<3yr	**Ministry of Def**, LNV, I&W
Restrict the use of explosives for other reasons than UXO, e.g. for demolition of old platforms to a minimum	Management and mitigation	High	Ongoing	**Ministry of I&W**, LNV, EZK
Validate effects of mitigation	Research and mitigation	Medium	<3yr	**Ministry of Def**, LNV, I&W

**Criteria used to assess priority: allocated funding, feasibility, data availability, policy context, key threat; score 4/5 out of 5 = High; 3/4 out of 5 = Medium; 1/2 out of 5 = Low*

Harbour Porpoise Conservation Action Plan 2020-2026

Recommendation *summary*	Category *research, monitoring, management, mitigation or policy measure*	Priority* *High, Medium, Low*	Time scale *short-term = <3yr, medium-term = <6yr, long-term = >6yr, ongoing*	Focal point *in bold is lead*
To monitor effectivity of mitigation measures, it is necessary to systematically record details of clearances	Monitoring and mitigation	High	Ongoing	**Ministry of Def**, I&W
Monitor whether alternative technologies for clearance of munition at sea become available	Monitoring, research and mitigation	High	<6yr	**Ministry of Def**, OC&W/NWO
Sonar				
Assess the use of sonar sources in relevant frequencies, other than military sonar, to signal a significant increase	Monitoring and research	Medium	<6yr	**Ministry of LNV**, I&W
Continuous noise				
Implement and further develop MSFD required noise monitoring, including under JOMOPANS to produce and assess risk exposure maps based on sound and HP distribution	Monitoring and management	High	<3yr	**Ministry of I&W**, LNV
Discuss and encourage the development of measures to decrease the impact of continuous noise (such as noise emission requirements) at both national and international (e.g. IMO) level	Management and mitigation	High	>6yr	**Ministry of I&W** (national) and IMO (international)
Improve (preferably through a joint international approach) the knowledge on the effects, mostly masking and stress of continuous noise on harbour porpoises	All	High	<3yr	**Ministry of I&W** in joint international collaboration
Assess the impact of underwater noise by recreational shipping	Monitoring and research	Medium	<3yr	**Ministry of I&W**
General recommendations underwater noise				
Contribute in delivering action 29 in the OSPAR Roadmap.	Policy	High	<3yr	**Ministry of I&W** in joint international collaboration and OSPAR
Evaluate the need to use frequency weighting to improve assessment of behavioural disturbance	Research and policy	High	<3yr	**Ministry of EZK**, LNV and I&W
Assess and address temporal and spatial cumulative impact of acoustic anthropogenic activities. This may include various activities of the same kind; all impulsive sound sources and include continuous noise	All	High	<6yr	**Ministry of I&W, EZK, LNV**, and **Def (for all ministries, for relevant sources)**
Motivate and stimulate the industry, using (legislative) incentives, to continue development, testing and use of mitigation measures	Research and mitigation	High	<6yr	**Ministry of EZK**, LNV, and I&W and OC&W/NWO
Provide an overview based on studies which ADDs potentially can cause a risk and which types can be used safely	Research and policy	Medium	<3yr	**Ministry of I&W**, LNV, EZK and Def

**Criteria used to assess priority: allocated funding, feasibility, data availability, policy context, key threat; score 4/5 out of 5 = High; 3/4 out of 5 = Medium; 1/2 out of 5 = Low*

Published by:

Ministry of Agriculture, Nature and Food Quality
Bezuidenhoutseweg 73 | 2594 ac The Hague
Postbus 20401 | 2500 ek The Hague
October 2020 | Publication-nr. 20405434

Photo: Marije Siemensma, MS&C