

Conservation plan for the Harbour Porpoise *Phocoena phocoena* in The Netherlands: towards a favourable conservation status

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Commissioning

This project was commissioned and financed by the Dutch Ministry of Economics, Agriculture and Innovation

Cover illustration

Reproduced with permission from The J. Paul Getty Museum, Los Angeles. Jan van de Cappelle (1649) “Shipping in a Calm at Flushing with a States General Yacht Firing a Salute” Oil on oak panel, Unframed: 69.5 x 92.1 cm. The image shows numerous animals in the water that could be recognised as Harbour Porpoises, which were abundant at the time.

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Contents

1. Summary

1.1 Short summary

- This is a conservation plan for the Harbour Porpoise *Phocoena phocoena* based on the current seasonal occurrence and abundance of porpoises within waters under Dutch jurisdiction.
- The conservation status of the Harbour Porpoise in The Netherlands has recently been evaluated as '*Inadequate*', and the population as '*Vulnerable*'.
- From 1900 to the early 1950s, Harbour Porpoises were abundant and widespread in coastal waters throughout the southern North Sea, including Dutch waters. The animal declined and was considered locally extinct during the 1960s-1980s.
- Harbour Porpoises have increased markedly in numbers in the southern North Sea in recent decades. Given changes in distribution and abundance, the conservation status of porpoises in Dutch waters is likely to require an update in the near-future.
- Harbour Porpoises are most abundant in relatively shallow sea areas and often forage near or at the sea bottom. Their prey spectrum includes pelagic and demersal prey species: different species of fish, cephalopods, crustaceans and polychaetes.
- The global abundance of the Harbour Porpoise is at least about 700,000 individuals. Within the North Sea at large, in 2005, total abundance was estimated at 230,000 individuals. A marked change in distribution was found, with considerably larger numbers of porpoises in the southern half of the North Sea in the 2005 than during an earlier census in 1994.
- Aerial surveys covering 50% of the Dutch sector of the North Sea produced 37,000 Harbour Porpoises in Feb-April 2009 and 56,000 in Mar 2010.
- The current Harbour Porpoise conservation plan is a generic plan rather than area-orientated: recent research in Dutch waters failed to identify areas or regions of particular ecological significance for Harbour Porpoises for any significant length of time.
- Incidental capture in fishing gear (bycatch) is considered to be the most significant threat to Harbour Porpoise populations worldwide. In The Netherlands, some 150-250 animals washing ashore per annum are at least bycatch-suspect.
- The main type of fishing gear responsible for drowning is currently unknown, but set-nets (passive gear) are the main suspects. Bycatches occurred year-round and throughout the study area.
- The catch composition during which most porpoise strandings occurred varied and no set-net fisheries should be excluded *a priori* from an observer scheme. An onboard observer scheme should be established *with priority* in the winter fisheries, Dec-Mar, in the northern coastal zone (IJmuiden-Vlieland).
- While there is concrete evidence for avoidance behaviour of loud (explosive) underwater sounds (such as pile driving for windfarm construction, seismic exploration, underwater explosions, and naval sonar operation), there is no factual evidence for lethal damage. Adequate studies of hearing damage and death as a result of underwater sound are lacking.
- The distributional shift of Harbour Porpoises from more northerly parts of the North Sea into the Southern Bight may have been caused by a reduction in available prey in the north. Studies of the ecology of Harbour Porpoises in the southern North Sea are required to shed more light on prey availability and resources (stocks).
- Siting, vessel strikes, the operational phase of windfarms, offshore mining, marine litter, chemical pollution, (chronic) marine oil pollution, natural predators, infectious disease, and parasites are all issues of concern that may in part require additional study, none of which required local (or regional, i.e. on a southern North Sea scale) mitigation measures, but rather on a higher governance level.

- None of the demonstrated threats can be quantified satisfactory, given the slender factual data currently at hand. It is obvious that further research is required, before effective mitigation measures can be proposed and the precautionary approach (UNESCO 2005) could be the safest way forward.
- The Harbour Porpoise is legally protected in The Netherlands following international, European and national legislation, although the patchiness of current policy does not benefit an adequate protection of the Harbour Porpoise.
- Implementing the research and mitigation measures, as advised in this species conservation plan, serves to fulfil the requirements of The Netherlands under the relevant international legal treaties.

Current research needs have been prioritised on a scale from 1 (highest) to 5 (lowest). Following discussions in Chapter 9, the following research needs are listed with the highest (1) priority

- Assessments of Harbour Porpoise population through state of the art aerial surveys, including analysis of seasonality and spatial patterns
- Innovative studies of the (foraging) ecology and habitat requirements of Harbour Porpoises in the Southern North Sea
- Prioritise an observer scheme on all fleets with passive gear to assess bycatch rates according to internationally accepted protocols
- Continue to assess bycatch rates in the most important fisheries (regarding bycatch) and evaluate the effectiveness of mitigation measures
- A **national scientific research steering group** would be a suitable instrument to deal with aspects such as research needs, research quality and the evaluation of the quality and conclusions of study reports. Such a steering group should be sufficiently authoritative, but also sufficiently "distant" from the ongoing research. We propose that such a committee should meet and advice annually, and be composed of at least two foreign marine mammals experts, one Dutch Harbour Porpoise expert, and (vitally) one statistician.

Recommended policy and mitigation measures are categorized into measures that should be applied at present and measures that depend of further knowledge from the suggested scientific research. Regarding bycatch in fishing gear:

- Investigate alternative gear other than set-nets and/or investigate modification of set-nets; controlled use of pingers when bycatch is identified
- Facilitate bycatch landing
- Restrictions in recreational fisheries, control illegal fisheries
- Amend EC 812/2004
- Monitor and control compliance fisheries restrictions

Regarding underwater noise (detonation, seismic, sonar, pile driving)

- Develop a system of standards for loud explosive sounds; alert animals ramping up sounds, use acoustic deterrents
- License and guidelines seismic surveys, pile-driving, underwater explosions; establish porpoise observer schemes before during and after and notification of the strandings network prior to acoustic impacts
- Reduce noise using bubble curtains, solid barriers, other solutions if proven to be effective; avoid explosives and use an alternative method for windfarm demolition

1.2 Korte Nederlandstalige samenvatting

- Dit soortbeschermingsplan voor de bruinvis werd gebaseerd op de huidige kennis van het voorkomen en de talrijkheid van Bruinvissen in de Nederlandse Noordzee
- De staat van instandhouding van de bruinvis werd bij aanvang van het project beoordeeld als 'matig ongunstig', de populatie als 'kwetsbaar'
- Van 1900 tot in het begin van de jaren 50 was de Bruinvis een talrijke, wijd verspreide soort in d e Nederlandse kustwateren. De populatie nam snel af en de soort werd lokaal als min of meer uitgestorven beschouwd van de jaren 60 tot en met de jaren 80.
- In de afgelopen tientallen jaren heeft de Bruinvis een opvallende 'come back' doorgemaakt. Vanwege deze verandering ligt een aanpassing van de staat van instandhouding in de nabije toekomst voor de hand.
- Bruinvissen zijn het talrijkst in relatief ondiepe kustwateren en zij foerageren vaak op de zeebodem. Hun pelagische en demersale prooidieren zijn verschillende soorten vis, inktvis, schaaldieren en borstelwormen.
- De wereldpopulatie van de Bruinvis wordt geschat op ongeveer 700.000 exemplaren. In de gehele (internationale) Noordzee werd de bruinvissenpopulatie in de zomer van 2005 op zo'n 230,000 exemplaren bepaald. Tijdens dat onderzoek werd een opmerkelijke verschuiving in talrijkheid geconstateerd in vergelijking met een eerdere telling in 1994: de zuidelijke Noordzee (waaronder het Nederlandse deel van de Noordzee) was sterk in betekenis toegenomen, in het noorden werd een sterke afname gevonden.
- Tellingen vanuit de lucht, waarbij ongeveer 50% van het Nederlandse deel van de Noordzee werd onderzocht, leverden bestandsschattingen op van ongeveer 37.000 Bruinvissen in feb-apr 2009 en 56.000 exemplaren in mrt 2010.
- Bijvangst in vistuig wordt wereldwijd als de grootste bedreiging voor Bruinvissen beschouwd.
- In Nederland, uitgaande van ongeveer 300-500 dood aangespoelde Bruinvissen per jaar, zijn op jaarbasis ongeveer 150-250 dieren op zijn minst "bijvangstverdacht".
- Het is onvoldoende bekend in welke typen vistuig in Nederlandse wateren de meeste bijvangsten voorkomen, maar passieve tuigen (staand want) zijn wereldwijd de voornaamste 'boosdoeners'. Bijvangsten onder gestrande dieren worden gedurende het gehele jaar en langs de gehele Nederlandse kust aangetroffen.
- Voor verschillende vissoorten worden verschillende vistuigen gebruikt, maar er zijn redenen om vooralsnog geen enkel vistuig van verder onderzoek uit te sluiten. Een waarnemersprogramma aan boord van vissersschepen (om bijvangst te monitoren) zou echter met *prioriteit* in de winter en in het vroege voorjaar moeten plaatsvinden (dec-mrt), vooral in het noordwestelijke kustgebied (IJmuiden-Vlieland) en verder offshore.
- Er zijn concrete aanwijzingen voor ontwijkend gedrag (snelle verplaatsingen) als gevolg van luid (explosief) geluid onder water (zoals bij het heien van palen voor de opstelling van windmolens op zee, seismisch onderzoek, explosies onder water, sonar operaties van de marine), maar er is geen direct bewijs voor dodelijke schade onder Bruinvissen. Onderzoek naar gehoorschade wordt echter zelden (goed) uitgevoerd.
- De verschuiving van Bruinvissen van noord naar zuid in de Noordzee kan veroorzaakt zijn door een vermindering van het voedselaanbod in het noorden. Ecologisch onderzoek naar Bruinvissen in de zuidelijke Noordzee is schaars, maar dringend nodig om de voedselbehoefte en de voedselvoorraad in Nederlandse wateren te kunnen schatten.
- Behalve bijvangsten, explosief geluid en voedselbeschikbaarheid werden nog tal van potentiële bedreigingen onderzocht (gebiedsinperking, aanvaringen, windparken, offshore mijnbouw, afval in zee, chemische verontreiniging, (chronische) olieverontreiniging, natuurlijke predatoren,

infectieziekten, parasieten) die vaak wel een reden tot zorg waren, waarvoor maatregelen op regionaal niveau (dat wil zeggen op een zuidelijke Noordzeeschaal) niet zinvol zijn. Een meer mondiale aanpak is vereist in deze gevallen.

- Door gebrek aan onderzoek kon geen van de potentiële bedreigingen voldoende gekwantificeerd worden. Aanvullend onderzoek zal daarvoor nodig zijn en het voorzorgsbeginsel zal moeten gelden alvorens effectieve maatregelen tegen significante bedreigingen genomen kunnen worden.
- De Bruinvis is in Nederland bij wet beschermd, onder meer als uitvloeisels van internationale verdragen en overeenkomsten.
- Het implementeren van de in dit beschermingsplan geformuleerde mitigerende maatregelen en aanvullend onderzoek zal in de belangrijkste verplichtingen op grond van internationale verdragen voorzien.

Urgente onderzoeksvoorstellen worden in hoofdstuk 9 van een prioriteitsstelling voorzien op een schaal van 1 (hoogst) tot 5 (laagst). Aan de volgende onderzoeksvoorstellen is de hoogste prioriteit (een 1) toegekend:

- De installatie van een **landelijke, wetenschappelijke commissie** om onderzoeksbehoeftes, onderzoeksvragen, onderzoeksvoorstellen en rapportages kwalitatief te evalueren. Deze commissie zal voldoende autoriteit moeten bezitten, maar ook voldoende afstand houden van de onderzoekslaboratoria. De commissie zou minstens jaarlijks bijeen moeten komen om een advies te geven over de (financiering van) hoogwaardig onderzoek en in de commissie zouden tenminste twee deskundigen uit omringende landen, een Nederlandse expert en een statisticus moeten bevatten.
- Onderzoek naar de voedselecologie en habitats van Bruinvissen in Nederlandse wateren
- Een opgelegd, steekproefsgewijs waarnemersprogramma op alle “vloten” van passief vistuig gebruikende vissersschepen in Nederlandse wateren om vistuigspecifieke bijvangstfrequenties te meten aan de hand van internationale waarnemingsprotocollen
- Continuering van de monitoring van bijvangsten om de effectiviteit van mitigerende maatregelen te onderzoeken

Voorgestelde mitigerende maatregelen vallen uiteen in direct toepasbare en onderzoeksafhankelijke maatregelen. Met betrekking tot bijvangsten in vistuigen worden de volgende maatregelen voorgesteld:

- Onderzoek alternatieve vistuigen of aanpassingen aan bestaande vistuigen waarmee bijvangsten worden voorkomen; een gecontroleerd gebruik van afsprikkende pingers in gevallen waar bijvangsten voorkomen
- Zorg dat incidentele bijvangsten aan land gebracht worden voor onderzoek
- Beperk de hobbyvisser en controleer illegale visserij waar bruinvis-gevaarlijke technieken worden gebruikt
- Amendeer EC 812/2004
- Controleer de naleving en de effectiviteit van genomen maatregelen

Voor wat betreft onderwater geluid (ontploffingen, seismisch onderzoek, soner, hei-activtiteiten)

- Ontwikkel een systeem randvoorwaarden voor onderwater geluid; zorg dat geluidsniveaus geleidelijk opgevoerd worden, gebruik vooraf afschrikkende geluiden om eventuele dieren te verdrijven
- Ontwikkel een vergunningensysteem en richtlijnen voor seismische surveys, hei-activiteiten, en gecontroleerde explosies onderwater. Pas bruinviswaarnemers toe voor tijdens en na de werkzaamheden en licht het strandingsnetwerk in bij geplande activiteiten
- Reduceer geluid met bellenschermen, constructies of andere oplossingen die zich bewezen hebben; vermijd het gebruik van explosieven onder water

1.3 Full summary

Preface and introduction (Chapters 2-3)

- This is a conservation plan for the Harbour Porpoise *Phocoena phocoena* based on a summary of our current understanding on the seasonality of migratory movements of porpoises through the North Sea, particularly within waters under Dutch jurisdiction.
- The conservation status of the Harbour Porpoise in The Netherlands has recently been evaluated as '*Inadequate*', and the population as '*Vulnerable*'. Reasons for concern were unknown causes for a recent shift in Harbour Porpoise distribution within the North Sea at large, the age structure and reproductive condition of porpoises in Dutch waters, and reported incidental bycatches in fishing gear.
- Harbour Porpoises have increased markedly in numbers in the southern North Sea in recent decades. Given changes in distribution and abundance, the conservation status of porpoises in Dutch waters is likely to require an update in the near-future. Research proposals have been formulated to allow a proper re-evaluation of the conservation status.
- An important step for this conservation plan was to research and discuss observed as well as expected population threats, by providing a summary of existing scientific evidence. Potential threats or other issues that could affect the conservation status have been evaluated. Based on the available scientific evidence and experiences in other (North Sea) countries, mitigation measures and suggestions for urgently needed additional scientific research have been formulated.
- A comprehensive stakeholder consultation has been part of the project. Both the available evidence as well as uncertainties have been discussed, leading to a general commitment by stakeholders and NGOs regarding proposed research and mitigation measures.

Current knowledge (Chapter 4)

- The Harbour Porpoise, an Odontocete, is the smallest and most abundant cetacean in NW European continental shelf waters. Adult females reach on average 1.6m in length (60kg); males are smaller growing to about 1.5m (50kg). Calves are usually about 70-75cm (5kg) at birth.
- 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.
- At sea, Harbour Porpoises can be separated from other cetacean species by their rounded (blunt) head, small triangular dorsal fin, and characteristic behaviour. They normally break the surface briefly with a rolling ("wheeling") motion, exposing little more than the top of their head (to breath) and the dorsal fin. Porpoises normally actively avoid motor boats, but may actively approach and bow ride sailing vessels, surfboards and kayaks.
- The Harbour Porpoise is a relatively small, endothermic predator with limited energy storage capacity, dependent on foraging throughout the year without prolonged periods of fasting. They are positioned near the top of the marine food web, but they are not quite apex predators. They are heavily reliant on echolocation for prey capture, communication and possibly for navigation. This makes them vulnerable to acoustic pollution in the marine environment.
- Porpoises are most abundant in relatively shallow sea areas and often forage near or at the sea bottom in waters less than 200m deep. Their prey spectrum includes pelagic and demersal prey species, suggesting that pelagic foraging activities are important also. Their diet consists of many different species of fish, cephalopods, crustaceans and polychaetes.
- The global abundance of the Harbour Porpoise is at least about 700,000 individuals. Population trends are unknown, but there is evidence of a decline in abundance in some areas.

- Within the North Sea, in 1994, total abundance was estimated at approximately 268,500 animals (CV = 0.15; 95% CI = 230,000-313,000; North Sea and Channel areas (SCANS I). An estimate for 2005 for approximately the same area was 231,000 (CV = 0.14; 95% CI = 201,000-266,000; SCANS II). These figures indicate no statistically significant difference in abundance porpoises between 1994 and 2005, but a marked change in distribution was found, with considerably larger numbers of porpoises in the southern half of the North Sea in the second survey than in the first.
- Genetic analysis shows that movements of Harbour Porpoises across the Atlantic appear to occur at a low level. ASCOBANS suggests a subdivision of the North Atlantic into 15 "management units". Harbour Porpoises in Dutch waters would be representatives of management unit #9 (MU9; Southwestern North Sea & Eastern Channel). The entire recent shift in distribution within the North Sea is covered within that management unit, no matter the genetic structure of this population.
- From 1900 to the early 1950s, Harbour Porpoises were abundant and widespread in coastal waters throughout the southern North Sea, including Dutch waters. Virtually none were reported (dead or alive) in the 1960s and 1970s and sightings were so rare, that the animal was considered locally extinct.
- Harbour Porpoises returned from near (local) extinction in the 1970s and 1980s to high numbers in winter and spring in the early 21st century (strandings and sightings).
- Dedicated aerial surveys covering half the Dutch sector of the North Sea produced 37,000 (19,000-68,000) Harbour Porpoises in Feb-April 2009 and 56,000 (24,000-120,000) in Mar 2010, during the time of year (early spring) when near-shore sightings are now normally peaking.
- A conservative estimate for the entire management unit 9 (MU9), based on the SCANSS II survey conducted in July 2005, would suggest a population of some 150,000 animals.
- There were no areas or regions of particular ecological significance for Harbour Porpoises for any significant length of time within the Dutch sector of the North Sea, even though certain clusters in sightings occasionally pointed at habitat preferences. An exception is the Oosterschelde area (Delta) where a very small but increasing, resident stock became established after 2001.

Observed threats (factors causing loss or decline) (Chapter 5)

- Incidental capture in fishing gear (bycatch) is considered to be the most significant threat to Harbour Porpoise populations worldwide. Within the North Sea, this problem is particularly related to bottom-set gillnets when porpoises forage at or near to the seabed.
- In The Netherlands, overseeing necropsies of 477 animals that had washed ashore that were sufficiently fresh or intact to the study, 48% were no bycatches, 38% were diagnosed as probable bycatch and the rest as equivocal (*i.e.* possible bycatch; **Table 4**). With 300-500 animals washing ashore annually, as an order of magnitude, some 150-250 animals are at least bycatch-suspect.
- While it is evident from necropsies that a substantial number of Harbour Porpoises had drowned, the main type of fishing gear responsible for drowning is currently unknown. The most common commercial fishing practice in the southern North Sea is bottom trawling (beam- and otter trawling); a more limited fishing effort exists with pelagic trawls and static gear. There is little evidence of porpoise bycatch in bottom trawls in the southern North Sea. Passive gears are becoming increasingly popular in Dutch commercial fisheries. Confirmed cases of recent bycatches in static gear are provided.
- Bycatches occurred year-round and throughout the study area. Even though the exact scale of bycatches is currently insufficiently known, as an evident threat inflicting direct mortality of otherwise fit and healthy animals, a reduction will certainly enhance the conservation status of porpoises in the North Sea.

- The catch composition during which most porpoise strandings occurred varied. In March 2006, Cod was the most important target species. During all other large stranding periods, Sole was the main target (or the main catch). Hence, no set-net fisheries should be excluded *a priori* from an observer scheme.
- Well-designed observer schemes provide the most valuable data, when planned and conducted according to recognised international protocols, non-voluntarily, after a power analysis to set the scale of the project and to ascertain an appropriate sample size. Another option to assess the scale of the bycatch problem would be the installation of cameras that record catch and bycatch 24 hours per day, 7 days a week.
- An onboard observer scheme could be established *with priority* (under the expectation of the highest bycatch rates) in the winter fisheries, Dec-Mar, notably in the northern coastal zone (IJmuiden-Vlieland).
- Siting (from infrastructural developments, land reclamation, or as a result of shipping or the tourism) may have an impact on Harbour Porpoises utilising coastal habitats. As a result of land reclamation the impact is currently negligible. Sightings within the busy shipping areas are currently not uncommon and although the animal may (at times) avoid certain areas, there is no firm evidence for persistent physical disturbance or population decline.
- Although vessel strikes may occasionally have lethal impacts on Harbour Porpoises, it is currently not seen as a significant threat. It is recommended to continue documenting available evidence nevertheless, to signal a possible increase in vessel strikes in time.
- There is abundant evidence that the construction of windfarms may trigger avoidance behaviour of Harbour Porpoises within the North Sea at large. Even during pile-driving events, however, the avoidance behaviour is short-lived and normal abundances are often restored within days after an impact. The effects are slightly more prolonged in some sites than in others. The operational phase of windfarms generally does not pose a significant negative effect on the abundance of Harbour Porpoises.
- Marine mammals rely on sound for all of the fundamental biological and ecological aspects of their lives. Sources of particularly loud underwater sounds include seismic exploration by mainly the oil and gas industries, echo sounders, pile driving activities during the installation of offshore windfarms, underwater explosions, shipping, and naval sonar operations. Certain loud (explosive) anthropogenic sounds cause strandings of whales, but documented cases of the lethal effects on Harbour Porpoises are lacking. There is concrete evidence for avoidance behaviour, however.
- The effect of sand and gravel extraction in offshore mining activities on Harbour Porpoises is currently unknown. Further studies would be needed to find adverse effects on marine mammals.
- Marine litter is an issue of concern. Entanglements occur with lethal effects and the ingestion of plastics and other litter has been documented from stranded individuals. Population-level effects may be small, but are in fact unknown.
- Chemical pollution is considered to be a significant threat, potentially suppressing immune functions resulting in increased susceptibility to infectious disease mortality. Hormonal effects of pollutants, disruption of reproductive success, effects of endocrinological organs such as the adrenal glands and immunological impairment have been attributed to pollutants affecting the marine mammals that are particularly vulnerable as top predators of the marine environment. Evidence for the *presence* of certain pollutants in stranded Harbour Porpoises in the North Sea is widely available in the literature, but the effects require additional study.
- There is no evidence for adverse effects of (chronic) marine oil pollution on Harbour Porpoises and oil pollution as an issue is declining rapidly in recent years.
- Reduced prey availability due to sea temperature rise, changing ocean currents and other climatic aspects or to fisheries or a combination of factors may affect porpoise distribution and abundance.

The distributional shift of Harbour Porpoises from more northerly parts of the North Sea into the Southern Bight may have been caused by a reduction in available prey in the north. Studies of the ecology of Harbour Porpoises in the southern North Sea are required to shed more light on prey availability and resources (stocks). With between a fifth and a third of all porpoises studied during necropsies in recent years being in poor condition (starved to death or severely emaciated), the indication that current resources may not be plentiful is too strong to be ignored.

- Natural predators of Harbour Porpoises, such as Killer Whales *Orcinus orca*, or large sharks do not occur in the Southern Bight or are so exceptionally rare that they cannot be a factor of importance.
- Infectious disease is an important factor in Harbour Porpoise mortality. Additional research is required to identify the cause of the disease(s), the seasonality, long-term trends, the frequency in different sex and age categories, and the environmental conditions that may enhance the occurrence of infectious disease as a cause of death in Harbour Porpoises.
- A large variety of parasites has been recorded during necropsies of Harbour Porpoises. Few recent studies have been conclusive in the sense of cause and effect on the animals. Further attention is required to investigate the issue.
- The term 'potential biological removal level' (PBR) means the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population. Potential mortality limits for Harbour Porpoises in the Dutch North Sea, applying different existing conservation aims, ranged from 280-460 (2009-2011) assuming an uncertain population status, or 560-920 assuming a healthy status. Alternatively, following conservation aims under ASCOBANS, "precautionary" mortality limits (1% of the stock) ranged from 370-604, "unacceptable" limits (1.7%) from 625-2015 (**Table 5**). Note that calculations are based on stock assessments from aerial surveys of only part of the Dutch sector of the North Sea. In the absence of mortality estimates and stock assessments for the northern (offshore) part of the Dutch sector of the North Sea, it is unclear if additional (unnatural) Harbour Porpoise mortality currently exceeds any of these thresholds.
- None of the demonstrated threats can be quantified satisfactory, given the slender factual data currently at hand. It is obvious that further research is required, before effective mitigation measures can be proposed and the precautionary approach (UNESCO 2005) could be the safest way forward. More precise research questions are required, leading to a more cost-effective and satisfactory research product.
- Each and every Harbour Porpoise study financed by the government should be scrutinised by external peer review. The installation of a scientific research committee is recommended to evaluate the quality of research proposals (including statistical power analysis) and the urgency of research questions. Publications resulting from these studies should be peer reviewed by default.

Overview of existing mitigation measures (Chapter 6)

- An overview of current mitigation measures available shows that not all threats can be dealt with on a national level only and certain threats call for an international, coordinated approach. It is the ambition of this conservation plan to enhance further regional cooperation between countries adjacent to the southern North Sea and streamline both national and international approaches, triggered by the ASCOBANS conservation plan for the Harbour Porpoise (Reijnders *et al.* 2009), to mitigate threats. The conservation plan focuses on mitigation measures to reduce bycatch and the adverse effects of loud explosive underwater noise as the most prominent regional threats.
- Fisheries mitigation measures can be roughly divided into general management measures such as freezing effort, establishing bycatch limits or fisheries periodical closures on one hand and more technical measures such as the use of acoustic devices, gear change and adaptation on the other hand. When taking management measures, careful planning and monitoring is needed to avoid

potential unwanted effects such as displacement of effort or increase in bycatch. The United States Harbour Porpoise Take Reduction Plan under the Marine Mammal Protection Act provides guidance, based on experience, on this.

- It is believed that of the current available mitigation measures acoustic devices are the best way to reduce bycatch, apart from gear modifications. Concern exists regarding the effectiveness and practical workability, potential habitat disturbance when deployed at large, the costs and the compliance of pinger requirements. Gear modification could increase the acoustic reflectivity of the nets. Alternative fishing methods could be explored.
- Mitigation measures to reduce the impact of loud explosive sounds (seismic surveys as a result of oil and gas prospecting, military activities and pile-driving activities) are far less advanced than the field of noise mitigation measures above water, in many cases the effectiveness of mitigation measures has not been proven yet.
- Alternatives to pile driving at sea causing less explosive sounds, each with its own criteria, are gravity based structures (GBS), drilling and vibrodriving. A potential method to reduce to some extent the piling noise is modification of the piling hammer or the piling interval. For seismic surveys, there are airguns with a reduced output compared to other airguns. A so-called power-down, which reduces the number of active airguns, lowers the emitted sound level temporally.
- Bubble curtains and solid barriers, based on mitigating sound propagation, can be used for both pile driving and the removal of old ammunition. There is need to optimize this methods.
- Deterring animals away from the impact area is another measure, using acoustic deterrents or ramping-up (soft-start) the noise, although its efficacy needs to be studied. It should be noted that both, acoustic deterrents and a ramp-up procedure, add on the total amount of underwater noise. It does also not mitigate any potential adverse effects at a larger distance.
- Protocols (guidelines) to minimize the effects of pile driving, seismic surveys and the use of explosives have been established by several countries. Germany laid down mandatory sound thresholds for the construction of offshore wind parks.
- Siting, vessel strikes, the operational phase of windfarms, offshore mining, marine litter, chemical pollution, (chronic) marine oil pollution, natural predators, infectious disease, and parasites are issues of concern that in part require additional study. None would be effectively mitigated with local (or regional, i.e. on a southern North Sea scale) measures; a higher governance level is required.

Policy and legislative context (Chapter 7)

- The Harbour Porpoise is legally protected in The Netherlands following international, European and national legislation, although the patchiness of current policy does not benefit an adequate protection of the Harbour Porpoise.
- There is a variety of international conventions, agreements and action plans dealing with the protection and conservation of cetaceans. Under the convention of migratory species (CMS) the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) established a conservation plan for the Harbour Porpoise in the North Sea (Reijnders et al. 2009), addressing its main threats, bycatch and underwater noise, but also pollution and engagement of stakeholders. ASCOBANS defines limiting levels of anthropogenic removal to no more than 1.7% for local populations (ASCOBANS 2006a, ASCOBANS 2000), and to reduce bycatch to less than 1% of the best available population estimate.
- A 2010 evaluation of the Ecological Quality Objectives (EcoQO's) of the convention of the protection of the marine environment in the North-East Atlantic (OSPAR) to reduce annual bycatch levels of Harbour Porpoises to below 1.7 % of the best population estimate concluded that the monitoring of

by-catch of Harbour Porpoises in the North Sea was inadequate to assess whether or not the EcoQO was being met (OSPAR 2009b, OSPAR 2006).

- EU instruments relevant for the protection of the Harbour Porpoise at species level in the North Sea are the EU Habitats Directive, the Common Fisheries Policy and the Marine Strategy Framework Directive (MSFD). The latter provides the parameters within which the member states must shape their policy for the marine environment, to achieve at the latest in 2020 a Good Environmental Status (GES) of all European seas. Eleven quality descriptors are used to describe GES, addressing issues affecting cetaceans such as the issue of marine pollution and litter, the maintenance of biological diversity and food webs and underwater noise.
- Under the EU Habitats Directive the Harbour Porpoise has been awarded the highest protective status by being listed on both Annex II and Annex IV of the Habitats Directive. Article 2 of the Habitats Directive asks for a favourable conservation status, which is the aim of this conservation plan.
- Despite its highest protective status under European nature conservation law, fisheries activities, causing one of the main threats – bycatch – to the species, are mainly managed with by the European community in its Common Fisheries Policy (CFP). The CFP brings together a range of measures designed to achieve a thriving and sustainable European fishing industry. To prevent bycatch of small cetaceans, Council Regulation 812/2004 has been issued, which requires the use of acoustic devices and monitoring of bycatch. However, the current Dutch set net fisheries fleet does not fall under the defined criteria and does not have any obligation under the CFP to prevent bycatch.
- National legislation imposes a strict protection of the Harbour Porpoise, which is legally protected under the 1998 Flora and Fauna Act and the 1998 Nature Conservation Act, both applying to the territorial sea and not reaching beyond the 12 nautical mile zone. Extension of both acts is expected for a few years now but is it still unclear when this will happen. This geographical gap is not the only obstacle impeding an adequate conservation.
- Another obstacle is the existing gap between fisheries regulations and nature conservation instruments. A Member State can fulfil criteria required under the Common Fisheries Policy, while at the same time infringing with both the Habitats Directive and the Flora and Fauna Act. This discrepancy is further worsened by the fact that fisheries regulations have to be dealt with at European Community level rather than at national level. Member states do have opportunities and obligations to address certain threats at national level, but measures are only effective and politically acceptable when they apply to both national and foreign fisheries fleets.
- Since January 2011 all recreational fisheries with static gear in coastal waters and the fisheries zone in The Netherlands are forbidden.
- The exploration, production and mining of minerals, such as oil and gas, are regulated in the 2002 Mining Act (Mijnbouwwet). The Mining Decree (Mijnbouwbesluit) describes the rules for seismic acquisition offshore the Netherlands, for which no license is required. Under the Mining Decree a soft-start (ramp-up) is required to alert marine mammals in the survey area, but no further measures are compulsory, such as noise reduction or observers on board.
- Licenses for offshore wind parks fall under the 2009 Water Act. An Environmental Impact Assessment (EIA) prior to the license procedure is obligatory. Once implemented as policy, this conservation plan and its measures have to be taken into account and considered in the EIA.
- Currently The Netherlands do not meet the requirements for the conservation of the Harbour Porpoise in their waters of both national and European law. A challenge for the future, given the current legal discrepancies, are the gaps between regulatory regimes for nature conservation and fisheries policy, the current inadequate conservation status, the gaps in ecological knowledge, the

unknown scale of identified threats, such as underwater noise, and their impact on the conservation status of the population.

- The 2010 evaluation by ICES of EC 812/2004 specifically addresses the situation in the Southern North Sea, e.g. Belgian and Dutch waters, recommending it would be sensible to monitor gill- net fisheries especially in the southern North Sea to determine whether ongoing gillnet fisheries there have higher than 'usual' bycatch rates. It would be of equal importance to get some quantification of unregistered gillnetting activity to help defining the likely scale of the threat (ICES 2010d).
- Considering legal commitments and the precautionary approach contained in the Habitats Directive, it is obvious that action of both government and industry is required. The current regulatory situation is insufficient. In the case for bycatch in set-nets the burden of proof for allowing this activity to continue lies with set-net fisheries.
- Given the strict protection required under the Flora and Fauna Act for the Harbour Porpoise, and the requirements under the Habitats Directive it should be emphasized that the legal requirements under both National and European law do not only apply to bycatch in fishing gear. The Netherlands also have the obligation to address other activities causing disturbance or killing, such as underwater noise or ship strikes. For this reason, activities causing explosive underwater sound should be also monitored and regulated, assessing the impact and mitigating the adverse effects.
- Implementing the research and mitigation measures, as advised in this species conservation plan, serves as a strategy to fulfil the requirements of The Netherlands under the relevant international legal treaties. Measures should be concrete and specific and need to be implemented and complied with. This does require an active and also flexible management approach, turning this conservation plan into an action plan.

Concrete measures: research proposals and mitigation measures (Chapter 9)

(1) Scientific research
Current research needs have been prioritised on a scale from 1 (highest) to 5 (lowest). Listed in Chapter 9 are the following research needs (priorities indicated in parentheses)

- Assessments of Harbour Porpoise population through state of the art aerial surveys, including analysis of seasonality and spatial patterns (1)
- Develop techniques to combine visual and acoustic detection opportunities (2)
- Conservation status should be re-evaluated (2)
- Continuation and strengthening of a co-ordinated strandings network (2)
- Production of guidelines for volunteers to enhance data quality (3)
- Develop concrete research questions for research in pathology, and adjust when needed (supervision by a scientific steering group) (2)
- Prioritise systematic, representative sampling of stranded carcasses (2)
- Prioritise investigations of reproductive condition and (exact) age during necropsies (2)
- Prioritise investigations of hearing damage (including tissue sampling protocols) (1)
- Carefully assess evidence for drowning (bycatch) during necropsies (2)
- Development of novel forensic techniques to demonstrate the likelihood of bycatch (3)
- Studies of nutritive status and diet linked with demographic parameters (1)
- Meta analysis of occurrence and seasonality of infectious disease in porpoises (4)
- Specific investigations or liaisons with other research institutes to investigate the effects of pollutants on Harbour Porpoises (4)

- Monitoring of pollutants burden and/or tissue banking (4)
- Prioritise an observer scheme on all fleets with passive gear to assess bycatch rates according to internationally accepted protocols (1)
- Continue to assess bycatch rates in the most important fisheries (regarding bycatch) and evaluate the effectiveness of mitigation measures (1)
- Development of an ageing protocol for field studies (4)
- Emphasis on the presence/absence of (small) calves during field studies (4)
- Innovative studies of the (foraging) ecology and habitat requirements of Harbour Porpoises in the Southern North Sea (2)
- Stimulation and funding of innovative studies of the behaviour of Harbour Porpoises in captivity (3)
- A stronger emphasis of publications in peer-reviewed literature (2)
- Formation of a national, scientific research steering group to evaluate research needs, research questions, and research proposals (1)

(2) Policy measures and mitigation

- Recommended policy and mitigation measures are categorized into measures that should be applied at present and measures that depend of further knowledge depending on the outcome of the suggested scientific research measures. Individual measures can be effective, but in most cases, if not all, a combination of measures addressing a problem will be more effective.
- A general recommendation is to involve stakeholders in the process of establishing a conservation and management plan. Promoting the cooperation and debate between scientists, NGO's, policymakers and industry would enhance a mutual understanding and acceptance of measures taken to protect the Harbour Porpoise. Also communication to inform stakeholders and the general public on activities related to the conservation of the Harbour Porpoise is recommended.
- Although policy and mitigation measures focus at the main identified threats, bycatch and loud explosive underwater noise, other (potential) threats need to be addressed as well, although in general, these cannot be addressed effectively at a national level. Nevertheless it is imperative that the problems caused by, for example marine litter and pollution should be addressed simultaneously at both national and international levels. The monitoring of chemicals in porpoises should be included in the Coordinated Environmental Monitoring Programme of OSPAR (CEMP). Harbour Porpoises should also be included in the monitoring programmes under the Marine Strategy Framework Directive (MSFD).
- Regarding siting and land reclamation planning systems should be used to steer potentially harmful activities away from sensitive areas or sensitive periods in time, including sensitive areas outside of marine protected areas.
- The scale and cause/effect of vessel strikes should be monitored and when relevant, seasonal restrictions should be considered when porpoises and shipping lanes overlap.
- Prey availability is not something that can be easily influenced at a regional scale. When having sound knowledge on the feeding ecology of the Harbour Porpoise, TACs & Quota of relevant fish species for the Harbour Porpoise can be proposed for adaptation.
- Depending on the results of the recommended observer programme (observers and CCTV/camera monitoring) several mitigation measures to mitigate bycatch are recommended. Measures to apply at present are to facilitate the landing and reporting of bycatch; to prohibit all recreational gillnetting in Dutch waters; to control illegal fisheries; to amend EC 812/2004 given its current inadequacy for set net fisheries in Dutch waters; to explore gear switch to gear types causing less impact on the marine environment and porpoises in particular; to continue exploring ways to modify gear which

reduces bycatch; to investigate bycatch in hook and line fisheries and to use acoustic devices in a controlled way when bycatch is defined.

- Measures dependent of further research could include decreasing the total effort of set net fisheries; instalment of time and/or area closures and the establishment of a take limit resulting in restriction of fisheries for a certain period and/or a certain area, taking into account displacement of effort which might even increase bycatch. Ideally a system of bycatch monitoring by all Member States bordering the North-western North Sea and Eastern Channel (i.e. Management Unit 9) Sea will be established, keeping track of all reported bycatches and as soon as the 1% limit has been exceeded MU9 will be closed for a certain time and period or other mitigation measures will be required for the fisheries responsible of bycatch.
- When designing measures to mitigate adverse (disturbance, temporary physical damage) and potential lethal effects of loud explosive sounds under water, a precautionary approach to management and regulation of underwater noise is recommended.
- A general measure applicable to all loud explosive sounds should be the requirement of an EIA, including a BACI study (before and after control impact) using aerial surveys prior to operations. Another general measure that should apply to all loud explosive sounds is the development of a system of standards, setting thresholds for underwater noise.
- Prior to any action causing loud explosive underwater noise a marine mammal observation protocol is recommended by international approved guidelines, using both visual and/or acoustic observation methods. As the porpoise is a notoriously difficult animal to observe at sea, this does not necessarily guarantee the absence of animals, nor do following mitigation measures prevent any potential adverse effects at a larger distance, unless sound reducing mitigation tools are used.
- Guidelines are proposed to mitigate effects of loud explosive sounds. The recommendations in this plan indicate the necessary measures within these guidelines. However, these guidelines need to be finalized and fine-tuned, preferably in cooperation with the regulatory body, that is responsible for the implementation and compliance of the guidelines. Such a set of guidelines should also be adapted whenever new knowledge, developments and insights become available.
- Regarding seismic surveys both a license requirement is recommended and the creation and implementation of guidelines.
- A set of guidelines should be also established for controlled explosions under water similar to that proposed for seismic surveys.
- Regarding pile driving a set of recommendations is given, comprising the avoidance of pile driving and the use of alternative foundation methods available. Explosives for the demolition of a windfarm should be avoided.
- For all three activities (seismic survey, pile driving, detonation) the following conditions should be met: (1) activity only in daylight hours and under good sighting conditions to detect porpoises, (2) permission only in seasons of low porpoise abundance to limit the number of animals exposed. Such a restriction should be based on latest insights in seasonal distribution, (3) notification strandings network prior to acoustic impacts, (4) a pre-activity search prior to the start should be undertaken by skilled marine mammal observers. An activity should not begin, if porpoises (or other marine mammals) are detected within the mitigation zone or until 20 minutes after the last detection, (5) mitigation measures such as acoustic deterrents or a ramp-up procedure should be properly used to alert porpoises and other marine mammals. Note that animals are disturbed from their natural behaviour, and (6) technical measures proven to reduce the sound emission during construction works should be used whenever possible
- For both fisheries and underwater noise mitigation measures, an appropriate monitoring and enforcing scheme should be established in order to check compliance to the prescribed measures.

Procedures to assess the effectiveness of any mitigation measures introduced should be developed and implemented by the appropriate bodies.

- National & international cooperation through relevant existing fora should be undertaken.

Discussion and conclusions

- Nor the population decline of the Harbour Porpoise in the 1950s and 1960s, nor its return since the mid-1990s is understood, largely as a result of a lack of research. Effective animal conservation starts with a high level of knowledge and understanding of the ecology of the animal, coupled with adequate monitoring programmes. Facts needed to be separated from personal expectations and believes.
- With a substantial part of the North Sea stock in waters under Dutch jurisdiction, even if this is only during part of the year, we share the responsibility for the general well-being of the Harbour Porpoise with other North Sea states (Habitats Directive, the Oslo-Paris Convention and the ASCOBANS Agreement under the Bonn Convention (Convention on Migratory Species).
- Updated status reports and a (national) conservation plan, to keep or bring the species in a favourable conservation status, are required.
- The current Harbour Porpoise conservation plan is a generic plan rather than area-orientated: recent research in Dutch waters failed to identify areas or regions of particular ecological significance for Harbour Porpoises for any significant length of time.
- Levels of monitoring and research should be such that any significant population trends should be recorded and could trigger timely action. Population censuses (basically 'counts' or stock assessments) alone will be inadequate to monitor the condition of a population. Assessments of age composition and sexratio, reproductive success and studies of the population-level effect of (potential) threats are equally important.
- Strandings data provide a biased subset of the offshore population.
- There have been substantial recent improvements in the quality of population census techniques. State of the art aerial surveys should be continued in years to come, but with improvements of the exact *planning (timing) and frequency* of surveys. A scientific research steering committee should discuss the needs and provide planning advice.
- Seabird observations from coastal headlands gave an early warning of the return of porpoises in Dutch coastal waters and are one of the best sources of information regarding seasonal trends in abundance in nearshore areas. This work is conducted by specialised volunteers (bird-watchers), but provides excellent data, without the need for additional funding for as far as the field work is concerned. Financial support to stimulate specific analyses of coastal seawatching sightings data within certain time-intervals (e.g. every five years) should be recommended.
- The online representation of recent strandings reports (www.walvisstrandingen.nl) is a major step forward. The dataset is invaluable and should be treasured, but the strandings network should preferably be maintained by a dedicated researcher, or a dedicated research institute, willing to put significant effort into it. Facilities and finances to maintain this volunteer network at strength are therefore required.
- A scientific evaluation of the type of observations made on stranded carcasses is lacking, and guidelines to instruct volunteers on beaches and forms to emphasise the need to provide certain data could improve the quality and completeness of the collected data.
- Pathological studies of porpoises stranded on the Dutch coast (necropsies) are important to reveal certain aspects of the life-history, ecology, parasitology, and causes of death of stranded cetaceans, but the underlying research questions and observation protocols should be clear, concrete, and adjusted when needed, to accommodate current (or future) research needs. A central scientific

research plan could make these studies more effective and more conclusive. A scientific research steering committee could discuss the research needs, formulate hypotheses and help set priorities for future research.

- Several of the observed threats, at the moment, cannot be addressed in appropriately because too many factors are still unclear. High quality research is needed to find out where the problems are most prominent. It can be concluded that (in order of priority) the most important threats are (1) bycatch, (2) pile-driving during the installation of windfarms, (3) underwater explosions, and (4) other particularly loud underwater sounds (e.g. sonar, seismic surveys). There are serious concerns regarding available resources (food), in the southern North Sea as well as in the North Sea at large. Additional research is needed for the first, immediate mitigation measures are proposed for the other impacts. All aspects require future monitoring, to assess the scale, the exact impact, but also the effectiveness of mitigation measures.
- Bycatch is a critical source of mortality for Harbour Porpoises throughout their distribution area. Progress at reducing the scale and conservation impact of cetacean bycatch has been slow, sporadic, and limited to a few specific fisheries. Within The Netherlands, the incidence of bycatch is currently best known from the necropsies (on a non-random selection of stranded animals). Strandings data alone, however, are inadequate to estimate mortality levels from bycatches. Measurements of at-sea mortality are a necessary component of any management framework, and independent observers at sea would be the most reliable source of information. A top-priority in the near future would be the implementation of an observer scheme to assess bycatch rates. The amount of observer effort should be set to achieve a desirable level of precision, sampling the fleet randomly.
- Crucially lacking are studies of the demography, ecology and migratory movements of Harbour Porpoises, and studies of the ecology and general well-being of the animals further offshore. There is an urgent need to deepen our understanding of habitat requirements, natural resources (prey), and the trophic position of porpoises within the ecosystem of the Southern Bight.
- A **national scientific research steering group** would be a suitable instrument to deal with aspects such as research needs, research quality and the evaluation of the quality and conclusions of study reports. Such a steering group should be sufficiently authoritative, but also sufficiently "distant" from the ongoing research, to address all these issues in a fully independent way. The terms of reference of this group should be such that high quality science is stimulated, investigating research questions that are currently important or that may become important in future. We propose that such a committee should meet and advice annually, and be composed of at least two foreign marine mammals experts, one Dutch Harbour Porpoise expert, and (vitally) one statistician.

2. Preface

Harbour Porpoises *Phocoena phocoena* are exposed to a number of anthropogenic pressures and are listed as threatened or even endangered in several international conservation instruments (e.g. EC Habitats and Species Directive 1992 (92/43/EEC), Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention), Convention on Migratory Species (Bonn Convention), IUCN Red List of Threatened Species; Reijnders *et al.* 2009). The conservation status of the Harbour Porpoise in The Netherlands has recently been evaluated as '*Inadequate*' (Jak *et al.* 2009), and the population as '*Vulnerable*' (VZZ 2007). Reasons for concern, in short, were unknown causes for a recent shift in Harbour Porpoise distribution within the North Sea, the age structure and reproductive condition of the Harbour Porpoise population in Dutch waters, and reported incidental bycatches in fishing gear in Dutch waters (VZZ 2007, Jak *et al.* 2009). Scheidat & Siebert (2003) suggested that the main anthropogenic impacts acting on Harbour Porpoises in the German North Sea included overfishing, bycatch in fishery, accumulation of pollutants and the degradation of habitat through noise. A slightly more comprehensive, but otherwise rather similar list of main threats that could potentially affect Harbour Porpoises within the North Sea area was produced by Reijnders *et al.* (2009): fishing, contaminant discharge, shipping, hydrocarbon exploration, sewage discharge, construction, aquaculture, mineral extraction, recreation, and military activities.

With this species protection plan, it is our aim to improve the current conservation status of Harbour Porpoises in North Sea waters under Dutch jurisdiction. There are several international agreements and conventions that require the development of a (national) conservation plan and to bring the species in a more favourable conservation status when needed. Examples are the Habitats Directive (HR), the Oslo-Paris Convention (OSPAR) and the ASCOBANS Agreement under the Bonn Convention (Convention on Migratory Species; CMS) (see **Box 1**). Within the Netherlands, implementation took place in the "*Natuurbeschermingswet*" and "*Flora en Faunawet*". A proposal to expand this legislation to the entire Exclusive Economic Zone (EEZ) is under debate within the Dutch Parliament. Another line of Harbour Porpoise protection follows from the European Common Fisheries Policy (CFP), via concrete measure to minimise fisheries bycatch (specifications of fishing nets, mesh size and the use of acoustic deterrents). In this case, it is the European Commission that is authorized to produce regulations (e.g. EC Council Regulation 812/2004 of 26 April 2004 laying down measures concerning incidental catches of cetaceans in fisheries and amending Regulation (EC) No 88/98)[1].

Harbour Porpoises have increased markedly in numbers in the southern North Sea in recent decades. It was our aim to develop a conservation plan on the appropriate ecological scale, given our current understanding on the seasonality of migratory movements of porpoises through the North Sea, including Dutch waters. Analyses of recent spatial and temporal trends in Harbour Porpoise abundance suggested that at least populations in northern France, Belgium, along the east coast of the United Kingdom and possibly parts of the German Bight could be somehow connected (Haelters & Camphuysen 2009, Gilles *et al.* 2009). Given the marked recent changes in distribution and abundance, the current population status in Dutch waters has been re-evaluated with the latest available data.

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[1] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:150:0012:0031:EN:PDF

Box 1

The **Habitats Directive** (together with the Birds Directive) forms the cornerstone of Europe's nature conservation policy. It is built around two pillars: the Natura 2000 network of protected sites and the strict system of species protection. All in all the directive protects over 1.000 animals and plant species and over 200 so called "habitat types" (e.g. special types of forests, meadows, wetlands, etc.), which are of European importance.

The **OSPAR Convention** is the current legal instrument guiding international 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.

ASCOBANS was concluded in 1991 as the *Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas* under the auspices of the *Convention on Migratory Species* (CMS or Bonn Convention) and entered into force in 1994.

It would have been an option to focus the conservation plan to areas within the North Sea that are currently protected under Natura 2000. However, species listed in Annex IV of the Habitats Directive (including the Harbour Porpoise) are protected not just within but also outside these Natura 2000 areas (generic protection throughout distribution area). In fact, only when designated protected areas are of particular ecological (food, rest) or demographical (reproduction) significance for a highly mobile, migratory, aquatic species such as the Harbour Porpoise would there be a case for an area based conservation approach. However, there is no evidence that within the Dutch EEZ areas of particular and persistent ecological and demographic importance for Harbour Porpoises occur (this document). Therefore, given the mobility of porpoises and the seasonality in their widespread occurrence throughout the Dutch sector of the North Sea, a generic conservation plan rather than an area based approach seemed more appropriate.

An important step for this Harbour Porpoise conservation plan was to research and discuss observed as well as expected population threats, by providing a summary of existing scientific evidence demonstrating whether or not (negative) population level effects exist, or could be expected. ASCOBANS produced a Conservation Plan for Harbour Porpoises in the North Sea (Reijnders *et al.* 2009). Potential threats were prioritised and for pragmatic reasons, the Meeting of Parties decided to focus on bycatch and underwater noise (MOP6 Resolution No.3; UNEP/CMS/ASCOBANS Secretariat 2010). Similarly, potential threats or relevant issues that could affect a favourable conservation status have been evaluated here. Based on the available scientific evidence and experiences in other North Sea countries, mitigation measures and suggestions for urgently needed additional scientific research have been formulated.

A conservation plan is more successful when a general (public) understanding of the issues, the threats, the selected mitigation measures and future research proposals has been achieved. Therefore, a comprehensive stakeholder consultation has been part of the project. Both the available evidence as well as uncertainties have been discussed. A general commitment by stakeholders and NGOs has been as a vital aspect of the project, and therefore, all have at least been given the opportunity to evaluate and discuss observed trends and demonstrated or expected threats to the well-being of the population and were involved when mitigation measures and/or further scientific research have been proposed.

3. Introduction

The Harbour Porpoise *Phocoena phocoena* (Dutch: Bruinvis) is the most abundant cetacean in the North Sea (Reid *et al.* 2003). In 1994, the population was estimated to number approximately 268,500 animals (SCANS I; Hammond *et al.* 2002). An estimate for 2005, for approximately the same area (although slightly smaller), was 231,000 animals (SCANS II 2008). These figures indicate no statistically significant difference in abundance of Harbour Porpoises in 1994 and 2005. A marked change in distribution was found, however, with many more porpoises in the southern half of the North Sea in the second survey than in the first.

Within The Netherlands, historically, the Harbour Porpoise was an abundant, indigenous species (Camphuysen & Peet 2006). Numbers had declined markedly, however, since the early 1960s, both sightings and strandings became rare (Camphuysen 1982, Addink & Smeenk 1989). During 1970-1985, some 15-30 Harbour Porpoises washed ashore annually, indicating that a small, probably offshore population still existed. The shift in distribution reported by the two subsequent SCANS surveys did not come unexpected, however (Hammond *et al.* 2002, SCANS II 2008). From the early 1990s on, a marked increase in strandings and sightings of Harbour Porpoises in Dutch coastal waters had been witnessed (Camphuysen & Leopold 1993, Camphuysen 1994, Witte *et al.* 1998, Camphuysen 2004, Berrevoets & Arts 2006, Camphuysen 2006, Thomsen *et al.* 2006, Camphuysen *et al.* 2008, Camphuysen 2011). In Dutch coastal waters, the Harbour Porpoise had "returned" after an absence of several decades and its status changed from a rarity to a common resident in just about 15 years (Camphuysen 2004). Meanwhile, necropsies of stranded specimens at the Rijksmuseum voor Natuurlijke Historie (RMNH) in Leiden indicated that a fairly large number of animals had apparently died unnaturally (Smeenk *et al.* 2004).

The Harbour Porpoise has a world population estimated at some 700,000 individuals and was listed under "*Least Concern* (LC)" in the 2010 IUCN Red List of Threatened Species (Hammond *et al.* 2008, IUCN 2010). In an earlier assessment, the species was listed as "*Vulnerable* (VU)" (Baillie & Groombridge 1996). As a justification for its current ranking, it was noted that, although the species is known to be harvested in some areas and while regional declines have been documented, it is a widespread and abundant species. A change from "Vulnerable" (*i.e.* considered to be facing a high risk of extinction in the wild; IUCN 2001) to "Least Concern" (widespread and abundant taxa), even skipping "Near Threatened (NT)" (taxa likely to qualify for a threatened category in the near future) over a short time span could either mean a substantial recovery of a population under threat, or a new conclusion based on more comprehensive data. The latter is apparently true in case of the Harbour Porpoise, while it should be noted that current population trends are in fact largely unknown. As stated previously in our Preface, while quoting Reijnders *et al.* (2009), Harbour Porpoises are listed as threatened in several European conservation instruments (EC Habitats and Species Directive, CITES, Bern Convention, Bonn Convention).

In some parts of the world (shelf waters USA and Europe) conservation measures for Harbour Porpoises have been implemented (Hammond *et al.* 2008), but the effectiveness of conservation measures is still subject of further study and debate. In fact, for many areas [the Netherlands included], major threats and conservation concerns, let alone measures to maintain a favourable conservation status, have not been fully evaluated and implemented. At the 9th Meeting of the Parties to ASCOBANS, strategic priorities were set for the coming years. It was agreed to develop a more focused approach towards a limited set of the most urgent priorities, while developments with respect to other issues had to be carefully monitored at the same time (UNEP/CMS/ASCOBANS Secretariat 2010). Special focus of the many activities in the Agreement under the triennial work plan (2010-2012) would have to be on two main issues: underwater noise and by-catch (MOP6 Resolution No.3; UNEP/CMS/ASCOBANS Secretariat 2010).

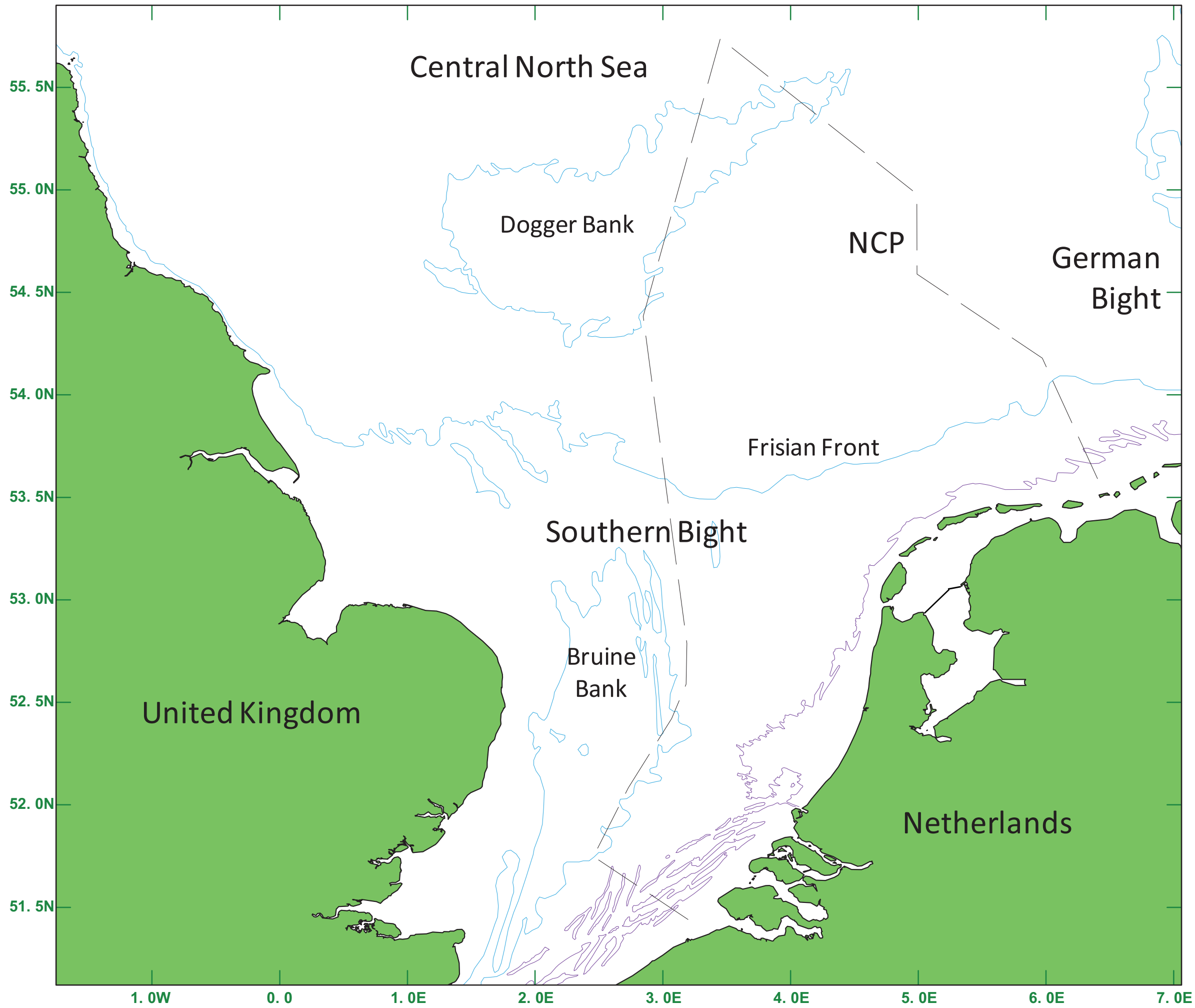


Figure 1. Dutch sector of the North Sea (NCP).

With a substantial population of Harbour Porpoises in waters under Dutch jurisdiction, and with concerns regarding the condition of that population and the bycatch issue (VZZ 2007, Jak *et al.* 2009), but also in order to meet requirements of the EC Habitats Directive to assess and maintain a favourable conservation status of Harbour Porpoises, further action is now required. First, our current knowledge and understanding of the status of Harbour Porpoises within the Dutch region (Southern North Sea) had to be updated. The first part of the present document provides this update. We will briefly introduce the species, describe recent population trends of Harbour Porpoises in waters under Dutch jurisdiction (Dutch sector of the Continental Shelf, between 51-56°N, and 02-07°E; **Fig. 1**) based on the latest datasets currently available, and comment on its present conservation status.

Secondly, a full inventory of current threats was needed in order to be able to more fully describe and evaluate current conservation concerns. The second part of this document provides an overview of apparent threats and suspected problems affecting a favourable conservation status (characteristics, evidence, scale, and potential population level effect). The threats are discussed, exemplified, and ranked in order of importance. Threats with demonstrated population level effects, such as factors inflicting acute death of at least some individuals on an annual basis, are considered most important.

And finally, given our current knowledge, mitigation measures had to be proposed to enhance the current conservation status of the species in The Netherlands. It became clear, however, that many aspects required additional research in order to be able to assess the relative importance of the observed or expected threats, or to be able to propose specific mitigation measures. For example, while evidence could be provided for the "frequent occurrence" of bycatches in fishing gear off the Dutch coast, the scale was unclear (how many bycatches per fishing effort) and the gear type that was most dangerous could not be identified. A substantial amount of information was derived from studies in relatively nearshore waters and strandings. In the offshore zone, notably in the area north of 54°N, our knowledge is very limited.

Specific research was proposed to solve exactly these issues, so that mitigation measures can be more specific, such as targeting seasons or parts of the fleet that posed the most significant problems for porpoises. Both research proposals and possible mitigation measures have been discussed with stakeholders, so that the implementation of conservation measures would be (more) acceptable or at least understandable for them. For each and every proposal, it was tried to provide a ranking of importance or urgency.

4. Current knowledge

4.1. Characteristics, size, reproduction and longevity

The Harbour Porpoise is the smallest and most abundant cetacean in NW European continental shelf waters (Reid *et al.* 2003). Harbour Porpoises are Odontocetes ("toothed whales") that have spade-shaped rather than conical teeth, a characteristic that distinguishes them from the dolphin family (Schulze 1987; **Fig. 2**). Adult females reach on average 1.6m in length (60kg); males are smaller growing to about 1.5m (50kg). The largest recorded porpoises were 2.0m in length (70kg; Bjørge & Tolley 2002). Calves are usually about 70-75cm (5kg) at birth but grow rapidly in their first year, reaching 1.2m in males and 1.25 m in females (Olafsdóttir *et al.* 2003). Addink *et al.* (1995b) found an average length at birth of 27 porpoises which, according to biological and/or pathological records were definitely neonate, of 74 cm (SD 8 cm; range 63—97 cm).

Figure 2. Harbour Porpoises have spade-shaped rather than pointed (or conical) teeth, a characteristic that distinguishes them from the dolphin family (photo C.J. Camphuysen).

Harbour Porpoises have an average life-span of 8-10 years (exceptionally up to 24 years; Lockyer 2003b) 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. Lockyer (2003b) estimated the natural rate of population increase at 9.4% (within 5-10%). Harbour Porpoises are seasonal breeders, with a contracted calving season lasting only a few weeks (Bjørge & Tolley 2002, Halldórsson & Víkingsson 2003). It is unclear where, if at all, in the Southern Bight breeding occurs. Strandings of fresh neonates on Dutch beaches and sightings of adults with small calves are indicative of reproductive activity within the Dutch sector of the North Sea, or at least nearby. Their peak calving in the North Sea is possibly around June (Lockyer & Kinze 2003). Addink *et al.* (1995b) found a pronounced birth peak in July (Jun-Aug), from stranded animals in Dutch waters, but with some neonates found in May and September.

Figure 3. Severely emaciated, stranded Harbour Porpoise, March 2006, Texel (photo CJ Camphuysen).

Harbour Porpoises are generally quite difficult to observe, because they only briefly break the water surface, while they rarely bow-ride or breach clear out of the water. They are normally seen as solitary animals or in small groups (2-3 individuals). The dorsal side of Harbour Porpoises is dark grey (which may appear light brownish in certain light conditions), while the chin and ventral side are a contrasting bright white, which sweeps up to the midflanks in a mottled pattern (Bjørge & Tolley 2002, Shirihai & Jarrett 2006; **Fig. 3**). Dark grey lines, vague in some individuals, originate on each side of the head near the back of the mouth and run back towards the flippers.

Figure 4. Harbour Porpoises normally break the surface briefly (seconds) with a rolling motion ("wheeling") exposing little more than the dorsal fin. The dorsal side of the animals is dark grey, which may appear light brownish in certain light conditions (photos RC Schmidt).

Figure 5. Porpoises normally actively avoid motor boats, and their characteristic escape response is useful for identification: 2-3 quick spurts at the surface (producing some glassy water spray) away from the approaching vessel, followed by a prolonged dive. The animal itself is often hardly visible at the surface during these spurts (left), but on other occasions they may show more of their body than they would normally do (right) (photos: CJ Camphuysen (L), ML Tasker (R)).

Figure 6. Harbour Porpoises approaching kayaks (Marsdiep, left) and sailing vessels (Oosterschelde, centre and Grevelingen, right). Certainly the animal in Grevelingen was a specialised individual, approaching sailing vessels through the year and for many years, following some boats for hours on end (photos G Aarts (L), D van der Avoirt (C), K Heijboer (R)).

At sea, Harbour Porpoises can be separated from other cetacean species by their rounded (blunt) head, small triangular dorsal fin, and characteristic behaviour. They normally break the surface briefly (seconds) with a rolling motion ("wheeling") exposing little more than the top of their head (to breath) and the dorsal fin (Amundin 1974, Schulze 1987; **Fig. 4**). Porpoises normally actively avoid motor boats, and their characteristic escape response is useful for identification: 2-3 quick spurts at the surface (producing a rooster tail of water spray) away from the approaching vessel, followed by a prolonged dive (**Fig. 5**). Harbour Porpoises may actively approach and bow ride sailing vessels, surfboards and kayaks (Camphuysen & Van der Avoirt 2008, Camphuysen & Heijboer 2008; **Fig. 6**).

4.2. Position in marine food chain, foraging ecology, predators, diet, competitors

The Harbour Porpoise is a relatively small, endothermic predator with limited energy storage capacity, dependent on foraging throughout the year without prolonged periods of fasting (Kastelein *et al.* 1997d, Bjørge 2003). These small cetaceans are positioned near the top of the marine food web, but they are not quite apex predators in all ecosystems. Like other cetaceans, they are heavily reliant on active echolocation (animals emitting sound waves and listening to the echo in order to locate objects or navigate) 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 acoustic pollution in their marine environment. Higher trophic-level marine predators are presumed to respond to environmental variability and therefore may indicate ecosystem changes that might be difficult to measure otherwise (Bowen *et al.* 2006). Upper-trophic predators suffer generally from higher rates of bioaccumulation that may endanger their health or reproductive condition. Detailed studies of their diet and foraging ecology are required, to understand which natural resources are exploited, what habitat characteristics are of vital importance and how environmental or climate change would affect the survival or abundance of this species.

Kastelein *et al.* (1997d) studied food consumption in six healthy Harbour Porpoises from the North Sea that had stranded alive and had been rehabilitated at the Harderwijk Marine Mammal Park. Food intake differed between animals of similar weight, but on average, the animals consumed between 750 and 3250 g fish (Herring *Clupea harengus* and/or Sprat *Sprattus sprattus*; 8000-25000kJ) per day (between 4 and 9.5% of their body weight). Lockyer *et al.* (2003) found a daily food consumption of 7-9.5% of body mass by two healthy porpoises kept in captivity in Denmark. These two studies indicated a clear seasonal pattern in consumption rates that is correlated with body mass changes and blubber stores (Lockyer *et al.* 2003). Kastelein *et al.* (1997d) argued that a high number of meals per day are crucial for small Odontocetes which live in cold water. They need a large amount of food per day relative to their body mass, and cannot survive by filling their stomachs completely a few times per day: Harbour Porpoises must eat often and therefore require a relatively dependable, if not abundant, food supply to survive.

These small cetaceans are preyed upon by Killer Whales *Orcinus orca* (which are now extremely rare in the southern North Sea) and large sharks (very uncommon in the Southern Bight, but see Anselmo & Van Bree 1995). Early accounts of stranded Killer Whales on Dutch beaches commented on remains of porpoises found in the stomach of these large predators (Van Dieren 1931, Slijper 1958). Harbour Porpoises in the United Kingdom are frequently attacked and often killed (but not eaten) by larger dolphins such as Bottlenose Dolphins *Tursiops truncatus* (Ross & Wilson 1996, MacLeod *et al.* 2007a), a species that went locally extinct in the Southern Bight somewhere in the 1960s. Rake marks found on extremities (dorsal, flippers, flukes) of porpoise stranded in The

Netherlands and in Belgium point at similar interactions between White-beaked Dolphins *Lagenorhynchus albirostris* [currently common in the Southern Bight] and Harbour Porpoises (Haelters & Everaarts 2011) Rare observations of aggressive behaviour of Grey Seals *Halichoerus grypus* towards porpoises suggest that the position of the latter in dominance hierarchies established at multi-species feeding assemblages where both occur may not always be clear (possibly forced to feed less efficiently or to move to another feeding site). Recent observations of Grey Seals handling dead porpoises suggest that scavenging occurs at least incidentally (**Fig. 7**).

Figure 7. Grey Seal *Halichoerus grypus* manipulating (scavenging) Harbour Porpoise corpse, 15 Feb 2011, Petten (photo N Koster).

Porpoises are most abundant in relatively shallow sea areas and often forage near or at the sea bottom in waters less than 200m deep (Bjørge & Tolley 2002). Their prey spectrum, including both pelagic and demersal prey species, suggests that pelagic foraging activities must be important also. Recent observations have confirmed their fish-herding skills, when Harbour Porpoises operate in small groups driving fish towards the surface in a joint, concerted action (Heinsius 1914, Hoek 1992, Baptist & Witte 1996, Warren 1996, Camphuysen & Webb 1999, Anon. 2000, Camphuysen *et al.* 2006). Feeding frenzies near the surface normally attract numerous seabirds (so-called "multi-species foraging associations, MSFAs; Hoek 1992, Pierpoint *et al.* 1994, Camphuysen & Webb 1999, Camphuysen 2004, Lange *et al.* 2005), whereas bottom feeding marine mammals normally go unaccompanied by seabirds (Camphuysen *et al.* 2006).

A strong relationship was found between Harbour Porpoise distribution and the average position of tidal fronts around the Faroes, suggesting that the species concentrates near the quasi-stationary circular shelf front separating mixed from stratified waters around the Faroes (Skov *et al.* 2003). Harbour Porpoise foraging in tide race habitats (high-energy environments) have been reported from different parts within the geographical range of the Harbour Porpoise (Pierpoint 2008). The preferred foraging location in South Ramsey Sound (south-west Wales, U.K.), is such a high-energy habitat where a tide race, overfalls and upwelling zones form during the ebb phase. Seabed topography and tidal currents combine to create a foraging resource exploited by Harbour Porpoises at regular and predictable intervals. Tidal currents and the steep walls of the trench are believed to concentrate prey which is funnelled towards the waiting porpoises (Pierpoint 2008). Within The Netherlands, nearshore sightings in for example the Marsdiep area (a high energy sea strait between Texel and Den Helder) confirmed that Harbour Porpoises utilise the area in a peculiar manner, but here foraging was most frequently observed when the tides were turning (slack tide; Rebel 2010). Some foraging porpoises have been seen in extremely shallow waters (Verwey 1975ab), close to the beach, making these mammals especially vulnerable to recreational set nets placed in beach locations (Haelters *et al.* 2004, Haelters & Kerckhof 2004, Haelters & Camphuysen 2009).

Harbour Porpoises inhabiting coastal waters are often seen in habitats that are characterized by high diversity and complexity in terms of their bathymetry, substrate, and fish communities (Bjørge 2003). The complexity in these habitats influences both the habitat use and feeding ecology of porpoises. Congregations of porpoises feeding primarily on one species are observed in some areas and seasons, while wide movements and diets composed of several species are observed in other areas. Bjørge (2003) suggests quite rightly that that caution is needed when extrapolating knowledge from one area to another with regard to porpoise habitat use. Management plans should be site specific and based on local knowledge incorporating porpoise population structure, habitat use, and multiple environmental factors in order to ensure appropriate conservation of this cetacean species.

Harbour Porpoises are generalist feeders and their diet consists of many different species of fish, cephalopods, crustaceans and polychaetes (Leopold & Camphuysen 2006; Santos 1998). Prey choice was found to vary according to area (geographical patterns in prey distribution), season, and age of the animals. Immature porpoises in the southern North Sea were recently found to focus on small demersal fish (especially gobies Gobiidae), while larger porpoises mainly feed on gadoids, clupeids (Sprat and Herring) and sandeels (Ammodytidae), mostly smaller than 30 cm in length (Leopold & Camphuysen 2006). Gadoids were the most important prey items (found in 62% of stomachs) followed by clupeoids (35%), gobiids (30%), and Ammodytiidae (30%) in stomach samples of Harbour Porpoises drowned in fishing gear in Danish waters in the 1980s (Lockyer & Kinze 2003). Dietary differences observed between porpoises captured within the Danish North Sea and in Inner Danish waters were thought to reflect the general occurrence of prey items rather than prey preferences (Lockyer & Kinze 2003).

Santos *et al.* (2004) reported interannual, seasonal, and regional variation in the diet of porpoises in Scottish waters based on stomach contents of animals stranded between 1992 and 2003. The most important prey types, in terms of contribution by number and mass, were Whiting *Merlangius merlangus* and sandeels Ammodytidae. Multivariate analysis confirmed the existence of regional, seasonal, and interannual variation in diet, as well as biases related to cause of death. There was some evidence that 1 yr old porpoises took more gobies Gobiidae and shrimps than older porpoises. Herring and Sprat formed a relatively small proportion of the diet, but their importance varied from year to year. Although possible methodological biases prevent firm conclusions, it appears that the importance of clupeids in porpoise diet may have decreased since the 1960s, mirroring the decline in North Sea Herring abundance. The recovery of the North Sea Herring stock in recent years is, however, not as yet reflected in porpoise diet.

Fontaine *et al.* (2007) investigated the feeding ecology and habitat use of 32 Harbour Porpoises by-caught in four localities along the Scandinavian coast from the North Sea to the Barents Sea using stable isotopes ($\delta^{13}C$, $\delta^{15}N$) and trace elements (Zn, Cu, Fe, Se, total Hg and Cd), in relation to habitat characteristics (bathymetry) and geographic position (latitude). Among the trace elements analysed, only Cd, with an oceanic specific food origin, was found to be useful as an ecological tracer. All other trace elements studied were not useful, because of physiological regulation or few specific sources in the food web. The $\delta^{13}C$, $\delta^{15}N$ signatures and Cd levels were highly correlated with each other, as well as with local bathymetry and geographic position (latitude). Variation in the isotopic ratios indicated a shift in Harbour Porpoise's feeding habits from pelagic prey species in deep northern waters to more coastal and/or demersal prey in the relatively shallow North Sea and Skagerrak waters. This result is consistent with stomach content analyses found in the literature.

Das *et al.* (2003) studied the diet of Harbour Porpoises and other species found stranded along southern North Sea coasts by measuring $\delta^{13}C$ and $\delta^{15}N$ in muscle tissue. Baseline data were collected from a sample including 49 invertebrate and marine fish species collected from the southern North Sea. The $\delta^{15}N$ data indicated that Harbour Porpoises (mean $\delta^{15}N$ value 16.2) occupied a slightly lower trophic position than Harbour Seal *Phoca vitulina*, Grey Seal, White-beaked Dolphins, and Cod *Gadus morhua* analysed from the same area (mean muscle values of 18.7, 17.9, 18.8 and 19.2 respectively). This finding was thought to reflect a higher amount of zooplanktivorous fishes in the Harbour Porpoise diet (mean $\delta^{15}N$ of 14.7).

Pauly *et al.* (1998) derived standardized diet compositions for 97 species of marine mammals from published accounts of stomach contents as well as from morphological, behavioural and other information. Diet was apportioned among eight categories of prey types (benthic invertebrates, large zooplankton, small squids, large squids, small pelagic fishes, mesopelagic fishes, miscellaneous fishes, and higher invertebrates, **Table 1**). Trophic levels for all 97 taxa ranged from 3.2–3.4 in baleen whales, to 3.8–4.4 in most pinnipeds and odontocete whales, to 4.5–4.6 in Killer Whales *Orcinus orca*. The trophic level of Harbour Porpoises was estimated to be 4.1 (diet composition BI 0.05, LZ 0, SS 0.10, LS 0.10, SP 0.30, MP 0, MF 0.45, HV 0), which is slightly lower than the commoner dolphins occurring within the same area (**Table 1**). Bjørge (2003) pointed out that North Sea porpoises rely more heavily on benthic (fish) prey than animals foraging along the Atlantic coast.

Table 1. Trophic levels, derived from standardised diet compositions (frequency of occurrence), of the most common marine mammals in the Southern North Sea from worldwide published accounts of stomach contents as well as from morphological, behavioural and other information (from Pauly *et al.* 1998). Diet simplified to eight prey groups: BI=benthic invertebrates; LZ=large zooplankton; SS=small squid; LS=large squid; SP=small pelagics; MP=mesopelagics; MF=miscellaneous fishes; HV=higher invertebrates. The trophic levels of prey types are indicated in the Table header).

Marine mammal species		Prey type \ Trophic level	BI 2.2	LZ 2.2	SS 3.2	LS 3.7	SP 2.7	MP 3.2	MF 3.3	HV 4.0	Trophic Level ↓
Sperm Whale	*Physeter macrocephalus*		0.05	-	0.10	0.60	0.05	0.05	0.15	-	4.4
Long-finned Pilot Whale	*Globicephala melas*		-	-	0.40	0.35	-	-	0.25	-	4.4
Sowerby's Whale	*Mesoplodon bidens*		-	-	0.25	0.30	0.05	0.20	0.20	-	4.3
White-beaked Dolphin	*Lagenorhynchus albirostris*		0.05	-	0.15	0.05	0.15	-	0.60	-	4.2
Bottlenose Dolphin	*Tursiops truncatus*		-	-	0.20	0.05	0.15	-	0.60	-	4.2
Striped Dolphin	*Stenella coeruleoalba*		0.05	-	0.20	0.15	0.05	0.30	0.25	-	4.2
Common Dolphin	*Delphinus delphis*		-	-	0.15	0.15	0.10	0.40	0.20	-	4.2
Harbour Porpoise	***Phocoena phocoena***		**0.05**	**-**	**0.10**	**0.10**	**0.30**	**-**	**0.45**	**-**	**4.1**
White-sided Dolphin	*Lagenorhynchus acutus*		0.10	-	0.15	0.10	0.15	0.10	0.40	-	4.1
Harbour Seal	*Phoca vitulina*		0.10	-	0.10	0.05	0.30	-	0.45	-	4.0
Grey Seal	*Halichoerus grypus*		0.15	-	0.05	-	0.30	-	0.45	0.05	4.0
Humpback Whale	*Megaptera novaeangliae*		-	0.55	-	-	0.15	-	0.30	-	3.6
Minke Whale	*Balaenoptera acutorostrata*		-	0.65	-	-	0.30	-	0.05	-	3.4
Fin Whale	*Balaenoptera physalus*		-	0.80	0.05	-	0.05	0.05	0.05	-	3.4

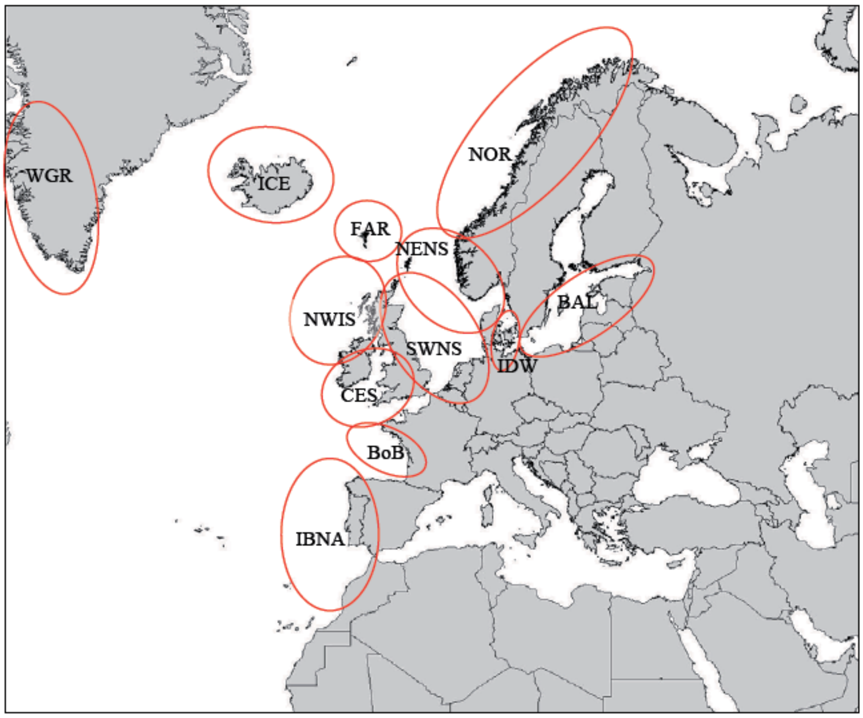
4.3. World status (international context)

World population There are no synoptic surveys covering the entire distribution area of Harbour Porpoises, but abundance has been estimated for selected portions of their range (Hammond *et al.* 2010). About 73,000 animals have been estimated to occur along the west coast of the USA. In Alaska abundance is estimated at about 89,000. In the western Atlantic, there are an estimated 75,438 in the Gulf of Maine/Upper Bay of Fundy to the entrance of the Gulf of St. Lawrence, and 27,000 for the Gulf of St. Lawrence. Abundance has been estimated at 27,000 in Iceland and 11,000 off North Norway - Barents Sea. In the waters of the European Atlantic, abundance in 2005 was estimated at 385,600, of which about 335,000 were estimated in the North Sea and adjacent waters, where abundance was estimated at 341,000 in 1994 (Hammond *et al.* 2002). The abundance in the Baltic (Kattegat and inshore waters around Danish islands excluded) was estimated at only 599. Line transect surveys have been conducted recently (since 2001) to estimate Harbour Porpoise abundance in different portions of the Black Sea. These suggest that total population size in the region may be at least several thousand and perhaps as much as 10,000-12,000 in the Black Sea. Taken together, these numbers indicate that the global abundance of the Harbour Porpoise is at least about 700,000 individuals (Hammond *et al.* 2008). Population trends are unknown, but there is evidence of a decline in abundance in some areas (e.g. in the Black Sea, in the Baltic Sea, and in inland waterways of Washington State, USA). The Harbour Porpoise has been hunted in many areas of its range (e.g. in Puget Sound, the Bay of Fundy, Gulf of St. Lawrence, Labrador, Newfoundland, Greenland, Iceland, Black Sea, and the Danish Belt Seas), but many of these fisheries are now closed (Lockyer *et al.* 2003, Hammond *et al.* 2008). Hunting of Harbour Porpoises still occurs in Greenland (>700 $year^{-1}$ were taken in 1990-1993 (Teilmann & Dietz 1998; Lockyer *et al.* 2003b), in 2003 the reported catch had increased to 2320 animals (NAMMCO 2005). Recent catches in the Faroe Islands appear to be low (Stenson 2003). Although assessments of population impacts of these local harvests are not available, the species is considered being widespread and abundant and not considered to be facing a high risk of extinction in the wild; Hammond *et al.* 2008).

North Sea population - Harbour Porpoises are the most abundant cetaceans in the North Sea. In 1994, total abundance was estimated at approximately 268,500 animals (CV = 0.15; 95% CI = 230,000-313,000) specifically for the North Sea and Channel areas (SCANS I; Hammond *et al.* 2002). An estimate for 2005 for approximately the same area (although slightly smaller) was 231,000 (CV = 0.14; 95% CI = 201,000-266,000) (SCANS II 2008). These figures indicate no statistically significant difference in abundance of Harbour Porpoises in 1994 and 2005. A marked change in distribution was found, however, with considerably larger numbers of porpoises in the southern half of the North Sea in the second survey than in the first.

Sub-populations, management units - Genetic analysis shows that movements of Harbour Porpoises across the Atlantic appear to occur at a low level, with a distributional barrier, if present, possibly lying east of Greenland (Rosel *et al.* 1999). Harbour Porpoises from West Greenland, the Norwegian West coast, Ireland, the British North Sea, the Danish North Sea and inland waters of Denmark are all genetically distinguishable from each other and six regional subpopulations were proposed by Andersen *et al.* (2001). During a study of the polymorphism at 12 microsatellite loci in 807 Harbour Porpoises collected from throughout the central and eastern North Atlantic to the Baltic Sea, overall, with one exception, Andersen *et al.* (2001) observed no significant deviations from the

Hardy-Weinberg expectations[2]. The exception was a sample of porpoises collected at the Dutch coast (mainly during winter) which was genetically heterogeneous and likely comprised a mixture of individuals of diverse origin. Lockyer (2003a) confirmed that the IWC proposal for 13 populations in the North Atlantic was generally supported at the time, but with some refinement and modification; in particular, allowing sub-divisions in the area through the North Sea to the Baltic. Evans *et al.* (2009) suggested a subdivision of the North Atlantic into the following 15 'management units' (**Fig. 8**):



1) Gulf of Maine & Bay of Fundy
2) Gulf of St Lawrence
3) Newfoundland
4) West Greenland (WGR)
5) Iceland (ICE)
6) Faroe Islands (FAR)
7) North-west/Central-west Norway & Barents Sea (NOR)
8) North-eastern North Sea & Skagerrak (NENS)
9) South-western North Sea & Eastern Channel (SWNS)
10) Inner Danish Waters (IDW)
11) Baltic Sea (BAL)
12) Celtic Sea (plus South-west Ireland, Irish Sea & Western Channel) (CES)
13) North-west Ireland & West Scotland (NWIS)
14) Bay of Biscay (West France) (BoB)
15) NW Spain, Portugal & NW Africa (IBNA)

Figure 8. Map showing Recommended Management Units for Harbour Porpoise in the ASCOBANS Agreement Area (Evans *et al.* 2009)

A population structure hypothesis suggested by the IWC (1996) for porpoises in the North Sea was one coherent North Sea population extending from southern Norway to Shetland and south to the Dutch coast, not including Skagerrak. More recent insights imply that Harbour Porpoises in Dutch waters would thus be representatives of management unit 9 (South-western North Sea & Eastern Channel). Currently, it is indeed hypothesised that Harbour Porpoises from the NW North Sea (the northern half of this management unit) have abandoned the area due to reduced resources (Camphuysen 2004, MacLeod *et al.* 2007b) and moved towards the Southern Bight and the northern entrance of the English Channel. This shift had not been noticed yet during the IWC review (1996) summarised and discussed by Andersen (2003). Earlier suggestions, of an east-west division of the North Sea porpoise populations with an east English sub-population and a Netherlands to Denmark subpopulation (even though these were not thought to be isolated but overlapping) may thus be questioned (Yurick 1977 and Gaskin 1984 in Andersen 2003). It was suggested that Dutch sample consisted of porpoises of diverse origin or non-random mating. A mixed stock analysis was used to test whether its composition

[2] To test the proposed population structure model it was necessary to address the hypothesis of sub-structuring within regions as well as among regions. This was conducted by testing for departures from Hardy-Weinberg expectations (HWE), and for homogeneity of allele-frequencies, by assignment tests, by conventional F- and RST statistics.

could be explained as a mixture of porpoises from neighbouring regions. This analysis indicated that the sample indeed largely consisted of a mixture of British and Danish North Sea porpoises (Andersen 2001). Previous studies based on mtDNA sequencing could not detect a difference between Dutch and east English porpoises (Walton 1997). The entire recent [presumed] shift in distribution within the North Sea is seemingly adequately covered with management unit 9, no matter the genetic structure of this population. A more or less frequent exchange of porpoises between the Southern Bight and the German Bight is possible, but has thus far only been demonstrated on the basis of DNA analysis of rather few stranded animals (Andersen 2001, 2003). The proposed management unit is acceptable as 'the appropriate ecological scale' for which the current conservation plan is most relevant, but there is clearly the possibility for mixing of sub-populations: there are no physical barriers (Lockyer 2003a).

The new management units have a rather poor overlap with subregions used in the most recent SCANS survey (SCANS II). Abundance estimates (and CVs) for Harbour Porpoises from shipboard surveys in July 2005 indicate a stock size of 47,100 (0.37) animals in the Central North Sea and 88,100 (0.23) in the Southern North Sea (Southern Bight and inner German Bight excluded). Aerial surveys in an adjacent zone just off the East Frisian Islands (Dutch Wadden Sea included) suggested a further 3900 (0.45) animals. The next zone, the Southern Bight, was combined with the entire Channel area for aerial survey results (40,900, CV 0.38), but it is clear that only a fraction of these animals would belong to management unit 9 (only Eastern Channel included). Yet, a conservative estimate for the entire management unit 9, based on a single project conducted in July 2005, would suggest a population of some 150,000 animals (one fifth of the world population; SCANS II, Hammond *et al.* 2008).

4.4. Historical population status in The Netherlands

"Van de 15 juist genoemde soorten komt alleen de bruinvisch te allen tijde, algemeen op onze kust voor; ook in de vele binnenwateren voor zover die gemakkelijk vanuit zee te bereiken zijn. Van de hele orde der Cetacea hebben we dus maar één vertegenwoordiger in ons land."

["Of the 15 species just mentioned, only the Harbour Porpoise occurs year-round and in large numbers off our coast and in estuaries. Of the entire order of Cetacea we have only a single representative in our country"]

Van Deinse (1925)

From 1900 to the early 1950s, Harbour Porpoises were abundant and widespread in coastal waters throughout the southern North Sea (Weber 1922, Van Deinse 1925, Verwey 1975). Probably, the shallow waters of the southern North Sea, with its estuaries and river mouths, and even the Wadden Sea and the former Zuiderzee, had been prime habitats for porpoises for many centuries and the utilisation of (stranded? captured?) porpoises had been confirmed in several archaeological sites (Camphuysen & Peet 2006). According to Weber (1922) and Van Deinse (1925), porpoises were common not only along the Dutch coast, but also in the Zuiderzee. In the latter area, porpoises were observed to hunt anchovy (*Engraulis encrasicolus*) and garfish (*Belone belone*) during summer months (Heinsius 1914). After the closing of the Zuiderzee with the Afsluitdijk (barrier dike), a substantial number of Harbour Porpoises was trapped. When the IJsselmeer froze over during a severe winter, all trapped porpoises died (Stoppelaar *et al.* 1935). Some authors claimed that during the early 20th century Harbour Porpoises were most numerous in summer months (IJsseling & Scheygrond 1943).

Neither the strandings data, nor anecdotal sightings data currently available seemed to support that claim (Verwey 1975, Camphuysen & Peet 2006). However, an analysis of over 1600 stranding records (Addink & Smeenk 1999) showed a summer peak before 1950, but also during 1950-1964 when autumn strandings increased in frequency. A considerable number of the stranded porpoises were reported by members of the "Strandwerkgemeenschap", an organisation with year-round, suggesting that a bias as a result of observer effort was probably unlikely.

More detailed information on the occurrence of the Harbour Porpoise in The Netherlands is available from around World War II, especially about porpoises in the western Wadden Sea. Before World War II, Jan Verwey and his colleagues of the Zoological Station at Den Helder often saw porpoises, but numbers varied widely (Verwey 1975). Small numbers were observed from February to May, an increase was seen in June and July, but the highest numbers were seen between December and February. For reasons not well understood, the species gradually disappeared from Dutch nearshore waters after World War II, somewhere during the 1950s and 1960s. At first, the decline was reported by some naturalists, but ignored - or denied - by established scientists such as Van Deinse (1952; 1956; 1957; 1958; 1960; 1961) and Vader (1956). An incidental report published by Dudok van Heel (1960) on 40-50 Harbour Porpoises in mid-January 1958 in the Texelstroom area (western Wadden Sea) seemed to confirm that Harbour Porpoises were still numerous. This was, however, the last documented sighting of any significance, and virtually none were reported in the 1960s and 1970s. In the 1970s, sightings of Harbour Porpoises were so rare, that the animal might as well be considered locally extinct (Camphuysen 1982, Kayes 1985, Kinze *et al.* 1987, Smeenk 1987).

4.5. Current population status in the Southern Bight/the Netherlands

Land-based surveys by the Club van Zeetrekwaarnemers (seawatchers, Dutch Seabird Group) since the early 1970s indicated that in nearshore waters, Harbour Porpoises returned from near (local) extinction in the 1970s and 1980s to high numbers in winter and spring in the early 21st century. From a new analysis of seawatching data (a combination of Club van Zeetrekwaarnemers database and www.trektellen.nl; effort-corrected data expressed as n animals per hour of observation), it became clear that numbers in nearshore waters increased rapidly between 1995 and 2005, peaked in 2006, slightly declined during 2007-2008 and peaked again in 2009 and 2010 (Camphuysen 2011; **Fig. 9**). An increase in sightings was also recorded during aerial surveys for seabirds covering the entire sector of the North Sea (Witte *et al.* 1998). Berrevoets & Arts (2006) and later Arts (2010) reviewed these aerial seabird surveys that were conducted between 1991 and 2005 during which Harbour Porpoises had been counted simultaneously. A similar long-term trend was found during aerial seabird surveys conducted between 1991 and 2009. Up until 1995/1996, recorded densities of porpoises were exceptionally low, but increasing numbers were found since: an increase between 1994 and 2005, significant after 2002, but a decline in densities between 2005 and 2009 (Arts 2010; **Fig. 10**).

Nearshore sightings from seawatching sites were almost year-round, but with low frequencies in May and June. During late summer and autumn (Jul-Nov), a gradual increase was found, followed by some stabilization in numbers in mid-winter (Dec-Jan) and a marked further increase in sightings in Feb-Mar. The frequency in sightings crashed early April, followed by the annual low abundance in early summer (Camphuysen 2011; **Fig. 11**). The seasonal pattern of the aerial seabird surveys of the Dutch sector of the North Sea was slightly different; most notably, the peak in abundance was later. Harbour Porpoises had been detected year-round during these surveys (1991-2009, mostly 2002-2009), but with low densities in autumn and winter (Aug/Sep to Dec/Jan), an increase in early spring

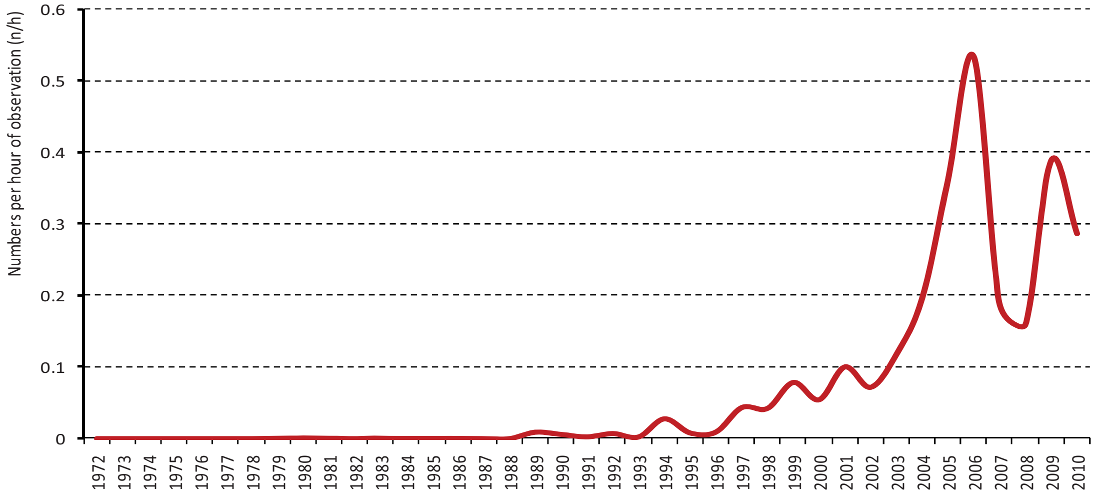


Figure 9. Numbers of Harbour Porpoises per hour of observation during seawatching (n/h), mainland coast observatories only (Scheveningen – Huisduinen, 1972-2010; from Camphuysen 2011)

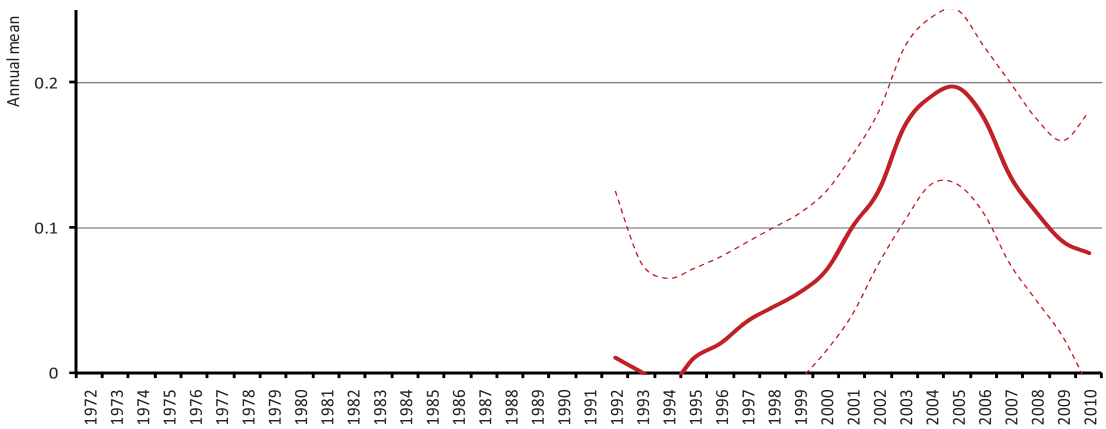


Figure 10. Trends in annual mean abundance (95% CV) of Harbour Porpoises found during bi-monthyl aerial seabird surveys, 1992-2010 (no data prior to 1992); redrawn from Arts 2010.

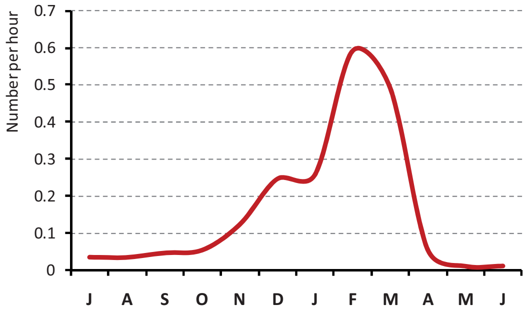


Figure 11. Seasonal pattern in numbers of Harbour Porpoises per hour of observation during seawatching (n/h), mainland coast observatories only (Scheveningen – Huisduinen, 1990-2010; from Camphuysen 2011).

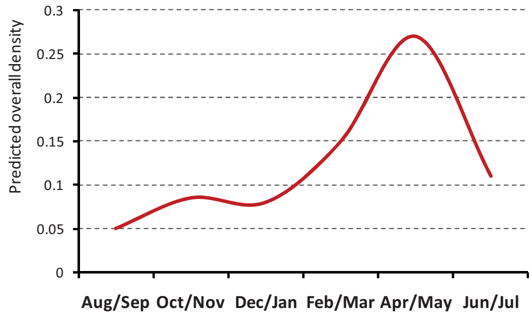


Figure 12. Seasonal pattern in abundance Harbour Porpoises during seabird surveys, 1990-2010; redrawn from Arts 2010).

(Feb/Mar) and a seasonal peak in abundance in late spring (Apr/May; Arts 2010; **Fig. 12**), two months later than during the nearshore observations in recent years. In the adjacent waters of Belgium, combined data derived from aerial surveys, passive acoustic monitoring and strandings revealed a clear seasonal pattern, with porpoises being typically abundant in late winter and early spring, while lower numbers tended to stay in more offshore and northerly waters from late spring to autumn (Haelters *et al.* 2010).

The precise number using coastal waters is difficult to census because of their small size and often 'shy' and elusive nature, which makes them hard to observe. Seawatching data, by default, are useless to try and assess population size, but are effective to monitor population trends and seasonal patterns. The seabird surveys reported by Arts (2010) were operated in weather conditions that are not necessarily good enough to perform reliable counts of Harbour Porpoises and also, the aircraft was operated at too great height to be fully confident about reported densities (Baptist 1987, Baptist *et al.* 1988, Baptist & Wolf 1991, Witte *et al.* 1998).

More advanced field techniques following standard line transect distance sampling methodology, different aircraft, lower altitude of flight and novel analysis techniques were used in the most recent years, as a result of which abundance estimates became more robust. The line-transect techniques used in the SCANS aerial surveys, especially designed to detect Harbour Porpoises (Hammond *et al.* 2002, SCANS II 2008), have now been adopted by most countries around the North Sea. These dedicated aerial surveys, especially designed to survey Harbour Porpoises, were conducted Feb-Apr 2009, on track-lines providing a representative coverage of half (50%) the Dutch EEZ (C & D, **Fig. 13**; Scheidat & Verdaat 2009). The resulting overall density was 1.12 animals per km². This corresponds to a spring estimate of Harbour Porpoise abundance for this study area of 36,825 animals (95% C.I. 19,090 – 68,130; 0.33 C.V.).

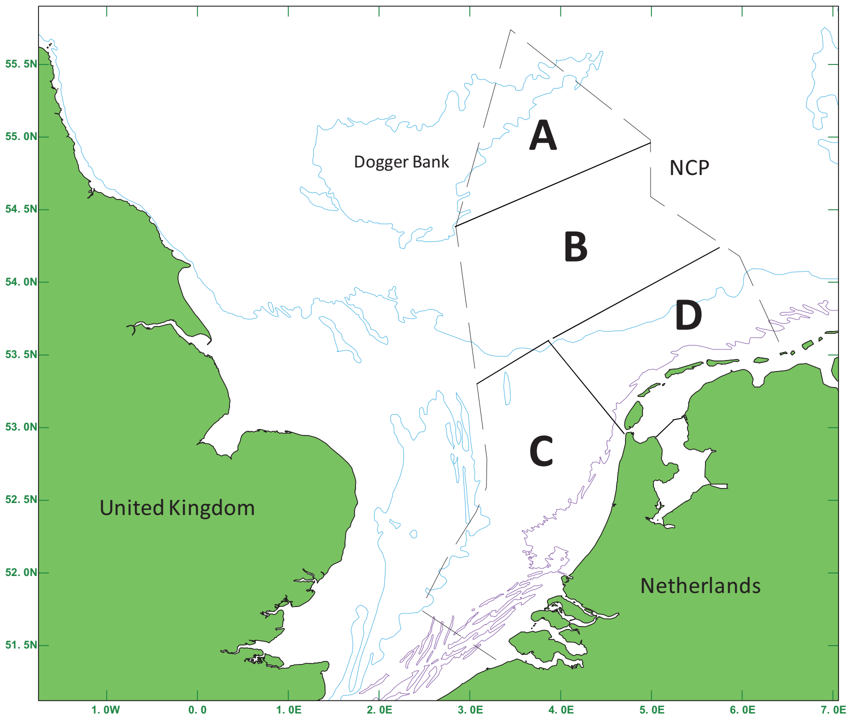


Figure 13. Dutch sector of the North Sea and subregions used in aerial surveys in 2009 and 2010 (Scheidat & Verdaat 2009)

Dedicated aerial surveys were again conducted in Mar 2010, but now on track lines providing a coverage of ≈80% of the Dutch sector (B, C & D, **Fig. 13**; Scheidat *et al.* 2011). The density, 1.33 animals per km², corresponded to a spring estimate of 66,256 animals (95% C.I. 34,245 – 134,735; 0.35 C.V.) Harbour Porpoises. Only subregions C and D have been surveyed in both years. Within C-D only (see **Fig. 13**), or within approximately half of the Dutch sector, during the time of year when near-shore sightings are normally peaking, between 37,000 and 56,000 Harbour Porpoises occurred[3]:

Feb-Apr	**2009**	**37,000**	**(19,000-68,000)**	**Subregion D&C**
Mar	**2010**	**56,000**	**(24,000-120,000)**	**Subregion D&C**

In the North Sea, in 1994, total abundance was estimated at approximately 268,500 animals (230,000-313,000) (SCANS I; Hammond *et al.* 2002). An estimate for 2005 for approximately the same area (slightly smaller) was 231,000 (201,000-266,000) (SCANS II 2008). This would suggest that in spring 2009 and 2010, the numbers found *within half the Dutch sector* (in sectors D & C only) represented **15-23% of the North Sea population** (26% in 2010 in areas B-C-D), or 25-37% of the annimals currently thought to occur within Management Unit 9 (MU9). An earlier survey in May produced a considerably more modest but still substantial late spring/early summer estimate of 6300 (95% C.I. 1300 – 15,000) porpoises in *c.* half the Dutch sector (Scheidat 2008). Note that estimates for the entire Dutch sector are currently unavailable.

Even the most modern, state of the art, and dedicated aerial surveys can underestimate the numbers of porpoises present in nearshore (turbid) waters or under particular cloud cover, possibly as a result of problems with the detectability (Scheidat *et al.* 2011). Yet, these estimates are without doubt the best ever produced for the Dutch sector of the North Sea.

4.6. Strandings, cause of death, age composition and sex ratio

Stranded cetaceans have long intrigued naturalists (Van Deinse 1931, Sliggers & Wertheim 1992, Addink & Smeenk 1999). Regardless of cause, strandings represent a sample of the living community, otherwise not always easily monitored, although their fidelity has rarely been quantified. Using stranding and sighting records compiled from archived datasets representing most ocean basins of the world, Pyenson (2011) demonstrated that the cetacean stranding record faithfully reflects patterns of richness and relative abundance in living communities.

The frequency of strandings of Harbour Porpoises in The Netherlands increased markedly in the late 20th century (Naturalis online database www.walvisstrandingen.nl & NZG Marine Mammal Database). Between 1970 and 1979, on average 17.3 ± 6.2 Harbour Porpoises were reported per annum. Strandings rates gradually increased in the two decades following: 26.5 ± 7.2 in the 1980s, 43.9 ± 18.8 in the 1990s. After a slight drop in strandings in 2000 (69 reported cases), the barrier of over 100 stranded porpoises was broken in 2001, 204 were found in 2004 and numbers stabilised between 400 and 500 animals per annum (max 541 in 2006, mean 2005-2010 413.0 ± 95.9) since then (**Fig. 14**). It is important to refer to *reported* strandings, because, despite continuous efforts, and for various reasons, not all animals that have washed ashore "make it" to the formal strandings lists.

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[3] The figure of 56,000 animals in half the Dutch sector of the North Sea (*c.* 33,000km²) has impressed many reviewers of this document. Note that 56,000 (only 1.7 km^{-2}) is the equivalent of the number of human inhabitants of fairly small Dutch communities such as Hoogeveen (Drenthe), Heerhugowaard (Noord-Holland) or Terneuzen (Zeeland), where populations of humans reach on average 225x higher densities!

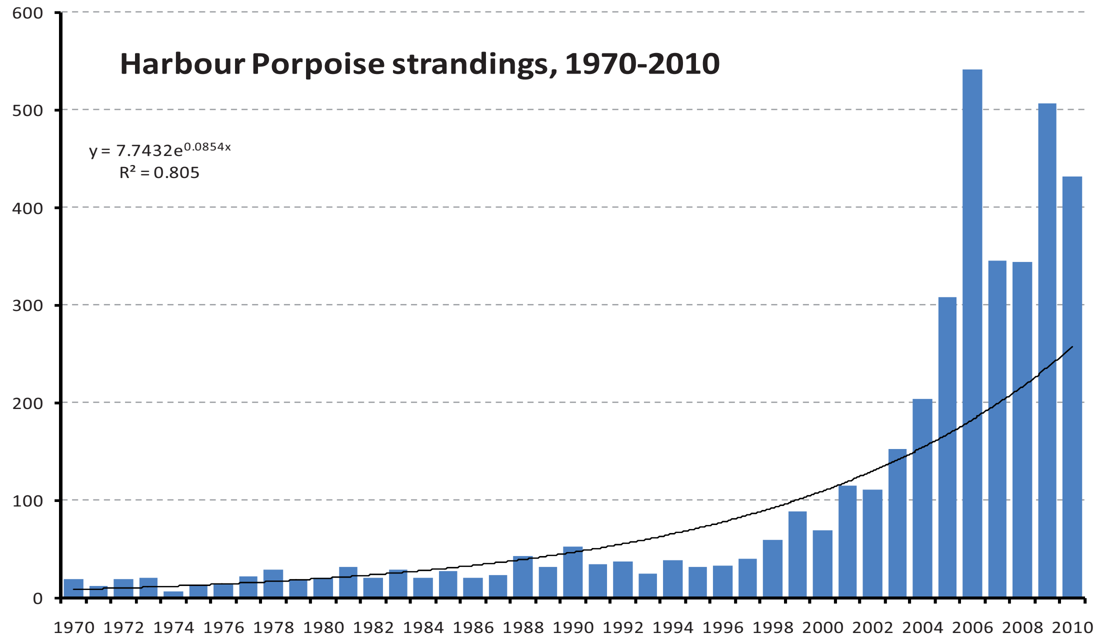


Figure 14. Increase in reported strandings of Harbour Porpoises in the Netherlands, 1970-2010 (n= 4005 reported cases; Naturalis & NZG Marine Mammal Database).

Table 2. Reported strandings of Harbour Porpoises in the Netherlands, 1990-2010 (n= 3567; five strandings were recorded of which the month of recovery is unknown), Naturalis & NZG Marine Mammal Database).

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Totals
1990	2	3	6	5	3	3	2	2	4	4	7	12	53
1991	6		1	3	6	2	4	2	1	4	2	3	34
1992	3	5	2	3	1	1	6	2		3	3	4	33
1993	1	2	5	1	2	4	2	2	1	1	2	2	25
1994	5	4	7	5	3	3	6	1		1	1	2	38
1995	2	1	2	3	4	5	1	2	1	2	7	1	31
1996		3	3	1	5	3	6	2	3	1	2	4	33
1997	1	7	11	5	2	3			5	1	1	4	40
1998	4	3	6	1	4	2	14	7	3	9	4	2	59
1999	11	11	9	13	7	3	9	4		3	8	10	88
2000	5	12	10	3	6	9	12	3	2	1	1	5	69
2001	5	5	7	12	13	12	7	9	16	7	11	11	115
2002	7	13	11	11	4	9	12	14	10	8	11	1	111
2003	17	13	22	7	9	10	10	18	14	8	8	16	152
2004	15	12	14	22	24	14	18	23	15	15	16	16	204
2005	27	20	27	37	27	21	28	54	15	11	18	23	308
2006	20	32	94	67	54	48	26	71	37	33	32	27	541
2007	25	30	54	33	26	16	42	46	32	15	19	7	345
2008	8	19	31	13	13	27	26	58	22	55	35	37	344
2009	34	60	48	28	29	45	58	49	54	37	26	39	507
2010	37	36	52	38	28	31	47	66	36	24	23	14	432
Totals	235	291	422	311	270	271	336	435	271	243	237	240	3562

Area	Hab	km	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Zeeuws Vlaanderen	S	14	0.07	0.07	0	0	0	0	0	0	0	0.07	0.14	0.14	0.14	0.14	0.07	0.21	0.43	0.29	0.14	0.29	0.43
Walcheren	S	37	0.03	0	0	0.03	0.03	0.08	0.03	0.03	0.11	0.14	0.16	0.32	0.38	0.46	0.51	0.95	1.38	1.16	1.32	0.62	0.81
Schouwen	S	24	0.17	0.04	0.04	0	0	0	0.04	0.21	0.17	0.17	0.04	0.21	0.38	0.33	0.42	0.75	0.75	0.75	0.33	1.08	0.67
Goeree	S	16	0	0	0	0	0	0	0.13	0	0	0.13	0.25	0.25	0.25	0.31	0.13	0.44	0.94	0.81	0.56	0.56	0.69
Voorne-Maasvlakte	S	25	0.04	0	0	0.04	0.04	0.04	0	0	0.04	0.08	0.08	0	0.04	0.16	0.24	0.32	0.48	0.36	0.28	0.24	0.16
Zuid-Holland	S	36	0.08	0.06	0.08	0.06	0.03	0.14	0.19	0.14	0.19	0.31	0.14	0.19	0.19	0.19	0.39	1.28	1.69	0.64	0.75	0.78	1.06
Noord-Holland Z	S	26	0.04	0.04	0.08	0.04	0.08	0.04	0.08	0	0.08	0.23	0.23	0.38	0.23	0.31	0.81	1.23	1.42	0.85	1	1.04	1.42
Noord-Holland M	S	29	0.07	0.07	0.1	0.14	0.24	0.03	0.07	0.21	0.52	0.1	0.24	0.45	0.31	0.31	0.34	0.59	0.9	0.48	0.55	1.31	0.97
Noord-Holland N	S	31	0.1	0.06	0.1	0.06	0.13	0.06	0.19	0.1	0.32	0.39	0.19	0.29	0.13	0.29	0.65	0.77	0.97	0.74	0.84	1.58	1.13
Texel strand	S	32	0.25	0.19	0.38	0	0.09	0.13	0.09	0.19	0.22	0.25	0.28	0.47	0.31	0.84	0.91	0.72	1.53	1.03	1.66	2.03	1.16
Vlieland strand	S	29	0.17	0.07	0.07	0.14	0.14	0	0.07	0	0.14	0.17	0.24	0.55	0.62	0.76	0.79	0.97	1.62	0.97	0.93	3.17	1.93
Terschelling strand	S	27	0.22	0.11	0.04	0.19	0.19	0.07	0.04	0.04	0	0.19	0.04	0.22	0.19	0.04	0.19	0.3	1.67	1.15	0.3	1.59	1.07
Ameland strand	S	27	0.11	0.15	0.15	0.11	0.11	0.19	0	0	0.04	0.56	0.19	0	0.11	0.41	0.81	0.85	1.93	1.15	1.07	1.63	1.41
Schiermonnikoog strand	S	19	0.11	0.05	0.11	0	0.11	0.21	0	0.05	0	0	0	0.21	0.05	0.05	0.16	0.11	0.47	0.47	0.58	0.63	0.84
Rottum	S	9	0	0	0	0.11	0.11	0	0.11	0	0.11	0	0.11	0	0	0.22	0	0.44	0.11	0.44	0.56	0.44	0.22
Texel wad	W	25	0.04	0.08	0.04	0	0	0	0.04	0.04	0.08	0.2	0.08	0.04	0.12	0.08	0.16	0.24	0.44	0.16	0.04	0.16	0.2
Vlieland wad	W	12	0	0	0	0	0	0	0	0	0	0	0	0.25	0.08	0	0	0.08	0.17	0.08	0.42	0.42	0.58
Griend	W	6.3	0	0	0	0	0	0	0	0.16	0	0	0	0.16	0.32	0.16	0.32	0.16	0.48	0	0.16	0	0
Terschelling wad	W	34	0.15	0.03	0	0	0.03	0	0.03	0.15	0	0	0	0.03	0	0	0	0.03	0.12	0	0.09	0.12	0.15
Ameland wad	W	22	0.05	0	0	0	0.05	0	0.05	0	0	0.05	0	0	0.27	0.23	0	0.09	0.18	0.09	0.14	0	0.09
Schiermonnikoog wad	W	20	0.05	0	0	0	0.05	0	0	0	0	0	0	0	0	0.1	0	0.1	0	0.05	0.05	0	0.1
Balgzand	W	23	0	0	0	0	0	0	0	0	0	0	0	0.04	0.04	0.04	0.04	0	0.13	0.04	0.09	0.04	0.04
Afsluitdijk	W	31	0	0.06	0	0.03	0	0	0	0.03	0	0	0	0	0	0	0	0	0.03	0.1	0	0	0.06
Friese kust W	W	38	0.08	0.03	0	0	0	0.03	0	0.03	0	0	0	0	0	0.03	0.03	0.05	0.24	0.05	0	0.03	0.03
Friese kust O	W	34	0.03	0.03	0	0	0	0.03	0	0	0	0.03	0	0	0	0	0	0.06	0.21	0.09	0.06	0.06	0.03
Groninge kust W	W	42	0.02	0	0	0	0	0	0	0.02	0	0	0	0.05	0	0	0.02	0.1	0.1	0.02	0.02	0.05	0
Groningse kust O	W	12.1	0	0.08	0	0	0.08	0	0	0	0.08	0	0	0.17	0	0	0.17	0.25	1.16	0.25	0.08	0.25	0.17
Westerschelde interior	I	31	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Westerschelde exterior	S	102	0	0	0	0	0	0	0.01	0	0	0	0.02	0	0.04	0	0.02	0	0.07	0.13	0.06	0.01	0.08
Veerse Meer	I	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0	0	0	0.03	0.08
Oosterschelde	I	149	0	0	0	0	0	0.01	0.01	0.01	0	0.02	0.02	0	0.01	0.05	0.03	0.03	0.09	0.04	0.1	0.08	0.05
Grevelingenmeer	I	77	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0
North Sea coastline		381	0.10	0.07	0.09	0.06	0.09	0.07	0.07	0.07	0.15	0.21	0.16	0.27	0.24	0.35	0.49	0.73	1.20	0.80	0.80	1.23	1.01
Wadden Sea district		299	0.04	0.03	0	0	0.01	0.01	0.01	0.03	0.01	0.02	0.01	0.04	0.04	0.04	0.04	0.08	0.21	0.07	0.07	0.07	0.09
Estuarine areas		399	0	0	0	0	0	0	0.01	0.01	0	0.01	0.01	0	0.01	0.02	0.02	0.02	0.05	0.05	0.05	0.04	0.05
Maximum density			0.25	0.19	0.38	0.19	0.24	0.21	0.19	0.21	0.52	0.56	0.28	0.55	0.62	0.84	0.91	1.28	1.93	1.16	1.66	3.17	1.93

Legend			Habitat
	0.01	0.10	
	0.11	0.25	S = beach locations
	0.26	0.50	W = Waddensea locations
	0.51	1.00	I = "inland" locations (deep in tidal gullies and inlets, away from the North Sea coast)
	1.01	2.50	
	2.51	5.00	km= length of stretch of coast (km)

Figure 15. Spatial pattern in Harbour Porpoise strandings 1990-2010 (n per km coast length per annum; n= 3565 stranded Harbour Porpoises), from reported strandings in www.walvisstrandingen.nl and NZG/Marine Mammal Database. Areas include North Sea coastline (top rows; Zeeuwsch Vlaanderen - Rottum) stretches of coast within the Wadden Sea area (central rows; Texel wad – Groningse kust O), and more or less "inland sites" in estuaries (Westerschelde-Grevelingenmeer). Colour shadings indicate lower (pale blue) and higher (orange and red) densities (see legend).

Harbour Porpoises are found everywhere along the Dutch North Sea coastline in variable densities, in lower densities within the Wadden Sea area and deep in inner waters of the Delta area (Zeeland and Zuid-Holland; **Fig. 15**). Even despite local reporting problems, over the years (1970-2010), the exponential increase in strandings rate has been highly significant ($y = 7.74e^{0.085}$, $r^2 = 0.81$; **Fig. 14**). In order to investigate local differences (or inconsistencies) in reported strandings frequencies, the strandings data were summarised in 19 subregions and annual densities were calculated over 2001-2010 (**Fig. 16**). Several 'problem areas' can be highlighted with regard to the tendency to report strandings, but it seems obvious that overall densities along the exposed North Sea shoreline peak at Texel and Vlieland and are gradually lower further to the east (Terschelling – Rottum) and further south (Noord-Holland –Zeeland). Reported densities on Terschelling are clearly inconsistent with neighbouring islands and most probably some 25% too low. However, there is evidence that reported densities at Schiermonnikoog and Rottum (Rottumeroog and Rottumerplaat) are also too low, despite the fact that these data fit a bell-shape pattern of the graph as a whole (Smeenk 2003, Camphuysen *et al.* 2008).

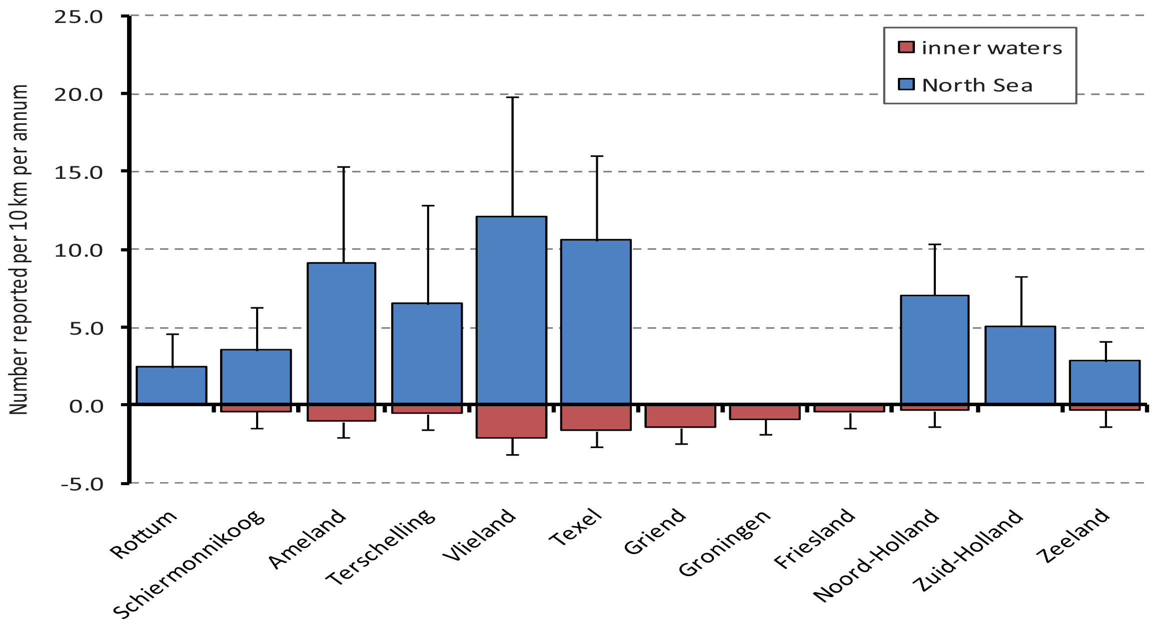


Figure 16. Densities (mean ± SD per 10 km coastline) of reported strandings of Harbour Porpoises in nine North Sea coast subregions (exposed shoreline; blue, positive values), in nine Wadden Sea area subregions (exposed shoreline; red, as negative values), and in inner waters of the Delta area (red, negative; Zeeland), The Netherlands, 2001-2010 (n= 3059 reported cases, Naturalis & NZG Marine Mammal Database).

Table 3. Monthly numbers (n) and relative abundance (%) in Harbour Porpoise strandings in ten-year periods, 1970-2010, from reported strandings in www.walvisstrandingen.nl and NZG/Marine Mammal Database (see **Fig. 17** for a graphical presentation of relative abundance).

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Totals
1970-1980	14	10	18	19	8	10	16	14	13	26	19	25	192
%%	7.3	5.2	9.4	9.9	4.2	5.2	8.3	7.3	6.8	13.5	9.9	13.0	
1981-1990	27	24	43	16	23	19	23	18	20	16	31	36	296
%%	9.1	8.1	14.5	5.4	7.8	6.4	7.8	6.1	6.8	5.4	10.5	12.2	
1991-2000	38	48	56	38	40	35	60	25	16	26	31	37	450
%%	8.4	10.7	12.4	8.4	8.9	7.8	13.3	5.6	3.6	5.8	6.9	8.2	
2001-2010	195	240	360	268	227	233	274	408	251	213	199	191	3059
%%	6.4	7.8	11.8	8.8	7.4	7.6	9.0	13.3	8.2	7.0	6.5	6.2	

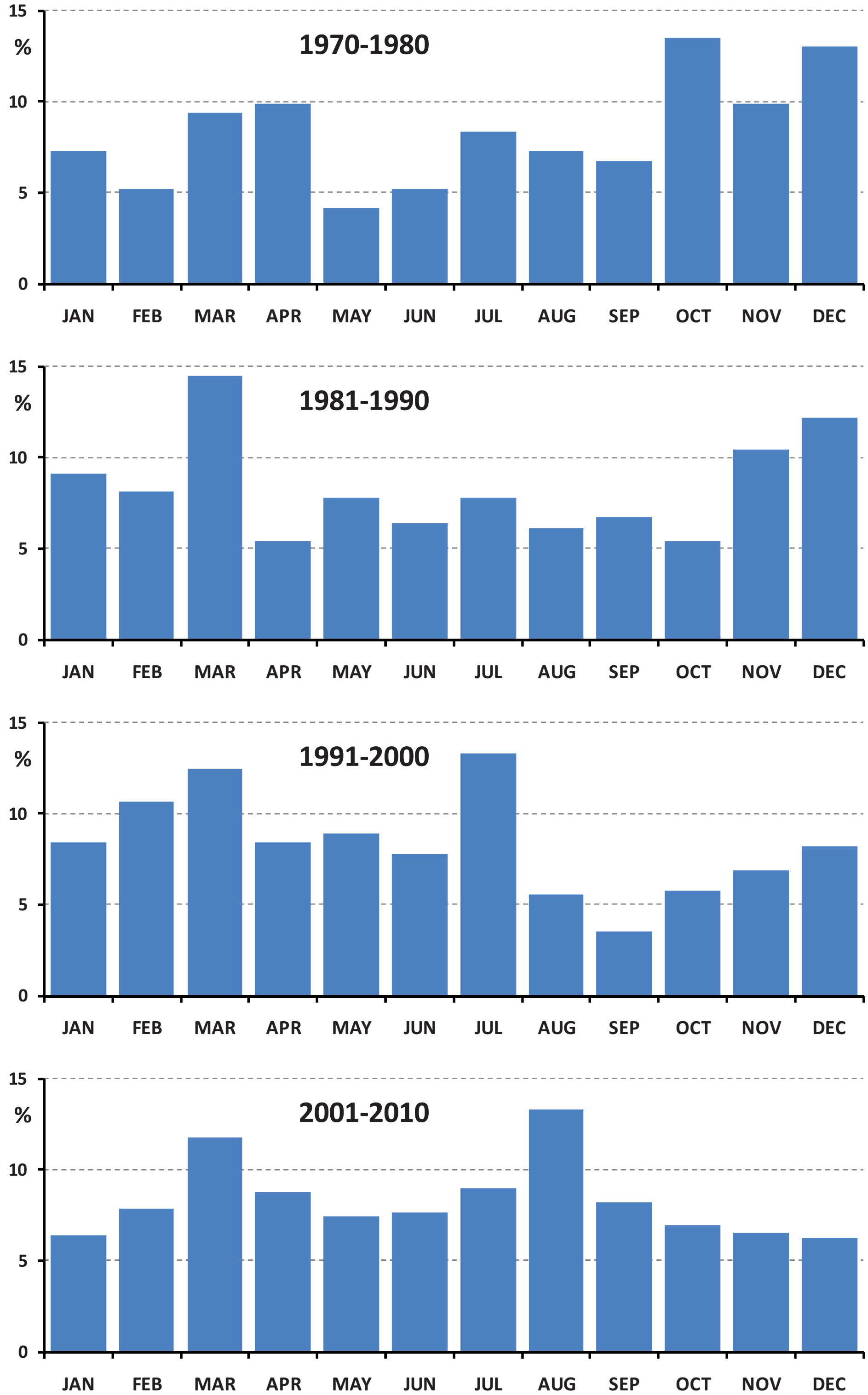


Figure 17. Seasonal pattern in Harbour Porpoise strandings 1970-2010 (% of total number found per decade), from reported strandings in www.walvisstrandingen.nl and NZG/Marine Mammal Database. See **Table 3** for tabulated data and decadal sample size.

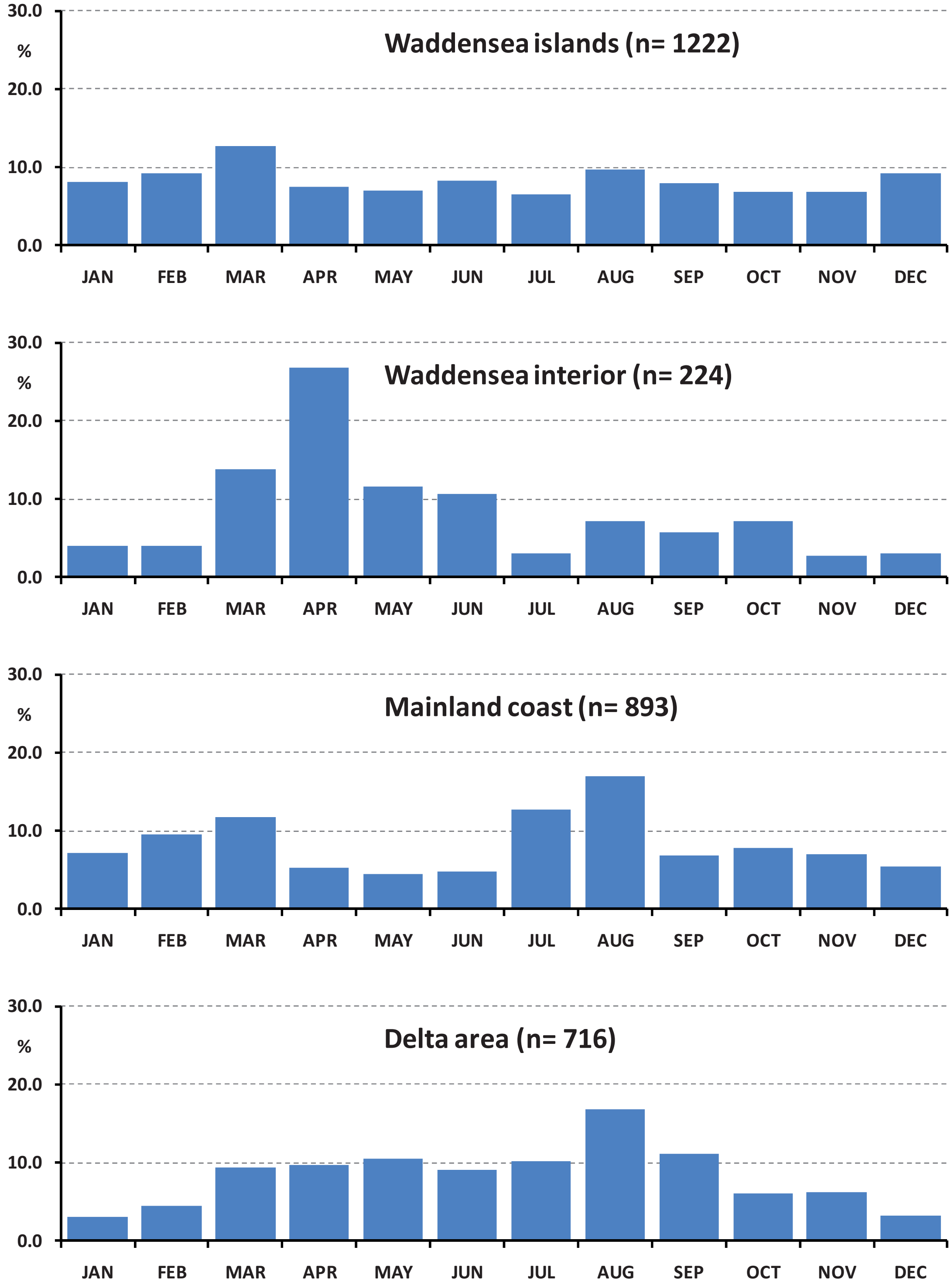


Figure 18. Seasonal pattern in Harbour Porpoise strandings 2001-2010 (monthly % of total number found) in four sectors of the Dutch coast, from reported strandings in www.walvisstrandingen.nl and NZG/Marine Mammal Database.

Harbour Porpoise strandings occur year-round along the Dutch coast, but in the 1970s, strandings frequencies peaked in early winter, with a second peak in Mar-Apr (**Fig. 17**). In the 1980s, most strandings occurred in the true winter months (Nov-Mar); with rather lower (but fairly constant) frequencies in late spring, summer and early autumn (Apr-Oct). In the 1990s, strandings occurred fairly constant between December and mid-summer (Dec-Jul). A peak in July for that period was caused by rather frequent strandings in Jul 1998 and 1999. Finally, in the most recent years, a bi-modal pattern was found with year-round strandings, but with discrete peaks in March and in August.

Contrary to many other countries, reporting rates in The Netherlands are not season-dependent: Dutch beaches are accessible shorelines that are generally well surveyed year-round, with the exception of some uninhabited islands in the Wadden Sea area that have wardens only in summer. This seasonal pattern is therefore almost certainly a realistic representation of the overall seasonality in strandings. When looking at monthly strandings frequencies over the last 10 years for four different areas of the Dutch coast (North Sea coast of the Wadden Sea islands, interior Wadden Sea, mainland coast from Hoek van Holland to Huisduinen, and the Delta area), rather different seasonal patterns were found (**Fig. 18**). While the North Sea coast of the Wadden Sea islands and the mainland do show the overall bimodal pattern (not quite surprising, given "their" contribution of 69% of all recorded strandings with month of stranding and finding location known; n= 3055), Harbour Porpoise strandings *within* the Wadden Sea peak in late spring and early summer (Mar-Jun). Within the Delta area, strandings were clearly most frequent in summer (Mar-Sep), with a peak in August.

Over the past 10 years, more than 3000 stranded Harbour Porpoises have been reported. The increase has been most pronounced in juvenile or immature animals (TL 90-145cm), but in recent years, strandings of adults (TL>145) and possible neonates (TL<90; length criterion only) are increasing more or less simultaneously (**Fig. 19**).

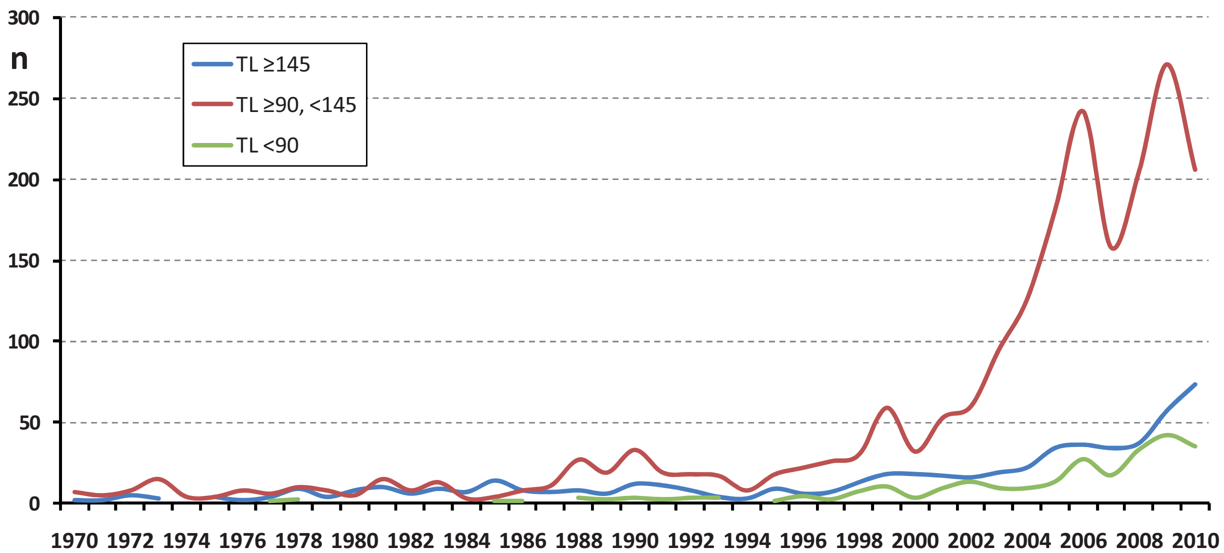


Figure 19. Relative abundance (n) of mature (TL≥145), immature (90-145) and possible neonates (<90; length criterion only) in Harbour Porpoises reported stranded in The Netherlands, 1970-2010 (n= 2639 reported cases with length information; Naturalis & NZG Marine Mammal Database). TL measured or estimated.

Overseeing the last 10 years of Harbour Porpoise strandings (**Fig. 20**), animals that could be identified as juveniles or immatures (total length 90-145cm) occurred around the year and with a bi-modal pattern in relative abundance not unlike the overall seasonal pattern for that period (see **Fig. 17**, note that 74% of all 2149 measured Harbour Porpoises for this decade were of this size class) Mature animals (≥145 cm total length) were most frequently found in summer (Jun-Aug). Whereas presumed neonates (TL <90cm, or TL <80cm) peaked in the June-July period (**Fig. 20**).

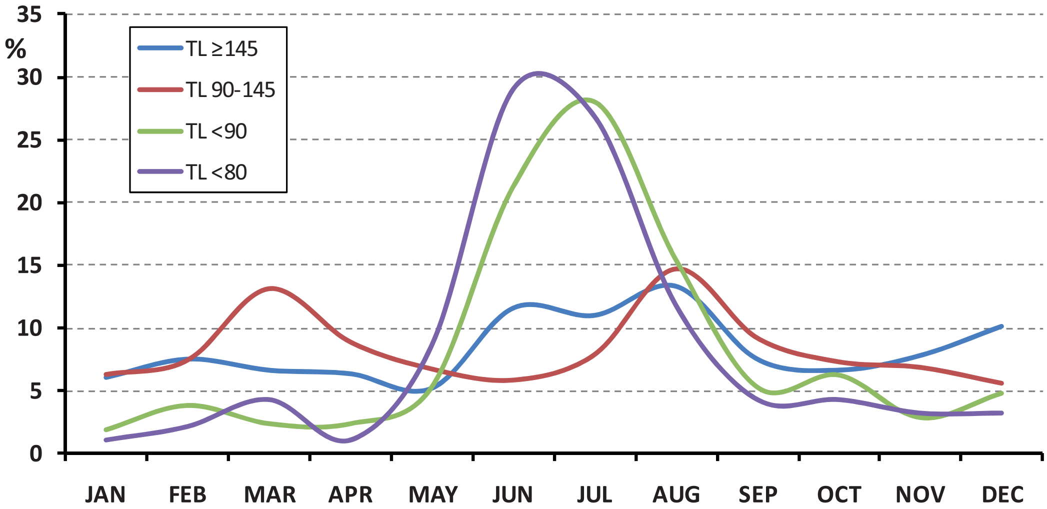


Figure 20. Seasonality in patterns of relative abundance (%) of mature (TL ≥145), immature (TL 90-145) and possible neonates (TL <90 or <80; length criterion only)in Harbour Porpoises reported stranded in The Netherlands, 1970-2010 (n= 2639 reported cases with length information; Naturalis & NZG Marine Mammal Database). TL measured or estimated.

The sexratio was male biased (64% males) in juveniles (TL 90-145cm; X^2_1= 44.0, *P*< 0.001), while the largest category of animals (TL ≥145) was female biased (41% males; X^2_1= 3.8, *P*= 0.05). Olafsdóttir *et al.* (2003) recorded that females grew faster than males and found asymptotic lengths of 150cm for males and 160cm for females. They also found that sexual maturity was reached at 1.9-2.9 years of age (TL 135) in males and at 2.1-4.4 years of age (TL 138-147) in females. Hence, a female bias could be expected in a category of animals with a TL ≥145, while the higher end of the so-called juveniles or immatures (TL 90-145) should include a fair number of sexually mature males and probably even females. The female bias disappeared in animals of TL ≥140 (46% males, X^2_1= 1.0, n.s.). In the smallest categories of measured Harbour Porpoises found stranded, a male bias was found (60% males in TL <80, n= 48; 58% males in TL <90, n= 129), but the difference from an even sex ratio is not statistically significant in either group (X^2_1= 1.1-1.7, n.s.).

From an update of two independent datasets: nearshore sightings (NZG/CvZ and www.trektellen.nl, **Fig. 9**) and the Dutch strandings data (NZG/Marine Mammal database and www.walvisstrandingen. nl, **Fig. 14)**, a significant correlation could be demonstrated: higher numbers of Harbour Porpoises washing ashore when nearshore sightings were frequent (**Fig. 21**). This is a somewhat unexpected outcome, given the distinct seasonality in sightings frequencies which is rather different from the seasonality in strandings. An analysis of data describing offshore abundance versus nearshore sightings and strandings would be needed to shed more light on the strong correlation between strandings and nearshore sightings data.

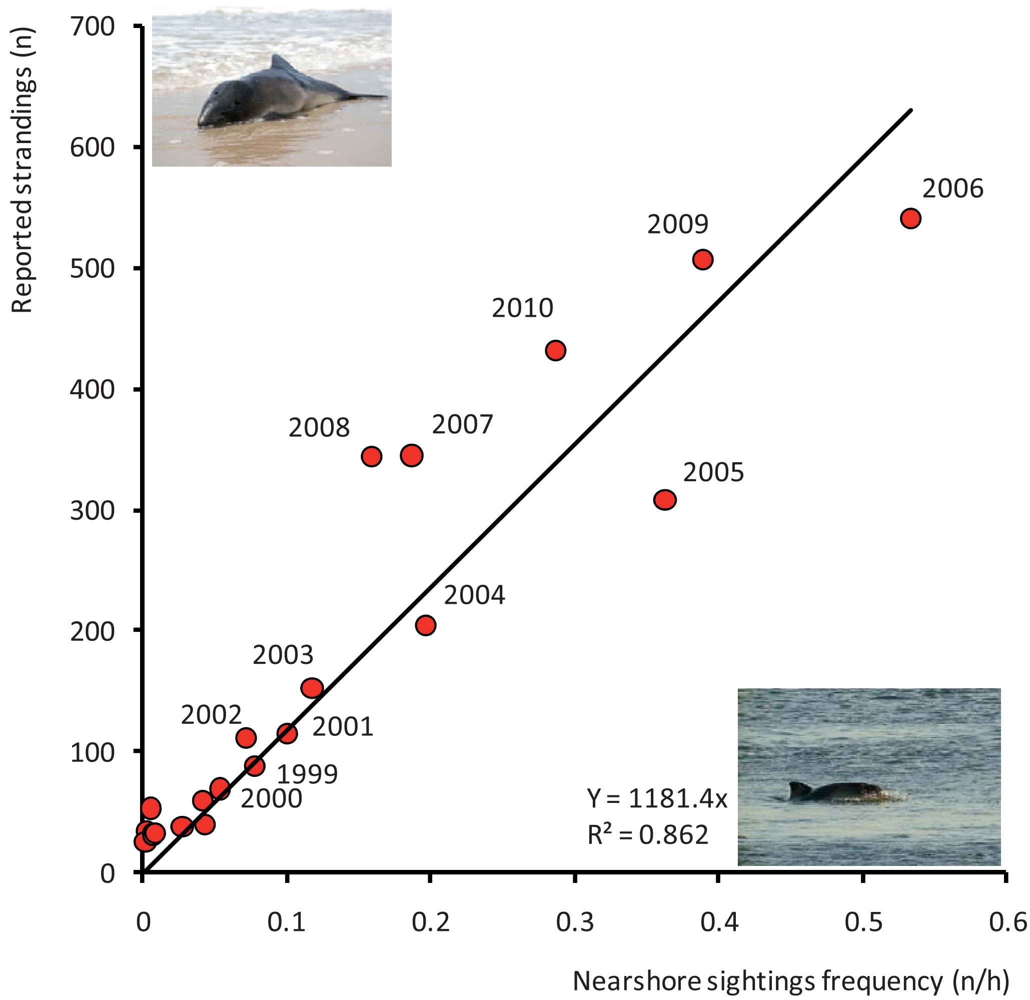


Figure 21. Harbour Porpoises found dead in The Netherlands (n); www.walvisstrandingen.nl and NZG/Marine Mammal Database) in relation to effort-corrected sightings frequency (n/h; www.trektellen.nl and NZG/CvZ) in Dutch coastal waters during seawatching (Scheveningen-Huisduinen), 1990-2010. The relative abundance of porpoises per annum was based on sightings of 9891 Harbour Porpoises during 73,332 hours of systematic observation in 21 years.

Reported causes of death (from necropsies of stranded individuals) include definite or probable bycatches (evidence for drowning, net marks, other characteristics; Kuiken & Hartmann 1992, 1993, Kuiken 1994ab), severe emaciation, haemorrhagic enteritis, pneumonia, interstitial pulmonary emphysema and oedema, chronic ulcerative stomatitis, and other factors (Van Nie 1989, Addink *et al.* 1995a, García Hartmann *et al.* 1994, 1996, Smeenk *et al.* 2004, Leopold & Camphuysen 2006, Jauniaux *et al.* 2007, 2008, Osinga *et al.* 2008, Wiersma & Gröne 2009, Gröne & Begeman 2010). Some very young animals died as stillborns or shortly after being born. Each of these causes of death has been reported in a number of studies. The research protocols may have been similar, but the interpretation of necropsy results has been different in several of these studies, so that comparisons could not easily be made. We have omitted all animals in which a diagnosis could not be made from the samples, and the frequency of occurrence (%) for each of the factors contributing to death may have changed in comparison with the original publication as a result. It should be noted that a factor like hearing damage has not been properly investigated (stranded animals have with few exceptions been frozen prior to examination; very few specimens have been examined to date) in any of these studies, so that underwater noise as a factor contributing to any of these strandings could not be evaluated. In the next chapter we will observe that in fact many necropsies in The Netherlands have not been completed, despite the sampling of tissues and other parts (virology, parasitology, pollutants). Harbour Porpoises from the southern North Sea are known to display high levels of Zn and Hg in their tissues linked to their nutritional status (emaciation; Das *et al.* 2006), but more recent necropsies have not contributed further data on these possible links.

In some periods, some areas, some years, a particular trauma is reported, including mutilated animals (**Fig. 22**), sometimes so severely damaged that the cause of death cannot even be evaluated during a necropsy (Gröne & Begeman 2010). In one particular strandings-flux with many mutilated animals involved in February 2009 (Camphuysen & Oosterbaan 2009), 81% of the animals studied during necropsies were possibly or almost certainly bycatches (Wiersma & Gröne 2009). In many of the reported animals, blubber layers were considerable, suggesting that possibly healthy animals are affected[4]. While many animals have been mutilated by (post-mortal) knife-cuttings, some may have been damaged mechanically (ship's propellers or otherwise). Additional research is required to reach firmer conclusions.

Figure 22. Examples of mutilated carcasses of Harbour Porpoise found on Dutch beaches in recent years. Main characteristics: fresh corpses, straight cuttings, often with acute angles (criss-cross).

[4] In acute or peracute disease, an animal may be diseased and still have abundant blubber; blubber thickness in itself is not a conclusive characteristic of a healthy animal; Wiersma & Begeman *pers.comm.*

Lockyer & Kinze (2003) analysed and discussed Danish material which was derived from strandings and bycatches and concluded that many factors can introduce bias into some analyses of the database records. Historical catches (in Danish waters) were clearly biased to mature animals (especially males), and they were also limited in season (the catching season). The Danish strandings data emphasised stillborns, neonates, calves, and the juvenile component of the population, while bycatches were thought to emphasise the male segment and sub-adult animals. In general it appeared that bycatches recovered animals of broadly similar size and excluded neonates and very young (pre-weaned) calves. While the Danish strandings indicated a consistent ratio with sex at birth, a male predominance existed in bycatch sex ratios (1.2:1.0), indicating that males may be more at risk than females. Note, however, that Olafsdóttir *et al.* (2003) found a *foetal* sex ratio of 1.2 male : 1.0 female in Harbour Porpoises obtained as bycatches in Iceland.

4.7. Reproductive activity in Dutch waters

Neonates were frequently found in historical times when Harbour Porpoises were abundant, they occurred, albeit in low numbers, when porpoises were rather rare in Dutch waters (at least 18 strandings of animals with TL<90, five with TL<80; 1970s-1990s) and are currently increasing in frequency (strandings data; **Fig. 19**). Addink *et al.* (1995b) found a pronounced birth peak in July (Jun-Aug), from stranded animals in Dutch waters in the 1990s, but with some neonates found in May and September. Near-term foetuses were observed in March and April. Some small Harbour Porpoises in this sample (<75cm total length), *i.e.* possibly neonates, were found in March, October and December. A strongly synchronized female reproductive cycle, as reported by Addink *et al.* (1995b), is consistent with similar studies in other areas (Read 1990, Sørensen & Kinze 1994), and appears to be true for males as well (histological examination revealed spermatogenetic activity in male from March). Foetuses or stillborns, neonates and pregnant females have been frequently found among stranded animals in recent years (**Figs. 23-25**).

Figure 23. Left: Harbour Porpoise uturus with outline of foetus visible. Right: 26cm long male foetus visible from opened uturus. Harbour Porpoise female collected 26 Feb 2006, Ouddorp (Zeeland), necropsies 17-22 September 2006 (photos CJ Camphuysen).

From body size, the peak in neonate strandings is currently in June-July (Dutch strandings data 2001-2010; **Fig. 20**). In mid-summer, nearshore sightings are relatively few and far between (**Fig. 11**), perhaps as a result of a movement away from the coast towards deeper areas (**Fig. 12**). Yet, many observers in recent years have reported sightings of young calves in the vicinity of larger (mature) animals in offshore as well as in nearshore waters, but an analysis to evaluate the relative frequency of these sightings is lacking. There is the risk of misidentification of the age of animals during sightings and while Harbour Porpoises are often seen as pairs (or duos), these need not be animals of a different age even if one animal is larger than the other (mature males are smaller than females and developing females grow faster than males; Olafsdóttir *et al.* 2003). The growth of young animals is such that during the next peak in nearshore abundance (late winter and spring), first year animals, which have reached a body length of *c.* 120 cm at that time (Olafsdóttir *et al.* 2003), cannot be reliably separated from older animals during sightings under normal field conditions.

Figure 24. Same foetus as in **Fig. 23** but removed from uturus with umbilical cord and sexual organs (penis, male) visible (photo CJ Camphuysen).

Figure 25. Foetus (TL 70) pulled out of a rotten corpse of a female Harbour Porpoise (TL *c.* 150) found at Terschelling, 17 April 2011 (photos C. Bakker & C. Kuiken).

4.8. Migratory movements, resident stocks

There are few studies of the migratory movements of Harbour Porpoises, anywhere. Modern technology has opened up opportunities that were unavailable previously, so that some insights are now available. Read & Westgate (1997) used satellite tracking to study movements of Harbour Porpoises in Bay of Fundy (Canada) and Gulf of Maine (USA) and found a high degree of individual variation in movement patterns. Despite the small sample size (9 individuals), the authors concluded that seasonal movement patterns of individual Harbour Porpoises were discrete and not temporally coordinated migrations. Molecular studies have indicated that migratory movements of Harbour Porpoises across the North Atlantic occur at best at a very low level (Rosel *et al.* 1999). Genetic variability in the Northeast Atlantic is lower than in the Northwest, indicating a more recent (re-) colonisation for the Northeast Atlantic.

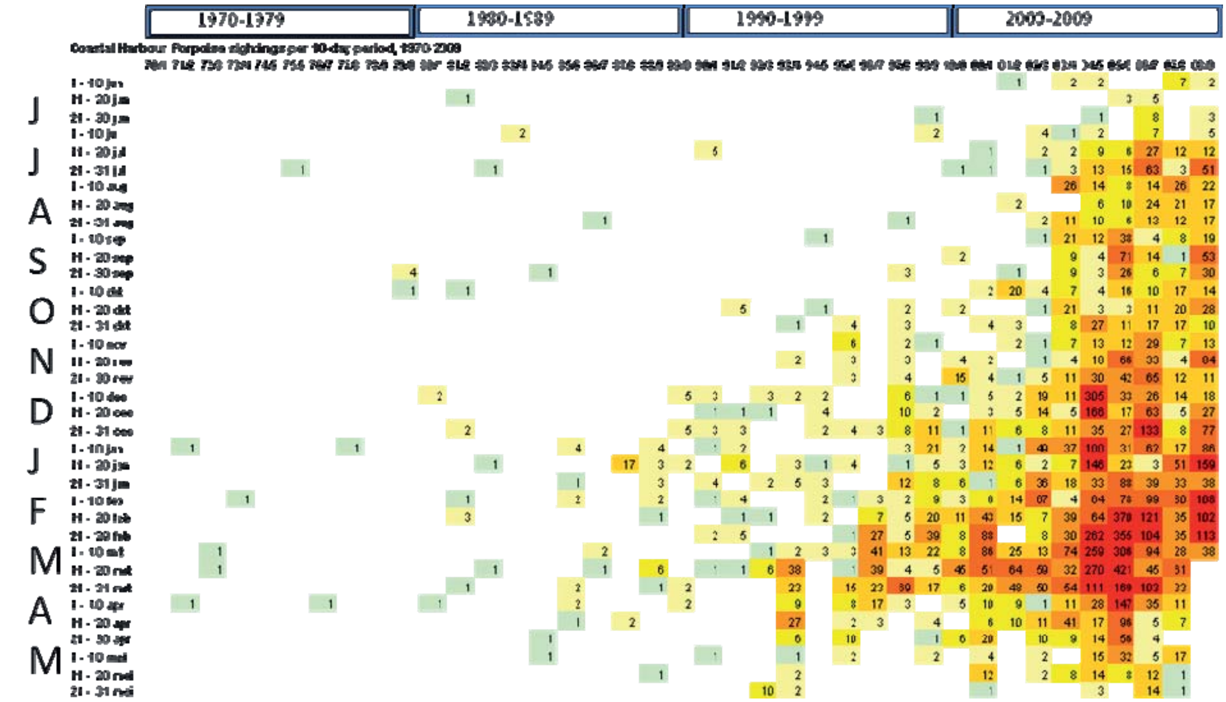


Figure 26. Nearshore sightings of Harbour Porpoises in nearshore waters from multiple sources per 10-day period (1970-March 2009), showing a change from a winter visitor in the 1990s to a nearly year-round local resident in recent years. From seawatching data (year-round coverage in effort since the early 1970s) and accidental sightings; NZG/Marine Mammal database. For seasonality and long-term trends in observation effort, see Camphuysen 2009).

Within the North Sea, few studies on migratory movements have been conducted thus far. From stable isotope analysis of Harbour Porpoises and their prey from the Baltic and the Kattegat/ Skagerrak Seas, it was concluded that porpoises move freely between the Baltic and Skagerrak (Angerbjörn *et al.* 2006). The authors suggest, however, that further studies are needed to evaluate the magnitude of these movements. The first comprehensive study using satellite transmitters in the North Sea was conducted around the turn of the century (Teilmann *et al.* 2004). Between April 1997 and October 2002, 52 Harbour Porpoises were tagged with satellite transmitters in Denmark (21 at

Skagen, 31 in the Kattegat and the inner Danish waters). The porpoises visited areas from the Shetland Islands (UK) in the west to Öland (Sweden) in the east. In winter, the porpoises tagged in inner Danish waters generally utilised the same areas as in the summer, but they tended to move further to the south. One individual porpoise moved from inner Danish waters to the North Sea, where it overwintered along the west coast of northern Jutland. For porpoises tagged near Skagen, the most important summer habitats were northern Kattegat, Skagerrak (except for the deep trench along the coast of Norway), as well as some areas in the central North Sea. In winter a significantly larger area was used extending from northern Kattegat through Skagerrak and into a large part of the eastern part of the central North Sea. Two animals moved to the northern North Sea and into the Atlantic and on both sides of the Shetland Islands. One animal stayed the entire winter in a limited area northwest of the Shetland Islands.

For the Southern North Sea, a strong seasonality in nearshore sightings is indicative for seasonal movements, either from offshore areas towards the coast, or from north to south and vice versa, during which coastal habitats are frequented. Since the Harbour Porpoise returned (somewhere in the course of the 1990s), coastal sightings were restricted to winter/early spring at first, but have gradually changed to include most of the year except mid-summer (**Fig. 26**). A peak in numbers in coastal waters of the southern North Sea is reached in February and March, apparently followed by a northward migration, towards more offshore waters (Haelters & Camphuysen 2009). In the Dutch Delta Area (Zeeland) a small resident population seems to have become established (Camphuysen & Heijboer 2008, Zanderink & Osinga 2010).

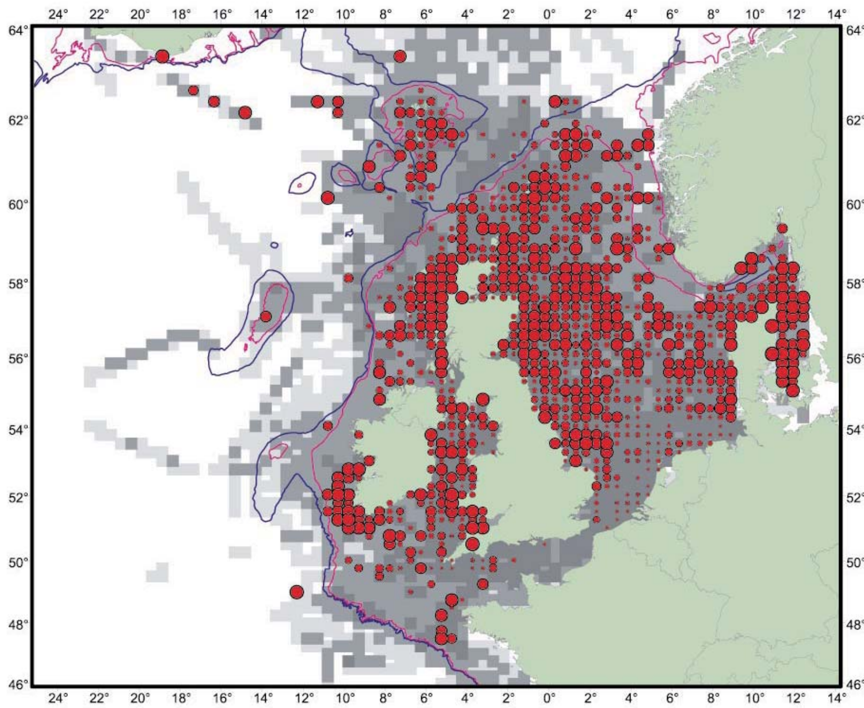
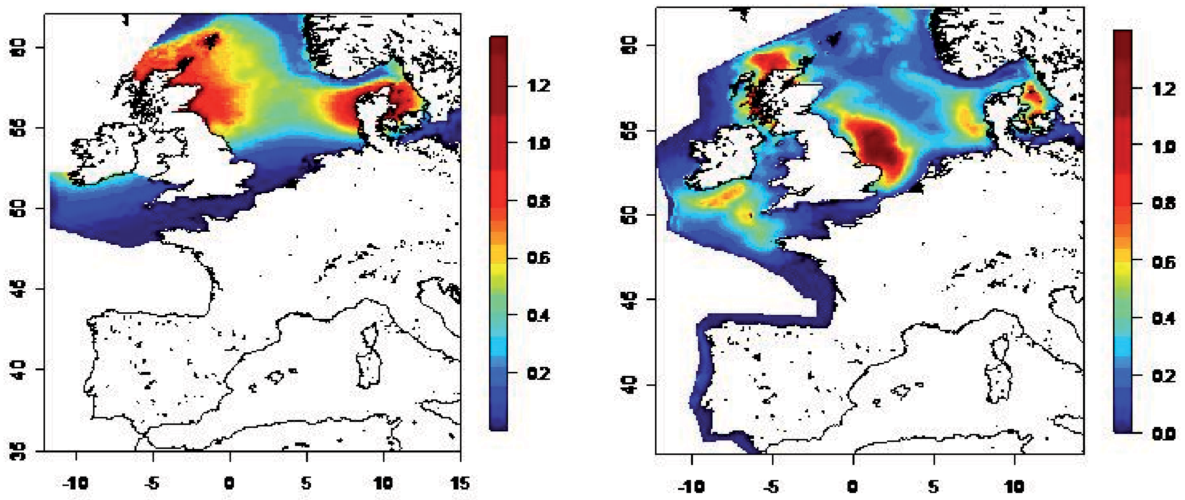


Figure 27. Harbour Porpoise sightings in and around the North Sea, most of which based on surveys in the 1980s and 1990s; multiple sources. From: Reid *et al.* 2003.

4.9. Evidence for sea areas of particular importance

Within the North Sea, synoptic surveys of Harbour Porpoises have been few and far between. Reid *et al.* (2003) plotted sightings rates (animals observed per standard hour of observation) of Harbour Porpoises in the North Sea at large, using a number of different datasets (mostly data collected in the 1980s and 1990s; **Fig. 27**). At the time, Harbour Porpoises were quite rare in the Channel area, scarce in the Southern Bight, and locally common in the Kattegat, Skagerrak, in the NW North Sea, and locally along the west coast of Britain and Ireland. Modelled distribution patterns generated by the two subsequent SCANS surveys, suggested that the mid-summer distribution pattern within the North Sea had changed markedly (**Fig. 28**). An important difference between the two surveys was the reduction in numbers of porpoises in the NW part of the North Sea and a marked increase in abundance off the east coast of England.



1994 **2004**

Figure 28. Areas of higher (yellow and red) and lower (blue) densities of Harbour Porpoises in the North Sea at large, based on synoptic surveys in summer 1994 and 2004. *From:* Hammond *et al.* 2002 and SCANS II 2008.

The seasonal distribution of Harbour Porpoises in the German North Sea was investigated, and the proportion of porpoises potentially affected by the imminent construction of offshore wind farms was estimated (Gilles *et al.* 2009; dedicated aerial surveys conducted year-round between 2002 and 2006 following line transect methodology). These data suggested that porpoises moved to certain distinct areas on a seasonal basis as their biological requirements change. They moved into German waters in early spring, reach high numbers in early summer and move out of the area in autumn. The abundance estimates for the German exclusive economic zone and 12 n mile zone were highest in spring (55,048 animals; 95% CI: 32,395 to 101 671) and summer (49,687 animals; 95% CI: 29,009 to 96,385) and lowest in autumn with 15 394 animals (95% CI: 8906 to 29 470). Important aggregation zones were detected in offshore waters: in spring, two hot spots, Borkum Reef Ground and Sylt Outer Reef (SOR), were identified as key foraging areas. In summer, only Sylt Outer Reef as a hotspot persisted. In autumn, porpoises were more evenly distributed. Most mother-calf pairs were observed during spring and summer in the Sylt Outer Reef, underlining its importance as a foraging area when reproductive costs are high.

In Dutch waters, where numbers of porpoises were subject of marked change over the recent decades, it has thus far not been possible to find any sea areas of particular significance. Equivalents of the German hotpots (Gilles *et al.* 2009) have not been detected, not even in the area bordering the Borkum Reef Ground (M. Scheidat *pers. comm.*). The most recent aerial surveys in spring have indicated that Harbour Porpoises were rather evenly distributed (Scheidat & Verdaat 2009, Scheidat *et al.* 2011). Simple plots of available ship-based survey data show clusters of sightings, usually in response to periods of particularly fine weather (increasing likelihood of detection), in areas where relatively many surveys have been conducted (e.g. around windfarm areas off Egmond), in some deep-water gullies in the Wadden Sea, and along certain repeated line-transects (**Fig. 29**). None of these clusters has shown to be persistent or has been thought to represent an area of ecological significance for porpoises. The seasonality in sightings is only partly understood (Haelters & Camphuysen 2009). The most recent aerial surveys have not provided new insights in this respect (Scheidat & Verdaat 2009; Scheidat *et al.* 2010). Harbour Porpoises are seemingly highly mobile throughout the year, with locally varying densities throughout the Southern Bight. Clusters of sightings may occur in certain areas, with hydrographical characteristics locally (and temporally) enhancing the foraging conditions (e.g. frontal systems), but these are seemingly short-lived and/or of seasonal importance only.

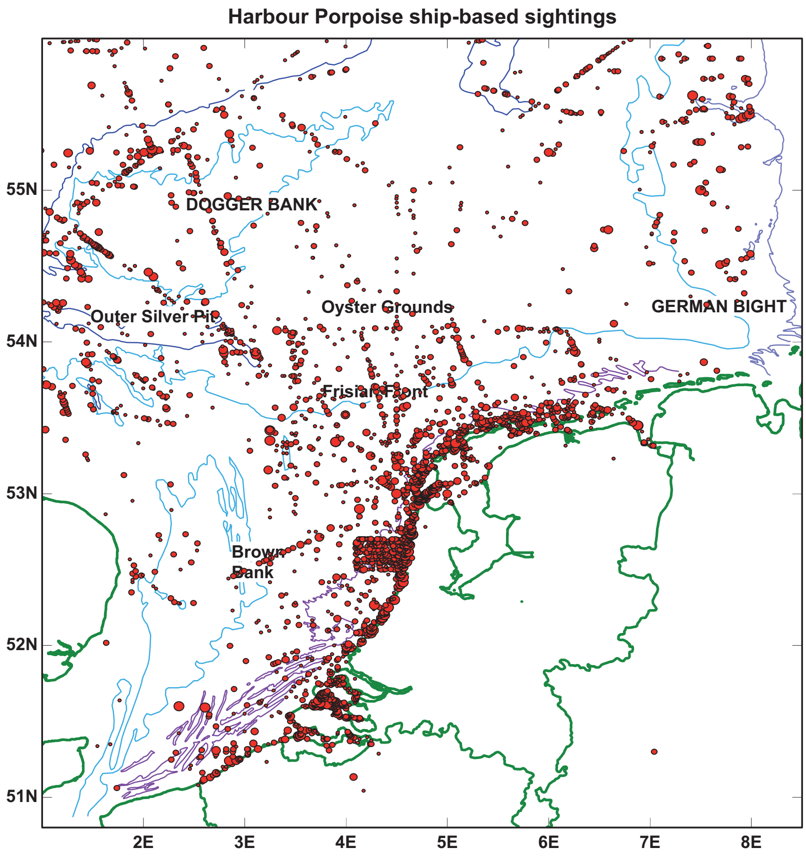


Figure 29. Plotted sightings of Harbour Porpoises from ship-based sightings, 1978-2008, NZG Marine Mammal Database, ESAS database & C.J. Camphuysen *unpubl. data*). These non-effort corrected plots clearly show individual transects (e.g. Dogger Bank crossings) and study areas (e.g. rectangular area off the mainland coast), or areas with particularly large numbers of observers (nearshore, some tidal inlets). Neither this composite of accidental reports and (ship-based) survey results, nor repeated surveys corrected for differences in observer effort have provided evidence for persistent hot-spots.

The Marsdiep area, historically a research area rather than an area of special significance (Verwey 1975ab), is currently an area where Harbour Porpoises are seen with a high frequency, at least during part of the year (Rebel 2010). Again, this is an area with considerable directed effort, rather than an area of particular ecological significance, at least as far as currently understood.

None of the (proposed) marine protected areas in Dutch waters (Lindeboom *et al.* 2005) are currently known to be of particular significance for porpoises. High numbers occur in coastal waters (Camphuysen 2004, Haelters & Camphuysen 2009), but even higher numbers may occur further offshore (Scheidat & Verdaat 2009, Scheidat *et al.* 2010), but rarely in persistent clusters of abundance that would point at areas of significance. Breeding, again as far as currently documented, occurs widespread rather than in particular regions. The Frisian Front area, situated at the boundary of central North Sea water and river-influenced water masses of the Southern Bight, is often characterised by locally enhanced abundances of piscivorous taxa (several species of seabirds; Leopold 1987, Baars *et al.* 1990, Leopold 1991, Camphuysen 2002, Baptist *et al.* 2010). Even though Harbour Porpoises can be common in the region, there is no evidence that the Frisian Front area would be of particular importance during any length of time for this species.

While Harbour Porpoises in Dutch coastal waters have dramatically increased in abundance since the mid 1980s and early 1990s, an increase in sightings in the Delta area did not occur before 2001. Another difference between coastal sightings north of Hook of Holland and sightings within the Delta area is the seasonal pattern: primarily winter/spring visitors in the north, year-round in Zeeland, notably within the Oosterschelde (a resident or semi-resident stock; Camphuysen & Heijboer 2008). Recent sightings of small calves suggest reproductive activities of Harbour Porpoises within the basin (http://www.rugvin.nl/Persbericht.htm), but there is little factual data about the exchange of inshore porpoises with the, considerably larger, offshore stock through Oosterscheldekering. The Oosterschelde population - if at all a discrete unit - is very small, currently estimated at less than 100 animals; Zanderink & Osinga 2010; press releases Stichting Rugvin), certainly in comparison to the North Sea stock. As a recent population, however, the Oosterschelde porpoise do deserve special attention and monitoring, perhaps even area-based management in years to come.

Designating protected areas for Harbour Porpoises should be more than just identifying areas of high Harbour Porpoise density (contra Teilmann *et al.* 2008). Understanding the physical mechanisms that influence the formation and persistence of these aggregations is essential in order to define and implement pelagic protected areas, because reserve designs must be guided by an understanding of natural history and habitat variability (Hyrenbach *et al.* 2000). Assessing densities should only be a first step, and to do so, given the elusive nature of Harbour Porpoises at sea, multiple techniques should be combined (Sveegaard *et al.* 2010). Within the Dutch sector, we have currently only a limited understanding of the ecological importance of the various sea areas for porpoises (estuarine, nearshore, offshore, frontal systems, sandbanks), but there are no geographical areas yet that would require further attention because the observed densities are higher than elsewhere, for any serious length of time. Possibly, generalised additive models (GAMs) would be useful to predict areas of high relative density for Harbour Porpoises in more than one year (*cf.* Embling *et al.* 2010). Static bathymetric and persistent hydrographic variables may be used in a step-wise model selection procedure to identify areas that could be of ecological significance for Harbour Porpoises in the Southern Bight, to form part of the Natura 2000 network. More adequate survey data would be required to start parameterising such models. The numbers using Dutch EEZ waters are currently in a constant state of change (through the year and between years). Even if certain areas of ecological importance would develop over time, any proposal today to designate protected areas based on variations in at-sea densities would be highly premature. Proposed conservation measures that would be implemented specifically within currently defined protected areas, such as fisheries restrictions, certainly when such measures would not be taken in adjacent sea areas, are unlikely to enhance the conservation status of this mobile, highly migratory species in Dutch waters.

4.10. Conservation status

Hammond *et al.* (2008) have listed the Harbour Porpoise under "Least Concern" in the 2010 edition of the global IUCN Red List of Threatened species. As a justification it was concluded that "*although the species is known to be harvested in two areas and regional declines are described, it is widespread and abundant".* The evidence available to us now, is that a ranking under "Least Concern" would be equally suitable for the Southern North Sea. The Harbour Porpoise today is both abundant and widespread in Dutch waters, throughout the year, but with marked local movements within and beyond areas under Dutch jurisdiction.

The current listing under "**Vulnerable**" (*kwetsbaar*; VZZ 2007), and certainly a ranking as "Critically Endangered" (*ernstig bedreigd*), as it was in the 1994 edition of the Red List of mammals in The Netherlands, is seemingly not or no longer warranted. It's ranking as "Vulnerable" for Dutch waters was justified with a number of arguments, including

(1) the current population increase in Dutch waters is caused by a shift in distribution from the northern North Sea to the south,
(2) this shift in distribution is seemingly caused by a decline in natural resources in the area of origin ("*het oorspronkelijke leefgebied*"),
(3) rather a lot of stranded Harbour Porpoises in The Netherlands may have drowned in fishing gear (net marks, cut open), and
(4) the regional population is a sink rather than a source (VZZ 2007).

With regard to the last point, models of source-sink population dynamics make assumptions about whether, and how, demographic parameters in source habitats are dependent on the demography in sink habitats (Gundersen *et al.* 2001). Good knowledge of the degree of density- or habitat-dependent dispersal is critical for predicting the dynamics of source-sink populations. Do we have that knowledge? Delibes *et al.* (2001) commented on how sinks may affect the demography of sources and proposed that this is a common result when animals lack cues associated with reduced fitness inside sinks and consequently select habitat inappropriately. These "attractive sinks" can result either from undetected risks of mortality or from poor reproductive success (e.g. due to bioaccumulation of pesticides). In the absence of demographical information in area (within the supposed source as well as in the supposed sink), the source-sink hypothesis must be considered poorly supported.

In terms of the Habitats directive, the key policy document describing the conservation status is the so-called profile document. This is a state of the art overview on the conservation status of a Habitats Directive species, and it is published by the Ministry of Economic Affairs, Agriculture and Innovation. It is used for reporting conservation status to the European Commission in line with the requirements of the Habitats Directive. It also is the basis for setting conservation objectives at Natura 2000 site level. The assessment of conservation status under the Habitats Directive follows the basic assessment methodology as prescribed by the European Habitats Committee (EC, 2005: DocHab-04-03/03 rev.3, including annexes). For a species such as the Harbour Porpoise it means that the conservation status is assessed on the basis of an a) range (i.e. distribution of population), b) population (incl. reproductive success, age structure), c) habitat for the species (i.e. living area of the population in terms of quality and extent) and d) future prospects. The overall conservation status can either be "favourable" , "inadequate" , "bad" or "unknown", and is equal to the lowest score of any of the categories a), b) , c) or d) above. The 2010 update of the Harbour Porpoise profile document (LNV 2010) was based on advice contained in the Jak *et al.* (2009) report.

Jak (*et al.* 2009) described the conservation status of Harbour Porpoises in Dutch waters as "**inadequate"** (matig ongunstig). The arguments can be summarised as follows: -

(a) *range* is 'favourable' (porpoises are widespread and occur everywhere in the Dutch sector),
(b) *population* is considered 'inadequate', because 1) the increase in number of the Harbour Porpoise in the Dutch North Sea 2) population size is above the reference value, and 3) the number of observed calves is small, indicating "an unbalanced age-structure of the population"
(c) habitat for the species is considered 'inadequate', because of the hundreds of stranded animals recorded per annum, mostly in spring, part of which drowned in set-nets, a mortality with unknown effects on the population
(d) *future prospects* being 'inadequate' because of uncertainties about 1) the effectiveness of the European policy for reducing the by-catch of Harbour Porpoises in gillnets, and 2) the persistency of the recent increase of Harbour Porpoises (or stabilisation at this higher level)

Jak *et al.* (2009) conclude that "under good conditions, the animals will reproduce and the age-structure will be balanced" It is unclear, however, what a "balanced age-structure" actually is, or how many calves had to be seen (or indeed *have* been seen) to call the reproductive success sufficiently high. The profile document mentions a population size of 25,000 Harbour Porpoises as a reference, for 568 10x10km quadrants (or a mean density of 0.44 porpoises km^{-2}), a default value which (if better methodologies for assessing the reference do not exist) is used for all vertebrates in profile documents.

There are published suggestions that the return of the Harbour Porpoise in the southern North Sea may have been triggered by a reduction in prey availability in the NW North Sea (Camphuysen 2004, MacLeod *et al.* 2007, Camphuysen *et al.* 2008). It is unclear whether this reduction in fish prey (if this had triggered a distribution shift) would have been some natural fluctuation or an effect of human action (climate change included). The evidence provided for the reduction in resources triggering a shift in distribution has also been questioned (Thompson *et al.* 2007), because small sample sizes and uncertainty over biases in these data have cast doubted on the evidence for any impact of climate change. Note, however, that Harbour Porpoises have returned to the southern North Sea, an area where they had been common for centuries (Camphuysen & Peet 2006) and where they had gone virtually extinct in the 1960 to 1980s.

Camphuysen *et al.* (2008) indicated that the sex-ratio and the age structure of *stranded* Harbour Porpoises had changed over time and that much of the increase in strandings was caused by rapidly increasing numbers of juvenile animals, often males. In the more recent seasons, moreover, older adult porpoises and neonates are also increasing in their strandings frequency, pointing at a continued change in these parameters. It is possible, but uncertain, whether this age- and sex ratio would be representative for Harbour Porpoises in the Southern Bight in anyone season. Lockyer & Kinze (2003) concluded that material which was derived from strandings in Denmark was biased and emphasised stillborns, neonates, calves, and the juvenile component of the population, while for example by-catches were thought to emphasise the male segment and relatively older animals. While the Danish strandings data indicated a consistent ratio with sex at birth, a male predominance existed in by-catch sex ratios. It is important to realise, that the conclusions by Jak *et al.* (2009) on an "unbalanced age structure" were based entirely on (Dutch) strandings data. Recent aerial surveys have indicated that more than twice the target population occurs in only half the area under Dutch jurisdiction (Scheidat & Verdaat 2009, Scheidat *et al.* 2011).

We conclude that the profile document as it currently stands (with the conservation status assessed as inadequate) needs to be updated with new information to be made available as a result of necessary further research. Apart from an update based on an increase in numbers, new data should be provided regarding the age composition of free-living Harbour Porpoises in the southern North Sea, regarding the reproductive status and breeding success of mature animals in the area, and regarding the current foraging conditions within the southern North Sea.

4.11. Discussion and conclusions

The Harbour Porpoise has a world population estimated at some 700,000 individuals. Population trends are unknown, and while declines in abundance are reported in some areas (Black Sea, Baltic, Washington State, USA), the Harbour Porpoise is not considered to be facing a high risk of extinction in the wild.

Harbour Porpoises have been abundant in Dutch nearshore waters in historical times, but disappeared in the late 1950s for reasons that were never studied and therefore not understood. From the mid-1990s on, Harbour Porpoises have increased markedly in the Southern North Sea, with peak abundances in nearshore sightings (so far) in 2006, 2009, and 2010. Today, Harbour Porpoises are apparently common from August-May (most abundant nearshore in Feb-Mar), but fairly scarce in mid-summer in nearshore waters, suggesting a movement away from the coast during the calving period. Further research is required to establish a link between nearshore abundance estimates and the long-term trends highlighted in the seawatching sightings data (Camphuysen 2004, 2011) and offshore abundance estimates derived from dedicated (aerial) surveys.

A subdivision of the North Atlantic into 15 ‘management units’ (MU) has been suggested, two of which have relevance to the North Sea: (8) North-eastern North Sea & Skagerrak and (9) South-western North Sea & Eastern Channel. A conservative estimate for MU9, based on a single survey conducted in July 2005, would suggest a population of some 150,000 animals (one fifth of the world population). The North Sea population as a whole has been estimated at *c.* 250,000 animals.

Harbour Porpoises in Dutch waters would be representatives of MU9, but exchanges of animals moving from east (MU8) to west (MU9) cannot be excluded. Stenson (2003) discussed the importance of identifying the correct biological scale, also in the context of management units (or proposed sub-populations) when the impact (actual “removals” from the stock, for example as a result of bycatches in fisheries) upon a population has to be quantified. If two populations are incorrectly identified as a single stock, the impact of extra-, human induced mortality may be disproportionally severe on one of the two populations. Alternatively, when a single stock is mistakenly divided into two sub-populations, the impact of extra-mortality may be overestimated (Stenson 2003). Identifying the correct scale can be difficult in a mobile species as the Harbour Porpoise. While many of the putative sub-populations (or management units) have received general support from scientific committees (IWC, ASCOBANS, Donovan & Bjørge 1995, Evans *et al.* 2009), the differences were less apparent in among males, suggesting that females are more philopatric (Wang *et al.* 1996, Andersen *et al.* 1997, Tolley *et al.* 1999, Stenson 2003).

Recent aerial surveys in spring 2009 and 2010 (the period of peak abundance in Dutch nearshore waters) of part of the Dutch EEZ have resulted into figures ranging from 37,000 (2009) – 56,000 (2010) individuals, or 15-23% of the North Sea population and 25-37% of MU9. The recent estimates of total abundance in (part of) the Dutch EEZ are high figures, but they must be seen in the international context, at least on the scale of MU9. Under the assumption that Harbour Porpoises are freely roaming through the entire management unit, food stress in one part of their range could stimulate them to explore another area. It is clear, however, that in recent years, the Dutch government has at least a seasonal responsibility for the well-being of a considerable part of the North Sea population of Harbour Porpoises. Also, with our current understanding of seasonal changes in abundance and the exchange between (seasonal) stocks off northern France, Belgium, possibly Germany, but certainly the UK, the conservation would be a shared responsibility between countries.

Strandings of porpoises along the Dutch shore have increased at a similar rate as nearshore sightings, with near-identical peaks in frequency. Contrary to the nearshore sightings, strandings do occur year-round, but with distinct peaks in spring (March) and late summer (August). Regional differences in strandings frequencies were found. Reported causes of death include bycatch in fishing gear, severe emaciation, acute haemorrhagic enteritis, pneumonia, interstitial pulmonary emphysema and oedema, and other factors. Some very young animals died as stillborns or shortly after being born. Periodic strandings of severely mutilated animals (post-mortal knife-cuttings or mechanical damage) require further research. Strandings of pregnant females and very young animals are indicative of reproductive activity in Dutch waters. There are many sightings of adults accompanying calves, from headlands and seawatching sites, from surveying vessels and from surveying aircraft, but an analysis to evaluate the relative frequency of these sightings is lacking. From recent strandings data (2009-2010), it is clear that adult females and very young, just born/stillborn animals are now increasing in numbers, while in earlier years much of the increase in strandings comprised juvenile males (Camphuysen *et al.* 2008). Many studies have found that samples obtained from strandings are biased towards younger animals and/or unequal sex ratios (Sørensen & Kinze 1994, Lockyer 1995, Lockyer & Kinze 2003, Richardson *et al.* 2003, Stenson 2003), and these strandings data should therefore be treated with care.

For the southern North Sea, a strong seasonality in nearshore sightings could be indicative for seasonal movements, either from offshore areas towards the coast, or from north to south and vice versa, during which coastal habitats are frequented. Long-term aerial seabird surveys (Arts 2010) suggest an offshore seasonal pattern in Harbour Porpoise sightings, with a peak two months after the nearshore peak in sightings (Apr-May). In the Dutch Delta Area (Zeeland) a small resident population seems to have become established. The seasonality in nearshore abundance suggests that high numbers occur only during a relatively short part of the year, while the long-term trend (1990s-present) suggests that more and more individuals participate in that "annual migration". These patterns can change again, provided that a scarcity in resources in the north were indeed a key factor triggering these southward shifts, and that these resources in more northerly waters might return. Annual sightings-frequencies from seawatching sites peaked in 2006, followed by two years of rather low numbers of sightings and rather high levels of sightings in more recent years (2009-10; Camphuysen 2011). It seems evident that the rapid increase (Camphuysen 2004) has come to a halt. Dedicated aerial surveys in all other seasons are needed to quantify the seasonal fluxes of numbers occurring in the Dutch EEZ, and tagging studies could be useful to scientifically *prove* a frequent connection between porpoises wintering/migrating into Belgian/Dutch coastal waters and the NW North Sea, or between one management unit and the next. In the absence of such data, the discussion about fluxes in numbers within (and beyond) MU9 remains highly speculative.

In Dutch waters, where numbers of porpoises were subject of marked change over the recent decades, it has thus far not been possible to find any sea areas of particular significance. Harbour Porpoises are seemingly highly mobile, throughout the year, with locally varying densities throughout the Southern Bight. Clusters of sightings may occur in certain areas with hydrographical characteristics locally (and temporally) enhancing the foraging conditions, but these are seemingly short-lived and/or of seasonal importance only. None of the (proposed) marine protected areas in Dutch waters (Lindeboom *et al.* 2005) are currently known to be of particular significance for porpoises. Proposed conservation measures that would be implemented specifically within currently defined protected areas, such as fisheries restrictions, certainly when such measures would not be taken in adjacent sea areas, are therefore unlikely to enhance the conservation status. Area-based management would be an option for the Oosterschelde (Delta area, Zeeland), where a small (semi-?) resident population developed in recent years.

The conservation status of Harbour Porpoises has been described as "inadequate" (matig ongunstig), because the age-structure of the population was considered unbalanced, and because hundreds of stranded animals were recorded per annum, part of which had drowned in set-nets, a mortality with unknown effects on the population (Jak *et al.* 2009). Concerns regarding the age structure were largely based on animals aged during necropsies (*i.e.* a selection of the strandings data), and many earlier studies have reported potential biases involved in that data.

In the 2007 edition of the Red List of mammals in The Netherlands, Harbour Porpoises were listed as "Vulnerable", because the population increase in Dutch waters was apparently caused by a shift in distribution from the northern North Sea to the south that was possibly caused by a decline in natural resources in the area of origin. Again, the high number of stranded porpoises that may have drowned in fishing gear (net marks, cut open) was seen as a concern and the population was seen as a sink rather than a source. Although information is available on some vital population parameters within the North Sea (pregnancy rates, age of sexual maturity; Sørensen & Kinze 1994, Lockyer 1995, Addink *et al.* 1995, Benke *et al.* 1998, Lockyer & Kinze 2003), nothing is known about annual survival and natural mortality rates (Stenson 2003). The samples of reproductive rates in most areas are based upon samples obtained as incidental catches or strandings Such samples can provide an indication of vital parameters that can be used as a starting point or for comparisons between samples, but caution must be used as they may exhibit unknown biases that could affect the estimates of the age structure, sex ratios and/or reproductive status of the population (Donovan and Bjørge 1995, Stenson 2003).

The evidence available to us now, given that the current trends continue, is that a conservation status such as "Favourable" and "Least Concern" could be more suitable for the southern North Sea, but the status of Harbour Porpoises in Dutch waters is currently best described as insufficiently known or even unknown. We conclude that the profile document as it currently stands (with the conservation status assessed as inadequate; LNV 2010) needs to be updated and research proposals have indicated which data needs to be collected to be able to re-evaluate the conservation status of this cetacean. Yet, in the next chapter we evaluate and discuss current threats and propose measures to possibly improve, or at least maintain, the current conservation status.

5. Observed threats (factors causing loss or decline)

Harbour Porpoises are abundant as a species in the Southern North Sea, certainly in comparison to other cetaceans (whales and dolphins). However, the species has experienced major declines in several parts of the Southern North Sea in the 1950s and 1960s, and the species was considered regionally near-extinct for several decades. The cause(s) of these population declines are unknown. Commercial catching of porpoises has only been a significant issue in the very distant past, when porpoises were still considered a delicious dish (Camphuysen & Peet 2006). There is no evidence for any significant consumption in the 20th century, except the sales of porpoise meat during World War II when the human Continental population was starving. The extinction of a particular Herring stock ("*Zuiderzeeharing*") after the 1930s when the IJsselmeer was formed (after building a dam in the Zuiderzee) may have lead to local reductions in food supply, but it took several decades before the species really started to decline. It is however quite likely that habitat degradation of various kinds (e.g. pollution, noise, a decrease in prey abundance or quality) may have contributed to this decline. Periodic catastrophic mortality resulting from for example severe winter ice conditions such as in the Baltic (Lindroth 1962, Berggren 1994, Teilmann & Lowry 1996) has never occurred in the Southern North Sea, but was an issue in the IJsselmeer, shortly after its formation when "captured" porpoises were unable to escape in some cold winters.

The Harbour Porpoise returned in the 1990s and early 21st century for reasons that are also not well understood. A reason, expressed by several authors (Camphuysen 2004, 2006, MacLeod *et al.* 2007b, Haelters & Camphuysen 2009), may have been a reduction in prey availability in the NW North Sea, where numbers have declined more or less simultaneously (SCANS II 2008).

It should be kept in mind throughout that *local* threats may not always be responsible for population trends observed in a given area; the international context should always be appreciated. Local threats, however, can be dealt with more effectively through national legislation or practical measures. A number of imminent threats are highlighted for most parts of their range and these include incidental captures (bycatch), acoustic and physical disturbance, disease, as well as prey depletion. These (potential) threats are discussed below, plus a number of local factors. For all threats we summarise the available evidence, the scale of impact, the possible effect on porpoises in the Southern North Sea, and the international context.

5.1. Incidental capture (bycatch)

Incidental capture in fishing gear (bycatch) is considered to be the most significant threat to Harbour Porpoise populations worldwide. Within the North Sea, this problem is particularly related to bottom-set gillnets when porpoises forage at or near to the seabed. This has been suggested as a factor causing declines in North Sea, North Atlantic and in particular in Baltic Harbour Porpoise populations (Lear & Christensen 1975, Andersen & Clausen 1983, Benke 1994, Kinze 1994, Baird & Guenther 1995, Berggren 1994, Kock & Benke 1996, Carlström & Berggren 1997, Tregenza *et al.* 1997, Vinther 1999, Clausen & Andersen 1988, Mentjes 2000, Skóra & Kuklik 2002, Stenson 2003, Davies *et al.* 2004, Haelters *et al.* 2004, Vinther & Larsen 2004, Read *et al.* 2006, Jauniaux *et al.* 2008, Haelters & Camphuysen 2009). Several studies in European waters have shown that bycatch levels in gillnet fisheries may not be sustainable in the long run, e.g. in the Celtic Sea (Tregenza *et al.* 1997), the central North Sea (Vinther 1999, 2004), the Skagerrak and Kattegat (Harwood *et al.* 1999; Carlström 2003). Vinther & Larsen (2004) estimated the bycatch of Harbour Porpoise in the Danish North Sea bottom-set gillnet fishery during 1987-2001 to be in the range of 2900-7600 Harbour Porpoise (mean of 5800) per annum. Significant seasonal variation of bycatch was identified with the highest bycatch rate in the first and third quarter of the year (Vinther 1999). Bycatch rates had not changed in the observed period and there was no significant difference in bycatch rates between sub-areas. However, the precise extent of the threat from fishing nets is difficult to judge, because there are few reliable population estimates associated with bycatch-rates.

Stranding networks, in which carcasses are recovered and sent to diagnostic laboratories for necropsy and determination of cause of death, have been developed around the world to monitor the health of marine mammal populations (Cox *et al.* 1998, Joly *et al.* 2009). Van Nie (1989), in a pathological study of porpoises stranded on the Dutch coast between 1983 and 1986, suspected the occurrence of by-catch, but considered it difficult to diagnose and therefore made no attempt to specify and quantify the issue any further. Advanced necropsy protocols became available in later years, enabling the diagnosis "bycatch" on different levels: "definite" or at least "probable", equivocal cases as "possible", and unlikely cases as "not" (Kuiken & Garcia Hartmann 1992, 1993, Kuiken 1994ab). All such scores, or rankings, are interpretations of a number of observations on carcasses that point into the direction of a certain cause of death. The presence of froth in the respiratory system, subcutaneous bleedings, blood-red eyes, net marks, good physical condition, and a full stomach are *indicators* that a case of bycatch may be at hand, but none of these factors in themselves are conclusive evidence. Needless to say, many (especially decomposed) carcasses show only a subset of these features, and not always very obvious.

Within the Netherlands, a number of research groups have been involved with necropsies on stranded Harbour Porpoises since the mid-1980s. Very few results have so far been published in the peer-reviewed scientific literature (Van Nie 1989, Osinga *et al.* 2008). The study of Hartmann *et al.* (2004) was made available as an unpublished manuscript (results had been reported at the European Cetacean Society Conference in Sweden, 2004). Results obtained by a series of mass-necropsies organised at Texel (material collected in 2006; IMARES & NIOZ in collaboration with Dept. of Veterinary Pathology, University of Liege), performed by T. Jauniaux, were published in the grey literature as a report to the Ministry of Agriculture, Nature & Food Quality (Leopold & Camphuysen 2006), while some results had also been reported at the 17th Biennial Conference on the Biology of Marine Mammals in Cape Town (South Africa) in 2007 (Jauniaux *et al.* 2007). Results from the same study group (material collected 2007-8, necropsies at Texel and in Utrecht) have thus far not even been written up for a report, though some data were reported at the ICES Annual Meeting, Halifax, Nova Scotia in 2008 (Jauniaux *et al.* 2008). Some results are reported below, but taken directly from the database (referred to as Jauniaux *et al.* unpublished). The last year of involvement in necropsies of Harbour Porpoise strandings of Jauniaux overlapped with the first year of a new porpoise research group, based at the Pathology department of the Veterinary Faculty of the University of Utrecht (research group A. Gröne). Commissioned by the Ministry of Agriculture, Nature and Food Quality (currently the Ministry of Economy, Agriculture and Innovation), this group has continued necropsies on a regular basis and reported twice in the grey literature (Wiersma & Gröne 2009, Begeman & Gröne 2010). Underlying criteria to find evidence for bycatch (or at least drowning) have been similar in most these studies, based on manuals produced by Kuiken and Hartmann in the 1990s (Kuiken & Hartmann 1992, 1993, Kuiken 1994ab, Kuiken *et al.* 1996). However, differences in the interpretation of evidence cannot be excluded. With regard to the likelihood of bycatches, Dutch necropsies have produced results shown in **Table 4**. To harmonise the data, bycatch rates were *only* calculated over stranded animals in which a diagnosis (a cause of death) was available (*i.e.* the sample rather than the total number of animals studied).

Table 4. Evidence for bycatch from necropsies on stranded Harbour Porpoises in The Netherlands, 1990-2010 (from Hartmann *et al.* 2004, Leopold & Camphuysen 2006, Osinga *et al.* 2008, Wiersma & Gröne 2009, Gröne & Begeman 2010 and Jauniaux, Leopold & Camphuysen *unpubl. data*).

Publication or data set	Hartmann *et al.* 2004	Osinga *et al.* 2008	Leopold & Camphuysen 2006	Jauniaux *et al.* unpubl	Wiersma & Gröne 2009	Gröne & Begeman 2010	Totals
Period	**1990-00**	**1984-2006**	**2006**	**2007-8**	**2008-9**	**2009-10**	**1990-10**
No bycatch (%)	30%	68%	30%	55%	51%	54%	48%
Possible bycatch (%)	8%	16%	6%	14%	9%	14-30%[1]	12-14%[1]
Probable bycatch (%)	62%	16%	64%	31%	40%	16%	38%
Bycatch range (%)	62-70%	16-32%	64-70%	31-45%	40-49%	16-46%[1]	38-52%[1]
Unclear (n)	8	85	31	44	19	17	204
Sample (n)	122	68	33	93	78	83	477
Total animals (n)	130	153	64	137	97	100	681

[1]Max range with 'trauma' category included; see text

Hartmann *et al.* (2004) demonstrated that many more Harbour Porpoises that were found stranded on the Dutch coast during 1990-2000 were suspected cases of bycatch than had been assumed so far: a minimum of 43% consisted of bycatches. For this study, Hartmann *et al.* (2004) used a tissue bank containing lung and kidney material of 130 Harbour Porpoises, stored in 10% neutral buffered formalin. The lung tissue was stained using the Gomorri silver stain. This histological method was previously tested successfully on lung tissue of dolphins drowned during fishing operations, and yielded good results in examining lung samples of the Harbour Porpoises. Histo-pathological features in the porpoises diagnosed as "bycatches" corresponded almost completely with those found in white-sided dolphins caught in midwater trawls (Knieriem & García Hartmann 2001), including lesions of the reticular fibres visible in the Gomorri stain, ranging from directionality and thinning to rupture. Only the dilated and open myosphincter was more pronounced in the porpoises of the present study than in the white-sided dolphins (Knieriem & García Hartmann 2001). Additional information for diagnosis was provided by a standard Hematoxilin-Eosine stain of kidney tissue. The reports of the gross post-mortem examination of each specimen were also used in the diagnosis. Based on standardized criteria, the histopathological and gross post-mortem findings were both divided into three main categories: (1) no by-catch, (2) equivocal or possible by-catch and (3) by-catch. For category (2), by-catch could not be proved or disproved. Judging by double-blind histopathological examination, 43% of the examined porpoises were diagnosed as bycatch, against 46% based on gross pathology. By histopathology 15% were diagnosed as not bycatch, against 25% by gross pathology. The category equivocal increased from 19% by gross pathology to 29% by histopathology. By gross pathology and histopathology, 10% and 13%, respectively, could not be evaluated properly due to constraints in the interpretation of tissue or data. These were excluded from the analysis. It was concluded that combining the specialized Gomorri histopathological study with a gross pathological examination of stranded porpoises reduces the uncertainty of the pathological examination alone, since gross pathology often reveals findings that may be rather common in various diseases. Thus, a diagnosis by gross pathology depends more on the experience of the pathologist regarding bycatch pathology than a diagnosis based on histopathology.

By-catch and drowning rates were calculated by Osinga *et al.* (2008) in two ways: (1) the percentage of the total number of necropsied animals (*i.e.* those with unknown cause of death included, n= 153) and (2) the percentage of the total number of necropsied animals, excluding 26 animals without clear lesions of which the cause of death was unknown (n= 127). They included 59 animals in which the cause of death was unknown but in which *significant* lesions were found (that likely contributed to the death of the animal, n= 59). The tabulated data in **Table 4**, however, include a bycatch rate based only on 68 animals in which the cause of death was known; excluding both categories of animals in which a cause of death could not be established. Osinga *et al.* (2008) concluded that in the absence of external lesions, 11 animals that had drowned could not be assigned to the bycatch category (*i.e.* "possible bycatch"). The most careful interpretation of the data, according to Osinga *et al.* 2008, was a by-catch rate of 10% (6/61) of the stranded porpoises in 1984–1997 (23% when all animals of undetermined cause of death were excluded, n= 26; **Table 4**) to 8% (5/66) in the period 1998–2006 (12% when all animals of undetermined cause of death are excluded, n= 42; **Table 4**) → ≥9% bycatch over 1984-2006 (*i.e.* 16% over 68 animals in which the cause of death had been identified; **Table 4**). The highest possible rate of by-catch (including the drowning cases) ranged from 16% (10/61) in 1984–1997 to 18% (12/66) in 1998– 2006, or 17% over the whole period (*i.e.* 38% and 29% respectively, overall 32% over 68 animals in which the cause of death had been identified in 1984-2006; **Table 4**).

A series of necropsies, results of which are not yet published (Leopold & Camphuysen 2006, Jauniaux, Leopold & Camphuysen unpublished data), was conducted at Texel (2006-2007) and in Utrecht (2008), using 201 carcasses found stranded in The Netherlands between 2006 and 2008. Of these, 75 were excluded from the analysis, because a diagnosis was impossible. Of the remaining 126 animals, 50 were diagnosed as bycatches (40%), 15 were possibly bycatches (12%) and 61 were no bycatches (48%). Bycatch estimates were rather higher in the material studied over 2006 than in material over the last two years. It must be realised that these are unpublished, non-scrutinised results and they should thus be treated with extra caution.

Wiersma & Gröne (2009) reported on results of necropsies of 97 stranded Harbour Porpoises, 19 of which involved carcasses of animals too putrefied or too incomplete to lead to a diagnosis (hence, sample size n= 78). Causes of death included emaciation (19 animals), starvation (9), infectious disease (14), bycatch (40) and otherwise (1). Of the animals categorized as bycatches, 31 were likely bycatches, 7 were possible bycatches. Many of the animals studied were collected in February 2009 (81% diagnosed as possible or likely bycatch) and July (mostly neonates and emaciated or sick animals). The first peak coincided with a large number of mutilated carcasses (Camphuysen & Oosterbaan 2009). The bycatch range presented in **Table 4** was calculated over a smaller sample (non-diagnosed individuals omitted, n= 78) than Wiersma & Gröne (2009) themselves.

Gröne & Begeman (2010) made a different interpretation of some of the results. For 100 individuals, 17 of which to rotten or incomplete for a final diagnosis (hence, sample size 83 rather than 100), collected between December 2009 and November 2010, a new category ("trauma") was introduced (12 individuals). In this category, a cause of death was in fact not given, but these were mutilated carcasses that mostly were found in winter. In the previous report (Wiersma & Gröne 2009), most mutilated animals were diagnosed as probable or definite bycatch, while they were left out of consideration in the more recent study. The proportion bycatch was now only based on a fairly small subset of fresh animals, excluding those categorised under 'trauma'. "Trauma" was mostly found in February, during period when the proportion of animals diagnosed as bycatch was higher than in any other season (just as a year earlier). Adding trauma (12 animals) to the bycatch suspects (now 25 animals; 13 very likely, 12 possibly) would result in some 16-46% bycatch (n= 83; **Table 4**).

In summary, overseeing all necropsies summarised in **Table 4**, some 681 animals had been studied, 477 of which were sufficiently fresh or intact to contribute to the study sample (70%). About half the sample were no bycatches (48%, range 30-68%), 38% were diagnosed as probable bycatch (range 16-64%) and the rest as equivocal (*i.e.* possible bycatch). This would mean that with 300-500 animals washing ashore annually, as an order of magnitude, some 150-250 animals are at least bycatch-suspect.

The necropsies in the Netherlands are linked to a strandings network (database held by Naturalis, Leiden, www.walvisstrandingen.nl), but the sampling effort is unfortunately not unbiased. Part of the area is overseen by volunteers of the seal rehabilitation centre in Pieterburen (so-called EHBZ-network), part of the area is overseen by Ecomare at Texel, or by volunteers with no specific ties to certain organisations, while other parts of the coastline are more or less neglected in the absence of dedicated co-workers. While significant progress has been made in attempts to streamline the transport from beaches to the research centre (now in Utrecht), a representative sample is still very difficult to achieve. From the Delta area, Texel and from parts of the mainland of Zuid-Holland and Noord-Holland, a relatively large number of carcasses is collected for necropsies. Many animals on the Wadden Sea islands (where higher densities of stranded animals are reported) remain unstudied. If the bycatch risk would be different in various parts of the Dutch coastal waters, an extrapolation of bycatch rates from the available (biased) subsample could well be misleading. Even though just below half the strandings in recent years may have been bycatch related (results from necropsies data), it is unlikely that the strandings record would provide information on the bycatch levels at greater distances away from the coast. Hence, the strandings records might lead to an underestimate of the problem, certainly so if 'risky' fisheries are common practice at larger distances from the coast and further to the north.

Responsible fishing gear While it is evident from necropsies that a substantial number of Harbour Porpoises had drowned, probably in fishing gear (**Table 4**), laboratory observations give little insight in the type fishing gear, if any, that was involved. Direct observations of Harbour Porpoise incidentally captured during Dutch fishing operations are few and far between (Couperus *et al.* 2009), and fishermen themselves claim that bycatches are at best infrequent, notably so in Sole *Solea solea* set-net fisheries and with trawl fisheries. In Belgium, however, sole-nets, standing low above the sea floor, are known to catch Harbour Porpoises at least occasionally (Haelters & Camphuysen 2009).

Figure 30. Harbour Porpoise entangled in recreational (illegal) set-net. Katwijk aan Zee, 23 February 2011.

In a report "*Marine mammals as bycatch in gillnets*" by Henrike le Semmler and Hans Lassen released 22 October 2010 (ICES Secretariat, Copenhagen, Denmark, *unpublished*), some observations by DEFRA (UK) in a dedicated programme since 1996 were made available by Simon Northridge (UK). These data report on gillnet bycatch rates of Harbour Porpoise for the entire North Sea in relation to the target (fish) species. No gillnet type in the UK gillnet fisheries could be assigned which did not any catch marine mammals and with 145 bycatches recorded in 10,879 observed hauls between 1996 and 2010, the average bycatch rate amounted to 1.33 porpoises per 100 hauls. The catch rate of Harbour Porpoises in skate fisheries (3.8 porpoises/100 hauls) was higher than in fisheries for any other target species. Crab (1.61/100), Monkfish *Lophius piscatorius* (1.33/100), and whitefish fisheries (1.09/100) also showed relatively high bycatch rates. Lower frequencies were recorded in pelagic fish (0.91/100), Turbot *Scophthalmus maximus* & Brill *Scophthalmus rhombus* (0.87/100), and smaller species of flatfish (0.33/100). These results are in accordance to the results from a Danish study on bottom set nets in the North Sea from 1994-98, which showed lower bycatch rates for Plaice *Pleuronectes platessa* and Sole fishing, while Turbot fisheries in particular roundfish fisheries showed significantly higher bycatch rates (Vinther 1999, Vinther & Larsen 2004). In Danish set-net fisheries, the highest bycatch rate was in the Cod fishery over wrecks and no bycatch was observed in the Sole fishery (Vinther 1999). Skóra & Kuklik (2003) report gear types in a study of Harbour Porpoise bycatches in Polish waters (1990-1999) and found that semi-drift nets for salmon (Salmon *Salmo salar* and Rainbow Trout *Onchorynchus mykissii*) posed the most significant threat. Bycatches did occur frequently in bottom set gillnets targeting Cod, Herring and other fish species and occasional bycatches occurred in Herring trawl nets.

The most common commercial fishing practice in the southern North Sea (in Belgium and The Netherlands) is bottom trawling (beam- and otter trawling) for demersal fish and Brown Shrimp *Crangon crangon*. Next to bottom trawling, a more limited fishing effort exists with pelagic trawls and static gear. There is little evidence of porpoise bycatch in trawls in the southern North Sea, probably due to the avoidance behaviour of porpoises towards motorized vessels. While dead porpoises may end up in the nets of the trawlers, such events are not considered as bycatch (Haelters & Camphuysen 2009). Belgium and The Netherlands are not considered as “gillnetting nations”, but passive gears (less costly in gasoline, less discards, less damage to bottom sediments and benthic fauna) are becoming increasingly popular. The main target species in static gear fishery in the southern North Sea are Sole and other flatfish, which are fished in the coastal zone, and preliminary in summer (Mar-Nov). Cod is targeted during winter months, especially near shipwrecks.

Haelters & Kerckhof (2004), Haelters *et al.* (2004) and Haelters (2006ab) reported frequent bycatches from Harbour Porpoises in recreational fish nets set at beaches. In Belgium recreational fisheries with gillnets are limited to the intertidal zone. In The Netherlands, there is no information on the number of recreational gill and tangle nets, the length of the nets set and the areas most frequented. In Dutch coastal waters, apart from a recently documented case (**Fig. 30**), this phenomenon is seemingly unknown, or not recognized, but there are recreational fishermen throughout the country (e.g. Van der Kamp 2011; **Fig. 37**). In November 2009, the Ministry of Agriculture, Nature and Food Quality imposed a ban on recreational set-nets[5].

Apart from professional Dutch/Belgian set-net fisheries and unregulated recreational fisheries, quite a number of other nations operate passive gears within the Dutch EEZ (ICES 2011). The recent winter peaks in strandings of animals diagnosed as probable bycatch (and/or trauma) in The Netherlands would suggest that not the summer Sole-fisheries can be held responsible, but some less well known winter fisheries; if static gears are at all responsible.

There is some, anecdotal evidence for animals with hooks and lines, suggesting that either angles catch Harbour Porpoises occasionally, or that the animals prey upon fish that was hooked by anglers but that was somehow lost during hauling. The incidence of ingested fish hooks is better

[5] http://www.everyoneweb.com/WA/DataFilesstaandwant/factsheetstaandwant.pdf

known from seals found stranded in The Netherlands (Osinga & 't Hart 2006), suggesting that this issue could be serious in marine mammals.

A new, more detailed analysis of data, including all possible spatial and temporal patterns in sightings, strandings, and fishing effort would be required to be able to zoom in on potential conflict areas/periods. Future research and onboard observer systems could then focus on these conflicts, to try and pinpoint where mitigations measures would be most effective.

Predicting coastal strandings of harbour porpoise strandings based on set-net fishing effort and nearshore sightings – In the absence of concrete information on fishing gear responsible for bycatches, and with insufficient knowledge regarding the scale of fisheries deployed and recent trends in fishing effort in Dutch waters, the Ministry of E.L. & I. commissioned a statistical analysis of data. The objective of this study was to investigate to what extent the temporal and spatial distribution of porpoise strandings can be explained by local abundance (based on coastal sightings; Camphuysen 2011) and set-net fishing effort (data provided by the Ministry of E.L. & I.). From the analysis, we hope to understand which fishery could best explain the distribution and timing of strandings. The results would form no proof or evidence of bycatch-responsible fisheries (given the correlative nature of the analysis), but serve rather as advice on when and where to monitor by-catch rates in a future observer scheme, given that not all active fishing vessels can be manned with observers. The basic research questions were: When and where were bycatch rates seemingly high, how many vessels were active at that time, and which were the target (fish) species of the fleet at that time.

Aarts & Camphuysen (2011) provide a general overview of the Dutch set-net fishing characteristics, such as their catch composition, number of vessels and inter- and intra-annual variability in fishing effort. Secondly, the temporal variability in fishing effort with the effort-corrected coastal sightings of harbour porpoises and beach strandings were compared. Harbour Porpoises found ashore consist of those which had drowned in nets and those that died from natural or other human-induced causes. To quantify both aspects, the number of by-caught individuals was quantified as a function of the number of porpoises present and local fishing effort. To quantify the set-net fishing effort, data from fishermen's logbooks were used which are digitally stored in the VISSTAT database, containing trip data from all vessels landing in Dutch harbours (note, this is not all fishing vessels operating in Dutch waters!). More specifically, the trip data consist of a vessel identification, length and power (in kW), gear type, days at sea, departure and arrival time, harbour, ICES rectangle in which most fishing took place and the total catch by species (mass). The gear types extracted for this study were set (anchored) gillnets (GNS), driftnets (GND), encircling gillnets (GNC), trammel nets (GTR), combined gillnets-trammel nets (GTN), non-specified gillnets and entangling nets (GEN) and non-specified gillnets (GN). Only data south of 54°N and west of 7°E are used (two subregions, one south and one north of 52°30'N). The Harbour Porpoise strandings data and effort-corrected nearshore sightings data (summarised in Camphuysen 2011) used in this study are essentially the same as presented earlier in this Harbour Porpoise Conservation Plan.

Modelling strandings as a function of porpoise occurrence and gillnet fishing effort

In addition to natural mortality, a certain proportion of dead porpoises found ashore can be attributed to the gillnet fishery (this document). If gillnet fisheries have an impact on Harbour Porpoise mortality, we hypothesise that the variability in fishing effort should be reflected in the strandings. To be more specific, the number of porpoises that get entangled, would be the product of the number Harbour

Porpoises present in the area, multiplied by the entangle probability, which is expected to be a function of fishing effort. To test this hypothesis two models are constructed.

1. The number of porpoise strandings is equal to the abundance of porpoises, multiplied by the a parameter which relates to a fixed natural mortality rate.
2. In addition, porpoise strandings may be effected by the product of porpoise abundance and fishing effort.

$$P \approx Poisson\ (p)$$
$$p = \beta_0 S_y + \beta_1 \Delta S_{y,m} + \beta_2 FS_{y,m}$$

The response variable P (the number of porpoise strandings per month, year and region, north or south of 52.5°N) is assumed to follow a Poisson distribution with an identity link function. p is the expected number of porpoises found ashore, which is a function of the mean annual (subscript y) number of porpoise sightings (S_y in nh^{-1}), the average monthly sighting rate relative to the annual mean sighting rate ($\Delta S_{y,m}$) and the product of monthly sighting rate S and fishing effort F (expressed in days at sea). In addition to total days at sea, F is also defined for each species by multiplying the relative contribution (in weight) of each species with the days at sea. E.g. a one full day trip, during which 90% of the catch consist of Cod, the F_{cod} is 0.9. First a model is fitted using only the sightings as a covariate. Next, using an Anova F-test, we test whether the product of fishing effort and sighting rate, significantly improves the model.

Gillnet fishing effort

Set-net fishing effort has increased over the past decades (**Fig. 31**), and although fisheries are year-round, the intensity peaks Mar-Sep (**Fig. 32**). The relative contributions of the Atlantic Cod and Sole fisheries in the set-net fishing fleet for February and March, when nearshore sightings rates of Harbour Porpoises are highest, have varied considerably over time (**Fig. 33**).

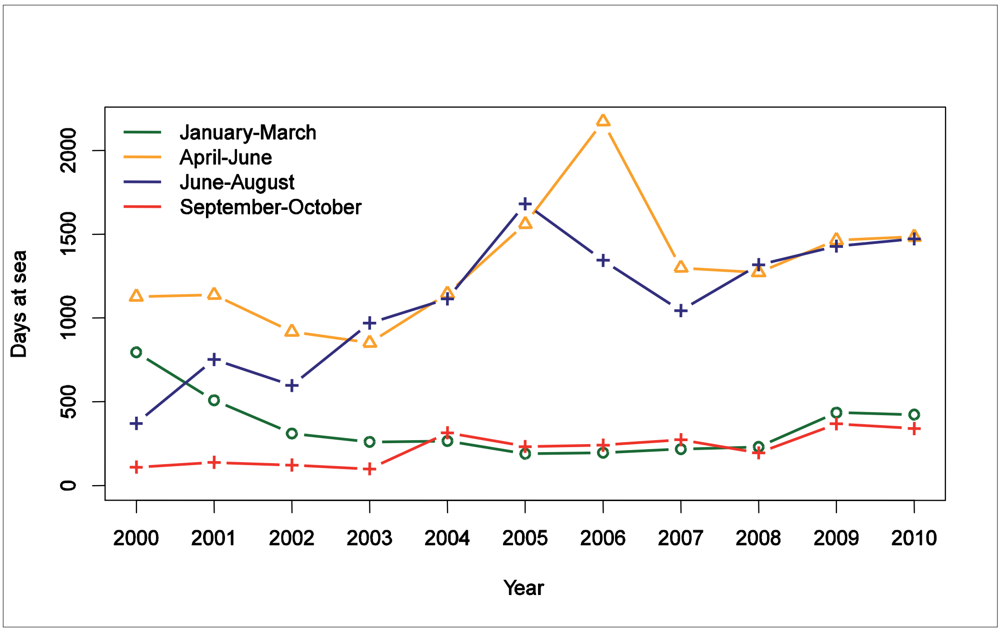


Figure 31. Fishing effort in late winter (Jan-Mar), spring and early summer (Apr-Jun), late summer and early autumn (Jul-Sep), and early winter (Oct-Dec) from VISSTAT database, containing trip data from all vessels landing in Dutch harbours.

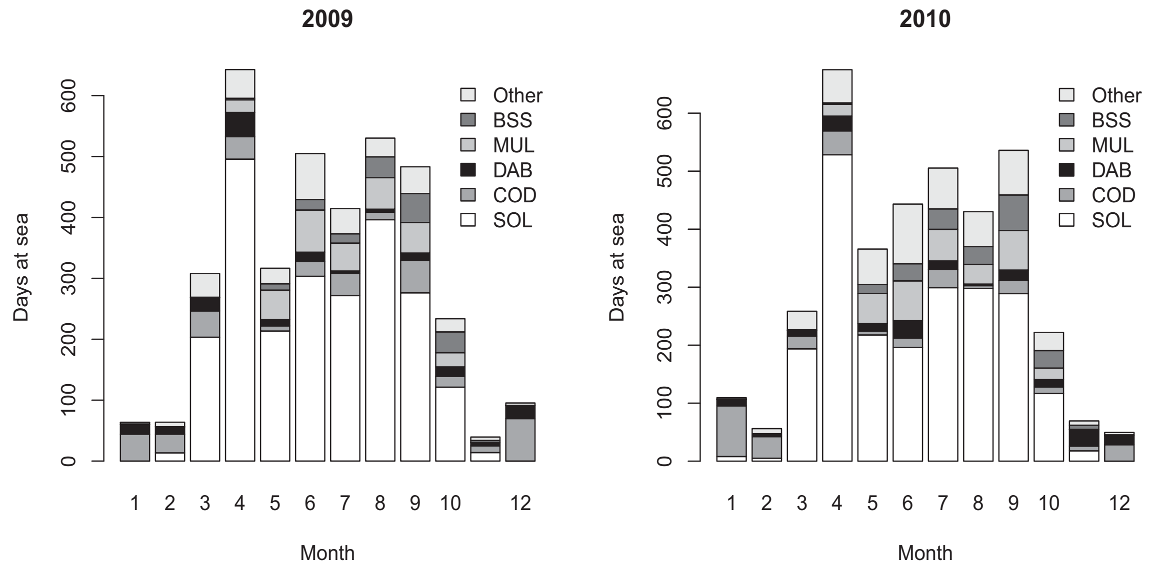


Figure 32. Catch composition of the most important target species by year and month in 2009 and 2010 from VISSTAT database, containing trip data from all vessels landing in Dutch harbours. SOL = Sole *Solea solea*, COD = Atlantic Cod *Gadus morhua*, MUL = grey mullets Mugilidae, DAB = Common Dab *Limanda limanda*, BSS = European Seabass *Dicentrarchus labrax*.

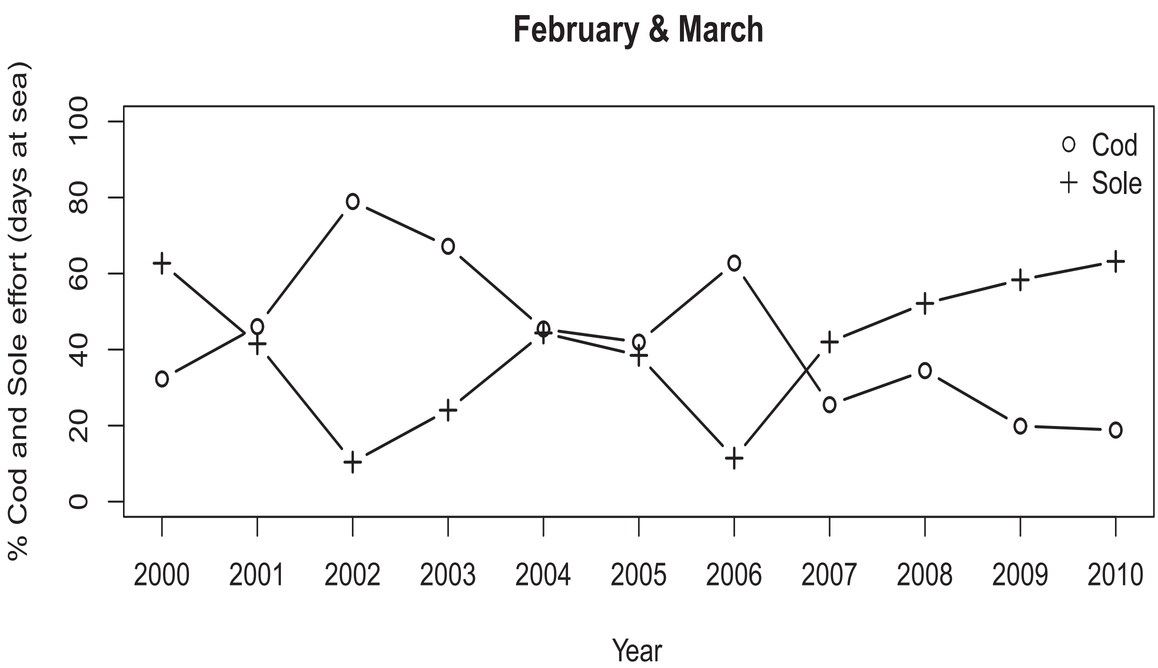


Figure 33. Relative contribution of Cod and Sole in the set-net fishing fleet for the months February and March, when nearshore sightings rates of Harbour Porpoises are highest; from VISSTAT database, containing trip data from all vessels landing in Dutch harbours.

Gillnet fishing effort versus Harbour Porpoise strandings and nearshore sightings

Strandings and nearshore sightings were discussed earlier in this document. In short, the number of stranded Harbour Porpoises has increased rapidly up until 2006, after which some stabilisation in numbers occurred (**Fig. 14**). Strandings peaked in 2006 (541 individuals). During that year, the highest number of animals stranded in March (94), but also in April (67), May (54), June (48) and July (71) high number of strandings occurred. In most other recent years (2001-2010), the highest numbers of stranded individuals were found in March and August (**Fig. 17**, but see regional differences illustrated in **Fig. 18**). Also nearshore sightings peaked in 2006 following a rapid increase in sightings frequency since the mid-1990s (**Fig. 9**). After 2006, there is considerable year-to-year variation in coastal sightings frequencies (**Fig. 9**), but always with very few nearshore observations in summer (May-Sep; **Fig. 11**; Camphuysen 2011).

To focus a future bycatch observer scheme, assuming a fixed proportion of the strandings consist of by-caught individuals, the probability of recording by-caught individuals during an on-board observer program is highest in winter, during periods when the number of strandings is large relative to the fishing effort (**Fig. 34**, showing the ratio between monthly strandings and days at sea). The stranding versus fishing effort ratio is highest from November to March. In March 2006, the number of strandings for each day at sea is > 1.

The catch composition during which most porpoise strandings occurred varied. In March 2006 (in subregions south and north of 52°30’N combined), Cod was the most important target species. During all other large stranding periods, Sole was the main target (or the main catch). Also in March 2009 and 2010, Sole was the most important target species. Hence, no set-net fisheries should be excluded *a priori* from an observer scheme (further details in Aarts & Camphuysen 2011, showing variable patterns of fleet composition during peak periods of cetacean strandings).

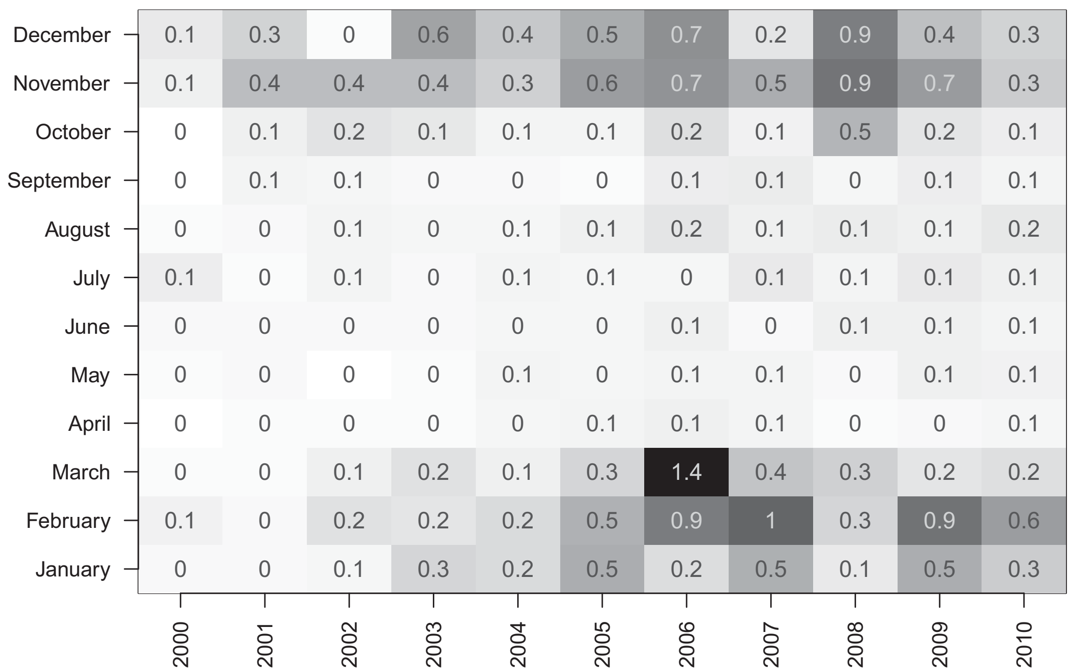


Figure 34. Number Harbour Porpoise strandings per months divided by monthly total set-net fishing effort (days at sea; from VISSTAT database), 2000-2010.

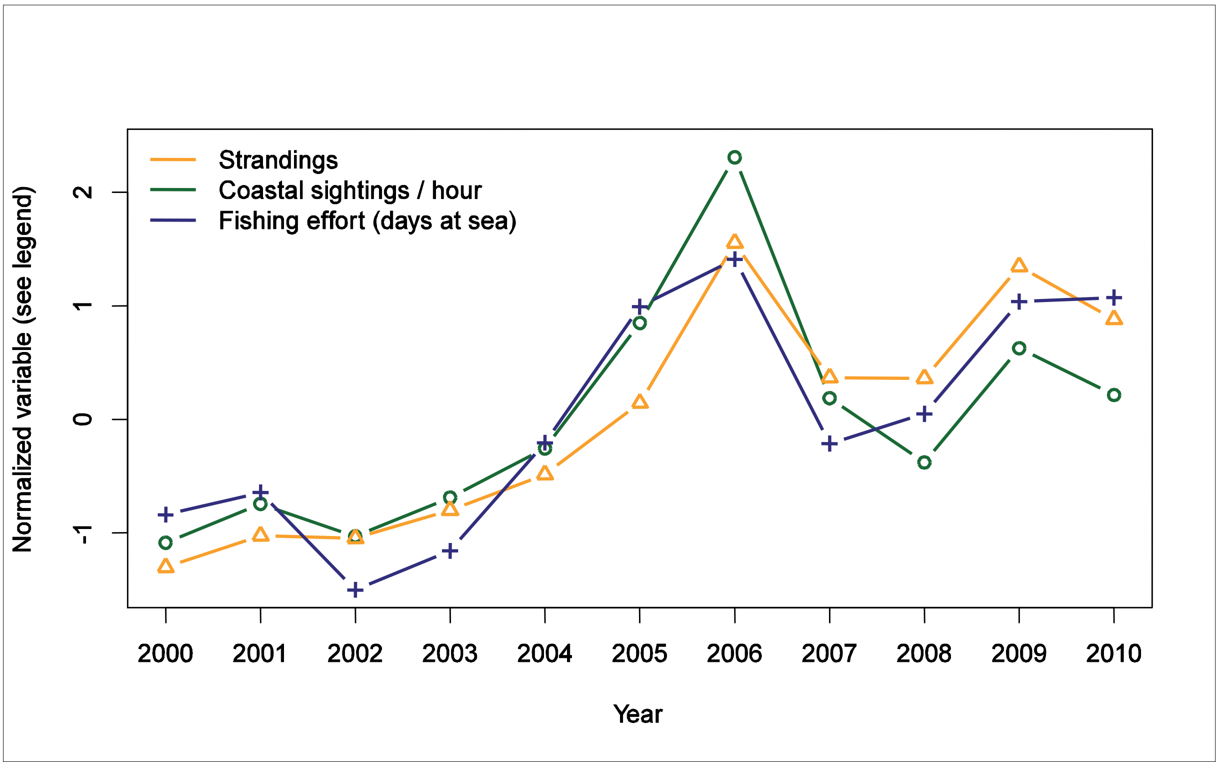


Figure 35. Normalised temperal trends in Harbour Porpoise strandings, nearshore sightings and set-net fishing effort, indicating more or less parallel trends, but also suggesting that more porpoises were found dead in recent years (2007-2010) than expected from nearshore abundance indices, when fishing effort (days at sea) was higher than before.

At first, a negative correlation between Harbour Porpoise strandings and set-net fishing effort seemed to exist (VISSTAT database). Particularly in early spring, when fishing effort is relatively low compared to summer, a rather large number of Harbour Porpoise strandings was reported. However, this ignores the seasonal pattern in porpoise abundance derived from effort corrected nearshore sightings frequencies. Numbers of Harbour Porpoise strandings are obviously closely linked with the number of porpoises present within the area (at-sea abundance). More or less parallel temporal trends were found in strandings data, nearshore sightings data and fishing effort, all peaking in 2006 (**Fig. 35**). However, more porpoises were found dead in recent years (2007-2010) than expected simply from nearshore abundance indices. Part of the discrepancy between the reported strandings and the expected numbers based on Harbour Porpoises observed may be explained by differences in fishing effort (and/or the type of fisheries involved). According to the analysis reported by Aarts & Camphuysen (2011), "days at sea targeting Sole" explained most of the residuals (**Fig. 36**). This is a purely empirical correlation, but this suggests that Harbour Porpoises may get caught, also in Sole fisheries, when the animals are particularly abundant at sea.

In summary, there is abundant evidence for frequent bycatches in fishing gear, notably set-nets, within the North Sea at large. In Dutch waters, necropsies have revealed that a substantial proportion of the stranded animals had drowned, probably as fisheries bycatch, but with little or no evidence regarding the type fishing gear. Even though the exact scale of bycatches is currently insufficiently known, as an evident threat inflicting direct mortality of otherwise fit and healthy animals, a reduction will certainly enhance the conservation status of porpoises in the North Sea.

Within the North Sea, certain types of set net have been found to pose a significantly greater risk than other types. For The Netherlands, that information is currently unavailable. The statistical analysis of a combination of strandings data, sightings data and fisheries effort (Aarts & Camphuysen 2011) would indicate that none of the fisheries with passive gear should be excluded from future attention. Bycatches occur seemingly year-round and throughout the study area. An observer scheme could be established *with priority* (under the expectation of the highest bycatch rates) in the winter fisheries, Dec-Mar, notably in the northern coastal zone (IJmuiden-Vlieland), even though the absolute number of bycatches may be lower in winter (with low fishing effort) than in summer (with high fishing effort, but probably with lower bycatch rates). Observer schemes are thought to provide the most valuable data, when planned and conducted "properly" (i.e. according to recognised international protocols, non-voluntarily, after a power analysis to set the scale of the project and to ascertain an appropriate sample size). Another option to assess the scale of the bycatch problem would be the installation of cameras that record catch and bycatch 24 hours per day, 7 days a week (Dalskov & Kindt-Larsen 2009).

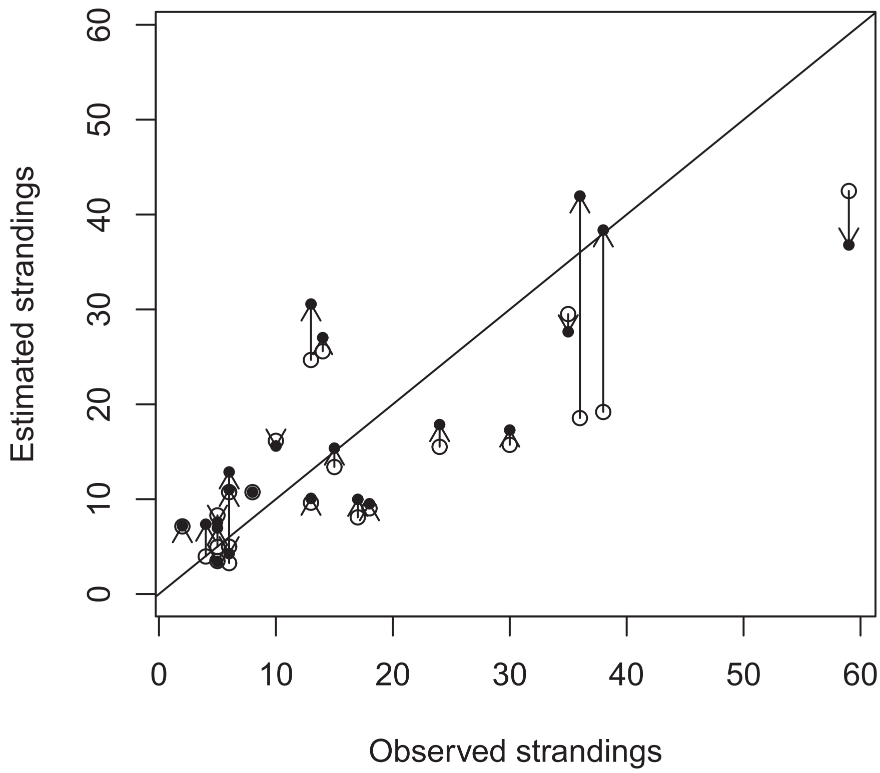


Figure 36. Improvement of the model after building in an effect of fishery for the month March in the different years. Normally, based on coastal sightings only, in March 2009 and 2010 the expectation would have been 19.2 and 18.5 strandings respectively. In fact there are 38 and 36 strandings, which could have been caused by the relative high fishing effort in these years. Building in fishing effort results in an estimated number of strandings of 38.4 and 41.9 stranded animals.

Figure 37. Recreational set-net, Hors, Texel, 2 April 2005 (Photos J.A. van Franeker).

Mitigation measures, further discussed elsewhere in this document, could include the deployment of 'pingers' (deterrent acoustic devices) and/or the spatial en temporal closure of certain fishing operations. However, in the absence of concrete bycatch data, measures to reduce bycatch would either be non-discriminant (negatively affecting a larger component of the fleets than needed), or perhaps mis-directed. The scale of the problem needs assessment and an observer scheme on board seems most appropriate (according to internationally accepted standards, conducted on a sufficiently large scale after a power analysis based on expected bycatch rates). In the absence of further information, a further growth of set-net fishing activities should be prevented, or some system of bycatch prevention should be an integrate part of the license for newcomers.

5.2. Siting, land reclamation

Siting, as a result of infrastructural developments, including all marine industries (marine renewable energy, oil and gas, carbon capture and storage, aquaculture and harbour/marina infrastructure and expansions, as well as new developments) or as a result of transient activities, such as shipping or the marine tourism industry may have an impact on Harbour Porpoises utilising coastal habitats. Areas with extremely busy shipping lanes, such as in the Southern North Sea (seaways through the English

Channel towards Antwerpen, Rotterdam, Amsterdam, Bremen, Hamburg and beyond) may be more or less permanently unavailable as foraging habitats for marine mammals, or pose significant dangers (e.g. vessel strikes, see below). Land reclamation is an issue of particular significance within The Netherlands (e.g. Maasvlakte, Maasvlakte II), during which marine habitats are modified or sacrificed and become dry land (unsuitable for any marine animals). Our current knowledge of Harbour Porpoise habitat preferences is insufficient to fully evaluate area losses as a result of land reclamation. Although the net amount of marine habitat slightly declines as a result of current land reclamation, the impact is seemingly negligible. A historical case in which a fairly large part of the Harbour Porpoise distribution area was lost followed the construction of the Afsluitdijk, which turned the Zuiderzee into a brackish or freshwater lake (IJsselmeer; Heinsius 1914, Stoppelaar *et al.* 1935).

The Harbour Porpoises declined in the 1950s and 1960s when shipping became more intense, but returned in the 1990s and early 21st century when shipping densities were unprecedented. Sightings within the busiest areas are not uncommon (NZG Marine Mammal database) and although the animal may at times avoid certain areas, there is no firm evidence for persistent physical disturbance. Habituation to shipping is still rare, and occurs so far primarily with sailing vessels or vessels with relatively small (silent) engines (Camphuysen & Heijboer 2008).

5.3. Vessel strikes

Figure 38. Possible propeller scars on a Harbour Porpoise observed in March 2011 (Photo: E. Dijkstra).

Collisions with vessels are dangerous for cetaceans, particularly large whales (Vanderlaan & Taggart 2007, Wells *et al.* 2008, Carrillo & Ritter 2010, M.E.E.R.e.V. 2011.). Fast ferries have proven to be particularly lethal with the great majority of collisions leading to severe injury or death at speeds of 14 knots or more. The most fatal or serious injuries have been caused by large ships (80m of length or more). At 40 knots, approaching a whale at 600m leads to a maximum reaction time of 30 seconds (Bräger 2009). Vessel strikes are particularly common in slow-moving marine mammals (Beck *et al.* 1982, Kraus 1990, Wright *et al.* 1995, Knowlton & Kraus 2001). Nowacek *et al.* (2004) studied the endangered Northern Right Whales off the east coast of the USA in which anthropogenic mortality caused by ship strikes is one of the primary factors inhibiting their recovery. Multi-sensor acoustic recording tags were used to measure the responses of whales to passing ships. In addition, they experimentally tested the responses of whales to controlled sound exposures (e.g. recordings of ship noise, the social sounds of conspecifics) and a signal designed to alert the whales. The whales reacted strongly to the alert signal, reacted mildly to the social sounds of conspecifics, but showed no response to the sounds of approaching vessels as well as to actual vessels. Whales responded to the alert by swimming strongly to the surface, a response likely to increase rather than decrease the risk of collision. Bloom & Jager (1994) reported the injury and subsequent healing of a propeller strike to a Bottlenose Dolphin off the Northumberland coast of England. Elwen & Leeney (2010) provided evidence for propeller scars (vessel strikes) in the Heaviside Dolphin *Cephalorhynchus heavisidii*, a small dolphin with a Harbour Porpoise-like life-style and behaviour.

Vessel strikes are perhaps not likely to occur frequently, due to the elusive behaviour of porpoises around motorboats, but jet skis and fast moving engine-powered vessels may pose a risk. High-speed ferries, including engine powered catamarans and hovercrafts could easily take Harbour Porpoises by surprise and wound or kill the animals. Ship-strike avoidance in fast moving vessels will be extremely difficult in case of Harbour Porpoises, because the animals are notoriously difficult to detect, even by specialised observers. Any ship strike-avoiding manoeuvres by fast moving vessels when porpoises *are* detected at short range are unlikely to be successful and are potentially risky for the vessel itself.

Figure 39. Wound in mature female Harbour Porpoise, Bornem, river Schelde, 6 March 2011 possibly caused by a vessel strike (Photo and pers. comm. Jan Haelters KBIN/BMM).

Within Dutch waters, shipping densities are highest within the major shipping lanes, in Westerschelde, Europoort, off IJmuiden, off Den Helder, and around the other, smaller ports. Recreational boats are most abundant within the Wadden Sea and Delta area, and these include vessels using sails and small motorboats. Jet-skis are not commonly used and in many coastal areas, the use of jet skis is restricted. High-speed ferries run between Harlingen, Terschelling and Vlieland. A presumed vessel strike was documented in March 2011 in the Dutch Wadden Sea in the shipping lane Texelstroom where a porpoise was seen with presumed vessel strike scars (**Fig. 38**). In Belgium, in the river Schelde, 6 March 2011 in Bornem, an adult female Harbour Porpoise was found dead. The animal showed a deep cut in the dorsal side, and the necropsy confirmed this injury, possibly caused by a vessel strike, as the cause of death (Jan Haelters pers. comm.; **Fig. 39**). Another vessel strike has been documented and occurred in August 2010 in the Oosterschelde (NL Delta area). A skipper reported a vessel strike with a porpoise June 23. The porpoise was hit at the tailstock, but did not immediately die. With near-certainty, the same animal was found stranded a few days later: with a broken tailbone and a wound on the back. Camphuysen & Heijboer (2008) reported on the unusual (bow-riding) behaviour of Harbour Porpoise in Grevelingenmeer (Delta area). Skippers of sailing vessels reported frequent physical contact between boat and that one particular animal (an initiative of the animal itself), but while superficial scars and scratches developed over time on the animal's body, adverse side-effects could not be witnessed and the animal was seen for many years.

Although vessel strikes may occasionally seem to have lethal impacts on Harbour Porpoises, it is at present not seen as a significant threat. Nevertheless it is recommended to continue documenting available evidence, to able to signal a possible increase in vessel strikes.

5.4. Windfarms

Offshore windfarms (or any other offshore renewable energy units), coastal fish farms or land reclamation may have a direct impact on Harbour Porpoises, displacing them from favourable habitat for feeding and other behaviours (Davies *et al.* 2004). Since the beginning of the planning and installation of offshore windfarms, the possible impacts on marine mammals have been discussed within the scientific community (Nedwell & Howell 2004, Thomsen *et al.* 2006). The noise created during pile-driving operations (**Fig. 40**) involves sound pressure levels were considered high enough to impair the hearing system of marine mammals near the source and disrupt their behaviour at considerable distance from the construction site. There were further concerns about the other operational phases of windfarms. Nedwell & Howell (2004) used four phases to assess the acoustical implications:

Pre-construction	Include geophysical and geotechnical survey, meteorological mast installation and an increase in vessel traffic. Vessel traffic will increase in the vicinity of a windfarm before its construction and continue through to decommissioning.
Construction	One of most significant activities during windfarm construction is foundation installation. Dredging and rock laying may be undertaken during windfarm construction. Other construction activities include cable laying, turbine and turbine-towerinstallation, and ancillary structure (e.g. offshore transformers) installation. In addition to this, divers will be used throughout windfarm construction to carry out underwater activities, and they may use a variety of tools.
Operation	By far the longest phase of a windfarm's lifecycle is the operational phase. Expected are low frequency sound levels from the turbines.
Decommissioning	The final stage of a windfarm's lifecycle, the majority of which may be a reflection of the installation process. However, the wind turbine foundation decommissioning process is unclear. Options for pile foundation removal include jet and explosive cutting below the seabed. While the process for concrete foundation decommission is not known, it may include explosive break up followed by dredging.

Koschinski *et al.* (2003) recorded behavioural reactions of free-ranging porpoises to the simulated noise of a 2 MW windpower generator and found a clear behavioural response, indicating that these animals were able to detect the low-frequency sound generated by offshore wind-turbines. Madsen *et al.* (2006) reported that the reported noise levels from operating wind turbines are low, and are unlikely to impair hearing in marine mammals. Scheidat *et al.* (2011) studied if Harbour Porpoises actively avoided a Dutch offshore wind farm at Egmond aan Zee by by studying acoustic activity of porpoises within the farm and in two reference areas (with T-PODs) prior to construction (Jun 2003-Jun 2004) and during normal operation (Apr 2007-Apr 2009). A strong seasonal pattern found (with more activity recorded during winter months) and an overall increase in acoustic activity from baseline to operation was in line with a general increase in Harbour Porpoise abundance in Dutch waters over the last decade. The acoustic activity was significantly higher inside the wind farm than in the reference areas, indicating Harbour Porpoises did not only not avoid the windfarm area, but were even seemingly attracted. The reasons of this apparent attraction to the wind farm area were not clear, but food availability (reef effect) and the relative absence of vessels within in an otherwise heavily trafficked part of the North Sea (sheltering effect) were mentioned as factors.

Figure 40. Windfarm (pile driving) construction activities 16 April 2006 (C.J. Camphuysen).

Danish results showed that perhaps the effects of noise generated in and around windfarms should not be generalized. At Horns Rev and Nysted Offshore Wind Farms in Denmark the potential effect of construction and operation was investigated from 2001 to 2005 (Teilmann *et al.* 2006). Only a slight decrease in porpoise abundance was found at Horns Reef during construction and no effect during operation of the wind farm was observed. However, a clear decrease in the echolocation activity of porpoises was found at Nysted during both construction and operation of the wind farm. This effect still persisted after two years of operation, with indications of a slow, gradual recovery. At both wind farms a substantial but short lived effect of pile driving was observed with larger responses at Nysted, where silent periods after pile driving were several days compared to hours at Horns Reef. The stronger response at Horns Rev compared to Nysted may be speculated to be caused by a higher motivation/competition to find food at Horns Rev regardless of the presence of a wind farm. Another explanation could be that the more turbulent and noisy environment at Horns Rev makes the turbines and the noise less detectable to the porpoises.

Thompson *et al.* (2010) used passive acoustic monitoring to assess whether cetaceans responded to pile-driving noise during the installation of two 5 MW offshore wind turbines off NE Scotland in 2006. Monitoring was carried out at both the turbine site and a control site in 2005, 2006 and 2007. Harbour Porpoises occurred regularly around the turbine site in all years, but there was some evidence that porpoises did respond to disturbance from installation activities.

Brandt *et al.* (2011) monitored the effect of pile-driving activities in summer 2008 (92 monopile foundations of 3.9 m diameter were rammed into the seabed of the Danish North Sea west of Esbjerg to construct the offshore wind farm Horns Rev II). Using passive acoustic monitoring devices (T-PODs) to record porpoise echolocation clicks, a clear impact of pile driving activities was found during construction of the wind farm on porpoise acoustic activity. Porpoise acoustic activity was reduced by 100% during 1 h after pile driving and stayed below normal levels for 24 to 72 h at a distance of 2.6 km from the construction site. This period gradually decreased with increasing distance. A negative effect was detectable out to a mean distance of 17.8 km. At 22 km it was no longer apparent, instead, porpoise activity temporarily increased. Out to a distance of 4.7 km, the recovery time was longer than most pauses between pile driving events. Consequently, porpoise activity and possibly abundance were reduced over the entire 5 mo construction period. The behavioural response of Harbour Porpoises to pile driving lasted much longer than previously reported.

There are several options to reduce potential damage:

Pre-construction	No expected effects, except when seismic surveys are part of the preparatory phase (see elsewhere); therefore no measures
Construction	Avoid pile-driving, or pile-driving only under controlled conditions (acoustic or other deterrents, ramping up noise[6]) in seasons of low abundance).
Operation	No measures
Decommissioning	Avoid underwater explosions, or only under controlled conditions (acoustic or other deterrents, ramping up noise) in seasons of low abundance.

Brandt *et al.* (2011) studying the effects of pile-driving in Horns Rev II in 2008 concluded that mitigation procedures that consisted of the application of scaring devices that aim to keep the animals out of a zone where physical injury might occur, seemed to have succeeded. Based on noise measurements near the construction site, injury would only have occurred at distances of up to 2 km. No animal was detected at distances less than 3 km during pile driving, and thus mitigation measures were probably effective.

In summary, there is abundant evidence that the construction of windfarms triggers avoidance behaviour of Harbour Porpoises within the North Sea at large. Even during pile-driving events, however, the avoidance behaviour is short-lived and normal abundances are restored within days after an impact. The effects are slightly more prolonged in some sites than in others. The operational phase of windfarms, for as far as monitored, generally does not pose a significant effect on

[6] **Ramp-up procedures**
A widely used mitigation method is 'rampup' or 'soft start'; the stepwise increase of the sound-level over a period of several minutes or hours, to enable animals to detect the sounds at low levels and move away before harmful effects occur. This is practical in some cases (for example, air gun arrays), but not in others (such as tactical use of sonar in antisubmarine combat). Ramp-up mitigation is based on the assumption that animals will locate the source of the lowlevel sound and will react appropriately to avoid exposure. Rigorous tests of the effectiveness of ramp-up techniques are seemingly scarce.

the abundance of Harbour Porpoises, but again, in some study areas the animals were seemingly more reluctant to return than in others. Mitigation measures, further discussed elsewhere in this document, would include extreme care during the construction phase: ramp up the noise levels, use of acoustic deterrents, appropriate timing.

5.5. Acoustic disturbance; loud explosive sounds

Marine mammals rely on sound for all of the fundamental biological and ecological aspects of their lives including navigation, prey location and capture, predator avoidance, and communication (including during migration and reproduction). Certain anthropogenic sounds are widely believed to cause strandings of whales. Underwater noises may not only affect the overall range or localised use of available habitats in whales and dolphins, but may be directly damaging. The effect may in these cases be more acute: lethal or deafening effects. Sources of particularly loud underwater sounds include seismic exploration by mainly the oil and gas industries, echo sounders, pile driving activities during the installation of offshore windfarms (discussed earlier), underwater explosions (nuclear and otherwise, including detonation of old ammunition), shipping, and naval sonar operations, and probably several others (Goold & Fish 1998, Stone 2003, Theriault 2005, Cox *et al.* 2006, Kvadsheim *et al.* 2007, Weilgart 2007, Weir & Dolman 2007, Lucke *et al.* 2009, Parsons *et al.* 2009, Santos *et al.* 2010, Thompson *et al.* 2010; see further references under Windfarms). Worldwide, several cases of whale strandings have been connected to the use of powerful military sonar (Balcomb III & Claridge 2001, D'Amico *et al.* 2002, Jepson *et al.* 2003, but see Bradshaw *et al.* 2005). Potential biological effects of air gun noises produced during seismic surveys include physical/physiological effects, behavioural disruption, and indirect effects associated with altered prey availability. Physical/physiological effects could include hearing threshold shifts and auditory damage as well as non-auditory disruption, and can be directly caused by sound exposure or the result of behavioural changes in response to sounds, e.g. recent observations suggesting that exposure to loud noise may result in decompression sickness in deep water (Gordon *et al.* 2003). Different taxonomic groups of cetaceans may adopt different strategies for responding to acoustic disturbance from seismic surveys; some small odontocetes move out of the immediate area, while the slower moving mysticetes orient away from the vessel and increase their distance from the source but do not move away from the area completely (Stone & Tasker 2006). Airgun arrays typically produce high amplitude sound with source levels in the region of 220-248 dB re. 1 μPa @ 1 m. The acoustic output has highest energy at relatively low frequencies of 10-200 Hz, which overlaps extensively with the low frequency sound produced by baleen whales in the 12-500 Hz bandwidth. Airgun arrays may also produce significant high frequency sound energy, with airgun sound dominating frequencies up to 22 kHz within a few kilometres of the source. Since small odontocete species utilise and are sensitive to sound in the 0.5-20 kHz range, both odontocete and mysticete species may potentially be adversely affected by airgun sound (Weir & Dolman 2007).

Lucke *et al.* (2009) performed an auditory study to derive data on temporary threshold shift induced by single impulses, to serve as basis for the definition of noise exposure criteria for porpoises. The measurements of temporary threshold shifts were conducted on a Harbour porpoise by measuring the auditory evoked potentials in response to amplitude-modulated sounds. After obtaining baseline hearing data the animal was exposed to single airgun stimuli at increasing received levels. Immediately after each exposure the animal’s hearing threshold was tested for significant changes.

The received levels of the airgun impulses were increased until a temporary threshold shift was reached. The animal consistently showed aversive behavioural reactions at received sound pressure levels above 174 dB_{pk-pk} re 1 μPa or a sound exposure level of 145 dB re 1 $μPa^2$ s. Elevated levels of baseline hearing sensitivity indicate potentially masked acoustic thresholds and the resulting temporary threshold shift levels should be considered *masked* temporary threshold shift levels. The levels found were lower than for any other cetacean species tested so far.

Acoustic disturbance is considered to have a significant impact also on Harbour Porpoise populations (Davies *et al.* 2004). For example, to prevent grounding of ships and collisions between ships in shallow coastal waters, an underwater data collection and communication network has been developed: Acoustic Communication network for Monitoring of underwater Environment in coastal areas (ACME; Kastelein *et al.* 2005). Marine mammals might be affected by ACME sounds since they use sounds of similar frequencies (around 12 kHz) for communication, orientation, and prey location. If marine mammals tend to avoid the vicinity of the transmitters, they may be kept away from ecologically important areas by ACME sounds. Kastelein *et al.* (2005) tested the effect of these sounds on porpoises in captivity and proposed simple mitigation measures. Numerous other anthropogenic sounds will have an effect on Harbour Porpoise behaviour, although habituation is likely in the less serious cases. A concern is the effect of persistent acoustic disturbance, situations in which Harbour Porpoises continue to move away from the sound source and cannot feed for a significant length of time. Harbour Porpoises require frequent, small meals and the prevention of feeding for a length of time could therefore potentially harm them (Kastelein *et al.* 1997d).

The observed effects of underwater noise of windfarms on Harbour Porpoises elsewhere within the North Sea have been discussed above. The situation within The Netherlands is likely to be similar (avoidance behaviour during pile-driving, habituation or non-avoidance during the operational phase of windfarms. For any of the other loud noises underwater (explosions, seismic exploration, naval sonar operations), there are no data available that Harbour Porpoises within the Southern North Sea are affected, but this mostly due to a lack of study rather than that there are no effects to be expected. One of the more common forms of "acoustic pollution", the sound of ship's propellers, is listed among the potential sources of acoustic disturbance. There is clear evidence for ship avoidance behaviour (small scale effects; visual observations during ship-based surveys at sea). Population level effects are not expected.

Controlled underwater explosions, currently by the "Explosieven Opruimingsdienst (EOD)"[7], to destroy old mines and other ammunition from the seafloor (clearly visualised at http://www.youtube.com/watch?v=DG7xrr1LqOE), are likely to have an impact on any nearby marine wildlife. The removal of old mines, bombs, granates and torpedo's has been intensified since April 2005, when three crewmembers of a Dutch trawler were killed as a result of an exploding bomb on deck. Since that time, the Dutch Royal Navy (now the EOD) has detonated or removed many hundreds (*c.* 860) of explosives within the Dutch sector of the North Sea[8]. 136 explosives have been cleared from the NCP in 2008, with an average charge weight of 60 kg. These explosives have been detonated using various types of charges: 119 times a 18 kg TNT charge, 3 times a 1.5 kg 'Seafox' and 14 times a 100 kg mine destruction charge. So the average charge weight for the detonations is 78 kg, which releases about 78 MJ of acoustic energy. The total annual charge weight is about 12 tons. In addition to that, an estimated maximum of 1.3 tons charge weight of ammunition was cleared by the DDG (Duik en Demonteer Groep) in 2008, at near-shore locations (Schulpengat, Marsdiep, Texelstroom and Petten).

[7] http://www.defensie.nl/actueel/nieuws/2009/06/03/46132043/Oprichting_Explosieven_Opruimingsdienst_Defensie
[8] http://www.depers.nl/binnenland/530332/Marine-ruimt-honderd-bommen-op-zee.html

There is also an unspecified limited amount of explosions for training of the Marines. This leads to an estimated maximum for the total released acoustic energy by explosions of circa 14 GJ per year. (Ainslie 2009)

New classes of military vessels undergo tests, called ship-shock trials, to determine their ability to withstand explosions (U.S. Marine Mammal Commission, 2004). However, these tests are not carried out in the North Sea. The Royal Netherlands Navy has tested their latest class of frigates at the Swedish facility in the Stockholm Archipelago (Baltic Sea) and the UK uses shock test facilities west of Ireland. (Ainslie 2009).

Regarding seismic exploration, the marine mammal mitigation measures currently in use worldwide show considerable variation in parameters such as the exclusion zone radius, the marine mammal species included in mitigation, and delay/shut-down procedures. Relatively few aspects of current mitigation have a firm scientific basis and proven efficacy in the field, and there remains a total lack of effective mitigation during night and adverse weather (Weir & Dolman 2007). To address conservation concerns that have arisen in relation to seismic surveys, the UK government issued guidelines for seismic operations. The guidelines have requirements for operators at the planning stage and during the operation of a seismic survey. For example, for at least 30 minutes prior to using airguns, onboard observers should check for the presence of marine mammals within 500m of the airgun array; if any are detected then use of the airguns must be delayed until at least 20 minutes after the last sighting. Whether marine mammals are detected or not, a 'soft start' procedure should be employed, where airgun array power is gradually built up over at least 20min from a low energy starting level (Stone & Tasker 2006).

5.6. Mining activities

Mining activities for sand and gravel at sea are increasingly important (Phua *et al.* 2002, Anon. 2004, Demeyere 2005). In the Netherlands, the most commonly used vessel for sand extraction is the trailer suction hopper (Phua *et al.* 2002). Trailer suction hoppers have varying carrying capacities, ranging from less than 1000 m3 to more than 7000 m^3. The vessel lifts material from the seabed via suction pipes (either 1 or 2) directed backwards, into the hopper while the vessel is in motion. The top layer of the sediment is removed, tracks sized 1-2 m broad and 20-50 cm deep is left on the seabed. Sediment and water will be lifted on board, the water and some silt will overflow during filling. Once the material is on board, most vessels can screen on board for the desired composition of grain size and aggregates. Unwanted sediment fractions will be rejected from the vessel. Often large plumes of increased turbidity in the vicinity of the vessel are created, when the hoppers overflow or when screening is being carried out. With static suction hoppers, a suction pipe facing forward lifts material on board while the vessel is static. The extraction leaves conical shaped pits, which range between 20 to 75 metres wide. This method of extraction is commonly used when the aggregates targeted are deep and/or spatially limited, or when the targeted aggregate is located under or is embedded with unsuitable material (for e.g. fine sediment, organic matter). The maximum dredging depth for both dredgers is usually around 30 metres. During the extraction process, plumes of suspended material are created. In the Netherlands the regular extraction of marine sediments has a maximum extraction depth of 2 meters below the seabed surface. This is referred to as 'regular' or 'shallow' dredging (all from Phua *et al.* 2002).

A study by Tillin *et al.* 2011 considered the direct and indirect impacts of aggregate dredging on among others marine wildlife. According to this study the impacts on marine mammals from marine aggregate dredging are generally considered to be minor. A direct impact is expected caused by the creation of sediment plumes causing turbidity leading to avoidance of areas. Indirect impacts of dredging shipping activities on marine mammals result from an increase in noise in the marine environment and the risk of collision with vessels. Dredging might be audible for most marine mammals over considerable distances up to several kilometres from the source, depending on conditions (Cefas 2009). Field studies having measured the source noise levels of different aggregate extracting activities at the surface and at different depths in the water column found that the sound signature (over a range of frequencies) from aggregate extraction resembles that of a large cargo transport ship. Any displacement of individual animals is considered to be localised and temporary. Hearing damage is unlikely to occur at the sound frequencies and intensities associated with aggregate dredging. A reduction in benthic invertebrate biomass, following dredging might affect marine mammals as predators (Tillin *et al.* 2011).

Hopper vessels produce noise when dredging and when moving (Phua *et al.* 2002). Underwater noise can have an effect on marine mammals (Richardson *et al.* 1985ab). The effect of sand and gravel extraction at sea on Harbour Porpoises is currently unknown. Further studies would be needed to find adverse effects on marine mammals.

5.7. Marine litter

Figure 41. Stranded Humpback Whale, Vlieland, 22 June 2004, strangled to death by a 'ghost' loop around the head (photos D. Bruin).

In the past decades, the use of plastics and other synthetic materials has expanded at a rapid pace (Laist 1987). The quantity of plastic debris entering the marine environment has undergone a corresponding increase. Many of these products degrade slowly. Those that are buoyant remain suspended at the sea surface for a long time, and those that are not, sink and remain on the bottom for years or even decades. The accumulating debris poses increasingly significant threats to marine mammals, seabirds, turtles, fish, and crustaceans. Marine litter includes a huge range of discarded inorganic debris including discarded user plastics (such as plastic bags, bottles, foils, and fragments), fishing gear, as well as industrial plastics (e.g. pellets; Coleman & Wehle 1984, O'Hara 1988; **Fig. 42**). Sources of marine litter are derived from vessels, land-based sources, and (least likely, given stringent sanitary procedures on board) from offshore installations (Dixon & Dixon 1983, Merrell 1984, Wolfe 1987, Heneman & Center for Environmental Education 1988, O'Hara K. *et al.* 1988, Schrey & Grosch 1990, Vauk & Schrey 1990, Williams *et al.* 1993, Orth *et al.* 1995, Wijffels & Span 1999, Clemens & Hartwig 2004, Hartwig 2004.). There is a wealth of literature, both about the scale of the global litter problem as well as about the effects on the marine environment and on wildlife (Derraick 2002). Marine mammals are mostly affected as a result of entanglements and by ingestion of plastic materials. Another less known threat includes the absorption of polychlorinated biphenyls from ingested plastics.

Plastic ingestion could have directly lethal effects (internal injury) or lead to starvation and delayed death. Around the world, there is evidence of lethal effects of plastic ingestion by cetaceans (Barros *et al.* 1990, Secchi & Zarzur 1999, Baird & Hooker 2000, Stamperi *et al.* 2006, Levy *et al.* 2009, Jacobsen *et al.* 2010). Several instances of plastic ingestion by Harbour Porpoises in the North Sea have been reported (Kastelein & Lavaleije 1992, Leopold & Camphuysen 2006).

Figure 42. Harbour Porpoise entangled in monofilament set net and an animal with nylon line around the flukes, Maasvlakte (photos J van der Hiele, EHBZ)

Entanglements in litter or lost fishing gear may result in external injuries or drowning and are another worldwide issue for larger marine vertebrates, cetaceans included (e.g. Croxall *et al.* 1990, Philo *et al.* 1992). 'Ghost fishing' is the term given to the continued fishing by fishing gear that has been lost or abandoned (Brown *et al.* 2005) and this is largely confined to 'passive gears' such as gillnets, trammel nets, wreck nets, and traps. It is a phenomenon that has attracted attention over the past two decades given the sometimes graphic images of fish and other marine life entangled in lost nets, illustrating the potentially wasteful and destructive impacts of lost fishing gear. Brown (*et al.* 2005) concluded that in relation to the total number of nets being used in EU waters, the rates of permanent net loss appear to be rather low (<1% of nets deployed), largely because most nets are deployed in shallow waters. A significant proportion of such nets are recovered; fishermen typically go to considerable lengths to recover nets given their cost. However, because the total length of nets being set is high, the total length of netting permanently lost may be significant, although exact figures are not available. An exception to the low loss rates seen in most European fisheries is in the deep water net fishery in the north east Atlantic. Preliminary research suggests that around 25,000 nets may be lost or deliberately discarded in this fishery each year, with a total length of around 1250 km. Brown *et al.* (2005) conclude, however, that knowledge about the extent of ghost fishing is still limited. Some fisheries have not yet been researched at all, and due to the costs and practical difficulties of underwater survey work and of simulating ghost catches through experiments, estimates of ghost catch rates are imprecise. During beach surveys in The Netherlands, carcasses of cetaceans and seals have been found with ropes, lines, nylon thread or remains of nets around flippers, tail or skeleton parts. One of the more dramatic cases was the Humpback Whale *Megaptera novaeangliae* stranded at Vlieland in 2004 in which a rope around the 'neck' had strangled the animal to death (**Fig. 41**). In several cases reported during beach surveys, however, post-mortal "entanglement" was suspected (damaged carcasses with a variety of beach litter associated with the body). In the absence of a proper observation protocol on the beach, the available evidence is at best anecdotal and remains inconclusive.

5.8. Marine pollution

Organic and metal pollutants Chemical pollution is considered to be a significant threat, potentially suppressing immune functions resulting in increased susceptibility to infectious disease mortality (Aguilar 1985, Borrell & Aguilar 1993, Caurant *et al.* 1993, Aguilar & Borrell 1995, Ridgway & Reddy 1995, Lockyer & Kinze 2003). Hormonal effects of pollutants, disruption of reproductive success, effects of endocrinological organs such as the adrenal glands and immunological impairment have been attributed to pollutants affecting the marine mammals that are particularly vulnerable as top predators of the marine environment (Reijnders 1984, 1986, 1988, García Hartmann 1997).

The main pollutants believed to be affecting cetaceans today are chlorinated hydrocarbons, brominated flame-retardants (chemicals to prevent fabrics, electronic instruments and other equipment from burning) and organic tin compounds (such as TBT – used as an anti-foulant on boat hulls). Generally, relatively low concentrations of toxic elements were encountered in the tissues of European porpoises. Significant geographical differences were seen in hepatic Zn concentrations. In recent years, a growing concern has been expressed about another class of organohalogen chemicals, namely perfluorinated organic compounds (FOCs). Results of previous studies suggest that perfluorochemicals, in particular, perfluorooctane sulfonic acid (PFOS), are spread worldwide in wildlife and in humans, even in remote arctic areas such as the Arctic Ocean (van de Vijver *et al.* 2004).

In the past, the North Sea ecosystem was highly loaded with both organic and metal pollutants introduced by various anthropogenic activities within the coastal zones and at sea (Kakuschke & Prange 2007). Recent studies have shown a decline in the input of pollutants into the ecosystem, but concentrations of Hg, Cd, Pb and Zn are still high compared to the "Background Reference Concentrations" which the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) derived for the "Greater North Sea" (Schmolke *et al.* 2005). Law *et al.* (2010), studying Harbour Porpoises sampled within the UK Cetacean Strandings Investigation Programme, stranded or bycaught during the period 1991-2005 (n= 440), demonstrated regional differences in the trend in summed congener concentrations over time but concluded that they are declining only slowly. Further efforts to limit or eliminate PCB discharges to the marine environment are thus still needed (Law *et al.* 2010).

Within that same stranding programme, analysis of brominated flame retardants began in 1999, initially focusing on brominated diphenylethers. Since the withdrawal of the pentamix and octamix polybrominated diphenyl ether (PBDE) formulations from the EU market prior to August 2004, two other highvolume products, hexabromocyclododecane (HBCD) and tetrabromobisphenol A (TBBP-A), have been included. Eighty-five samples were analyzed for HBCD, and 68 of these for TBBP-A. R-HBCD dominated over the other isomers and was detected in all samples analyzed. The maximum concentration was about double that reported in earlier U.K. studies. On the contrary, TBBP-A was detected in only 18 samples and at much lower concentrations. The sharp increase in HBCD concentrations from about 2001 onward, was not confounded by age (length), sex, nutritional status, or location, but may have been a result of changing patterns in the use of HBCD within the EU (Law *et al.* 2006).

The effects of pollution on cetaceans are typically delayed and appear as changes in health, nutrition, growth, reproduction and mortality, but they can be hard to detect. There are considerable methodological difficulties in the study of bioaccumulation of trace elements in delphinids (André 1997). Metals and their effects on marine mammals have been reviewed by O'Shea (1999), Reijnders, Aguilar, & Donovan, (1999), and Das *et al.* (2003).Apart from metal body burden data, however, only limited information is available on the related health effects (Kakuschke & Prange 2007). In a study on Harbour Porpoise found in the United Kingdom, the hypothesis that PCBs cause immunosuppression in Harbour Porpoises and increase their risk of dying from an infectious or parasitic disease was not supported (Kuiken *et al.* 1994). Jepson *et al.* (1999) investigated the associations between chronic exposure to PCBs and infectious disease mortality in Harbour Porpoises in UK waters. The infectious disease group had significantly greater chlorobiphenyl concentrations than the physical trauma group. The relationship between higher chlorobiphenyl and the infectious disease group was not confounded by age, sex, nutritional status, season, location or year of stranding. In addition, adult females had significantly lower chlorobiphenyl levels than adult males due to maternal transfer of chlorobiphenyls to offspring. These findings are consistent with the hypothesis that chronic PCB exposure predisposes Harbour Porpoises in UK waters to infectious disease mortality (see also Jepson *et al.* 2005).

Evidence for the *presence* of certain pollutants in stranded Harbour Porpoises in the North Sea is widely available in the literature. Harbour Porpoises collected in Northern Europe were heavily contaminated with PFOS and to a lesser extent with perfluorocarboxylates. The concentration range in the German Baltic Sea was significantly higher compared to Iceland and Norway corresponding to previous reports on increased pollution levels in this area. Harbour Porpoises may be considered indicators of coastal pollution and high concentrations of anthropogenic contaminants in the organism are expected from animals living in polluted seas, such as the North or Baltic Seas (Boon *et al.* 1994, Kleivane *et al.* 1995; van Scheppingen *et al.* 1996; Bruhn *et al.* 1999). Kleivane (*et al.* 1995) indicated that organochlorine concentrations in Harbour Porpoises incidentally caught in Scandinavian waters were 2-3 times higher than corresponding levels detected in Harbour Seals from the same areas. Selected trace elements (Cd, Cu, Hg, Se, and Zn) were measured in kidneys and liver of 104 Harbour Porpoises stranded along the coasts of France, Galicia (Spain), Ireland, Scotland (UK), and The Netherlands (Lahaye *et al.* 2007). Elevated Zn concentrations in porpoises found in The Netherlands were related to their poor health status (Lahaye *et al.* 2007). Concentrations of organochlorine pesticides (HCB, DDTs and HCHs) in Harbour Porpoises stranded on the Belgian North Sea coast were low, but relatively high concentrations of PCBs were measured (Covaci *et al.* 2002).

Oil pollution The Southern North Sea is, worldwide, one of the more severely polluted basins with regard to chronic oil pollution (Couper 1983, Clark 2001). The amount of oil released at sea has declined substantially over time (Camphuysen 2007, 2010), but was substantial until the early 1990s.

Beached bird surveys conducted between 1901 and 1910 did not produce evidence that contamination with oil is an important threat to Harbour Porpoises. Of 436 animals found and checked, (some) oil was found on only three carcasses (1x Feb 1933, 1x Mar 1978, and 1x Aug 1981; Dutch Seabird Group, NZG/NSO files, *unpublished data*[9]. Oil spills were ranked by 44% of the interviewees as being a `serious threat' during a campaign in summer 2001, when 252 members of the public in south-west Scotland were interviewed to determine their awareness of, and opinions on, cetacean conservation issues (Scott & Parsons 2005). We are unaware of any spills, however, in which a substantial number of Harbour Porpoises has been killed, within Europe or anywhere in the world. No measurable effect of the "*Erika*" oil spill was found in dolphins and seals (Ridoux *et al.* 2004). Large numbers of seabirds were killed in the Sea Empress spill in the Irish Sea, but SEEC (1998) concluded that the spill had no impacts on mammals. Fish and mammals appeared to be able to avoid the worst of the oil.

5.9. Reduced prey availability

Reduced prey availability due to sea temperature rise, changing ocean currents and other climatic aspects or to fisheries or a combination of factors may affect porpoise distribution and abundance. Davies *et al.* (2004) suggested that Harbour Porpoises are opportunistic feeders, and that they may thus change their diet, or alternatively move further away to more favourable feeding grounds within their geographical range. Despite this, MacLeod *et al.* (2007) investigated whether these changes are affecting the Harbour Porpoise. Sandeels Ammodytiidae are known to be negatively affected by climate change in a number of ways. Stomach contents were collected from stranded porpoises from the coasts of eastern Scotland, Orkney, Shetland and the Pentland Firth (collectively the Scottish North Sea coasts) as part of a dedicated strandings reporting scheme that also investigated the cause of death and other biological parameters. Porpoise diet was examined in spring (March-May), a critical time of year for survival when sandeels are important prey, from 1993 to 2001 to provide baseline information on the proportion of sandeels consumed. When data from spring 2002 and 2003 were compared to these baseline data, the diet was found to be substantially different, with a significant and substantially smaller proportion of sandeels being consumed in March and May. There were also differences in the number of porpoises starving between the two time periods (33% in spring 2002 and 2003 died of starvation, but only 5% in the baseline period). This suggested that a lower proportion of sandeels in the diet of porpoises in spring increased the likelihood of starvation. MacLeod *et al.* (2007) therefore, suggested changes in sandeel availability, as a negative effect of climate, may have had a serious impact on Harbour Porpoise populations in the north-western North Sea by increasing the likelihood of starvation in spring. There has been an immediate critique on the MacLeod at al. (2007) publication (Thompson *et al.* 2007). Two fundamental problems with MacLeod *et al.*'s (2007) analyses were outlined: firstly, the results as percentage changes were based on small sample sizes, and secondly, assessments of the biological significance of changes in the frequency of sandeels in the diet, or numbers of starving porpoises, require closer examination of alternative states. Several hundred Harbour Porpoises are stranded annually around UK coasts and over 40% are killed traumatically (primarily fisheries by-catch or attacks by Bottlenose Dolphins) and the remainder die from various natural causes *including* starvation (Jepson 2006).

[9] Between 1901 and 2010, 11,323 surveys were conducted along the Dutch shoreline in the Beached Bird Survey programme, covering 70,937 km in total. During these surveys, 286,369 dead birds were found, 95,611 of which contaminated with oil. Of 436 Harbour Porpoises found dead, 261 were unoiled, 3 were oiled, the remainder were not fit for external inspection of oiling (NZG/NSO database, Dec 2010).

Kuiken *et al.* (1994) significant differences in body condition between animals that died from an infectious or parasitic disease, or physical trauma and recommended a quantitative measure of body condition, such as relative body girth, as a diagnostic aid in the pathological examination of Harbour Porpoises.

In 78 stranded porpoises studied between Dec 2008 and Nov 2009 in The Netherlands in which a cause of death was identified (**Table 4**), Wiersma & Gröne (2009) reported emaciation or starvation as the proximate cause of death in 26 (34%) of the animals. Emaciation or starvation was listed as a proximate cause of death in 18 of 83 (22%) studied porpoises (with cause of death identified) in The Netherlands between Dec 2009 and Nov 2010 (Gröne & Begeman 2010). In the last study, it was observed that most animals diagnosed as bycatch or trauma were found during the late winter peak in material (February), whereas the summer peak comprised mostly animals in poor condition (including neonates). Our understanding of the effects of pollutants on animals in poor nutritive status is currently very incomplete and would require further attention. Investigating potential associations between chronic exposure to chemical pollutants (such as polychlorinated biphenyls) and infectious disease (Jepson *et al.* 1999), levels of nematode infestations (Bull *et al.* 2006), and the effect on individuals in a more nutritive status is important. Neonates and older individuals should be investigated separately.

Studies of the ecology of Harbour Porpoises in the southern North Sea are required to shed more light on prey availability and resources (stocks). With between a fifth and a third of all porpoises studied during necropsies in recent years being in poor condition (starved to death or severely emaciated), the signal is too strong to be ignored. Even though the factual evidence is slender to support the hypothesis that porpoises from the northern North Sea have invaded the southern Bight in recent years in search of food (Thompson *et al.* 2007), we have no data showing that the hypothesis may be rejected, or that the southern North Sea has developed into an attractive feeding area for Harbour Porpoises in recent decades.

5.10. Natural predators, competition

Natural predators of Harbour Porpoises, such as Killer Whales *Orcinus orca* (Van Dieren 1931), or large sharks (Anselmo & Van Bree 1995) do not occur in the Southern Bight or are so exceptionally rare that they cannot be a factor of importance. Among several hundred Harbour Porpoises that are found stranded annually around UK coasts, over 40% are killed traumatically either as fisheries bycatch or as a result of Bottlenose Dolphin attacks (Thompson *et al.* 2007). The majority (63%) of Harbour Porpoises stranded around the Moray Firth, Scotland, died from trauma characterized by multiple skeletal fractures and damaged internal organs. Surface injuries consisted of skin cuts resembling the teeth marks inflicted by bottlenose dolphins, of which there is a (resident) population in the Moray Firth. Reasons for these interactions are unknown and similar documented examples between other mammals are extremely rare, but the findings challenge the benign image of bottlenose dolphins and provide a hitherto unrecorded cause of mortality in porpoises (Ross & Wilson 1996).

Within the Netherlands, Harbour Porpoises and Bottlenose Dolphins co-occurred in fair numbers, at least until the mid-1950s (Van Deinse 1923, Ter Pelkwijk 1937, Viergever 1940, Verwey 1975ab, Camphuysen & Peet 2006, Van der Meij & Camphuysen 2006). Today, Bottlenose Dolphins are rare in the Southern Bight and there is no (recent) documented evidence of interactions between the two species (Camphuysen & Peet 2006). Haelters & Everaerts (2011), however, report two cases of physical interaction between White-Beaked Dolphins and juvenile Harbour Porpoises in the southern North Sea, one in Belgium and one in the Netherlands. Both animals had similar healed lesions: scars originating from skin cuts and resembling teeth marks (rake marks) inflicted by other cetaceans. Both Harbour Porpoises stranded alive, the animal in Belgium died on the beach, while the other was cared for by the rehabilitation facility at Harderwijk (SOS Dolfijn).

Competitors of Harbour Porpoises in the Netherlands could be seals (both Harbour Seal *Phoca vitulina* and Grey Seals *Halichoerus grypus*), and large predatory fish (nowadays an uncommon commodity in the overfished Southern Bight). There is no published evidence that Harbour Porpoises actively compete for prey with any of these species (interactions between species), but they share a common resource with many taxa, humans included.

5.11. Infectious disease

Van Bressem *et al.* (2009) reviewed emerging infectious diseases in cetaceans, examined their potential to impact populations, re-assessed zoonotic risk and evaluated the role of environmental stressors. Cetacean morbilliviruses and papillomaviruses as well as Brucella spp. and Toxoplasma gondii were thought to induce high mortality rates, to lower reproductive success or to increase the virulence of other diseases. The zoonotic hazard of marine mammal brucellosis and toxoplasmosis may have been underestimated, attributable to frequent misdiagnoses and underreporting. Environmental factors seem to play a role in the emergence and pathogenicity of morbillivirus epidemics, lobomycosis/LLD, toxoplasmosis, poxvirus-associated tattoo skin disease and, in Harbour Porpoises, infectious diseases of multifactorial aetiology. Inshore and estuarine cetaceans such as Harbour Porpoises were thought to incur higher risks than pelagic cetaceans due to anthropogenic factors such as chemical and biological contamination, direct and indirect fisheries interactions, traumatic injuries from vessel collisions and climate change.

From studies of Harbour Porpoises found stranded in the United Kingdom, Jepson *et al.* (1999) showed that animals with infectious diseases had significantly greater chlorobiphenyl concentrations than a physical trauma group. These findings were consistent with the hypothesis that chronic PCB exposure predisposes porpoises to infectious disease mortality. Between 1991 and 1996, Siebert *et al.* (2001) performed necropsies on 133 Harbour Porpoises, in states suitable for histopathological, immunohistochemical and microbiological examination The animals were found stranded on German coasts or accidentally caught by German fishermen and originated from the North and Baltic Seas. Pneumonia was considered to be the cause of death in 46% of the stranded subadult and adult animals. The findings gave no evidence of any epidemic due to bacterial or viral infection. Bacteriological examination suggested that pneumonia was mainly caused by secondary bacterial infection and not by parasitic infestation alone. Beta-haemolytic streptococci were considered to be the main infectious agents. In 55 Harbour Porpoises stranded along the Belgian and northern French coasts between 1990 and 2000 the most common findings were emaciation, severe parasitosis and pneumonia (Jauniaux *et al.* 2002).

The multidisciplinary research group MARIN (Marine Animals Research & Intervention Network) investigated the causes of death of marine mammals stranded on the continental coastline of the southern North Sea along the coasts of Belgium and France, and The Netherlands (Jauniaux *et al.* 2008). In this study, the main lesions and causes of death of porpoises stranded on the Dutch coast in 2006 were discussed. Of 520 animals found on the coast, 64 were kept frozen for a 5-days necropsy session using standard protocols (24 females and 40 males; 7 neonates, 45 juveniles and 12 adults). Frequent observations included net marks on the skin, sub-cutaneous and muscular bruises, emaciation, pulmonary and gastric parasitism, acute pneumonia, and pulmonary congestion and edema. In 26 cases, the animals were too putrefied to identify lesions. For the others, and apart from animals diagnosed as likely bycatch, infectious diseases occurred most frequently. Symptoms of bycatch was most frequent (64%) in animals stranded in March and April, while infectious diseases (30%), mainly acute pneumonia, occurred throughout the year. The study showed that the diagnosis of capture cannot be based only on external observations, and that by-caught porpoises are not always healthy.

In 92 stranded porpoises studied between Dec 2008 and Nov 2009 in The Netherlands (of which 67 with additional histopathology), Wiersma & Gröne (2009) attributed infectious disease as a cause of death in 13 of the animals (16.5%, n= 78 with cause of death identified). Of porpoises that had washed ashore between Dec 2009 and Nov 2010, 100 individuals were necropsied and the cause of death was identified in 83 cases (Gröne & Begeman 2010). Infectious disease ranked sixth (11 cases, 13%, n= 83) as mortality factor.

Infectious disease is clearly an important factor in Harbour Porpoise mortality. Additional research is required (including a meta-analysis of necropsy data that have accumulated over time) to identify the (bacterial?) cause of the disease(s), the seasonality, long-term trends, the frequency in different sex and age categories, and the environmental conditions that may enhance the occurrence of infectious disease as a cause of death in Harbour Porpoises.

5.12. Parasites

Most of our understanding of the parasites of marine mammals derives from studies on specimens which come ashore (Geracia & St. Aubina 1987). The information is fragmentary, and suffers from difficulties to follow the progress of infection and the overall condition of the parasitised animal. Some parasite infections are lethal and for example the trematode Nasitrema sp. infects cranial sinuses and enters the brain, thereby leading to stranding and death. Gibson *et al.* (1998) studied the helminth parasites from more than 300 cetaceans stranded in England and Wales (1990-1994), the majority of which were Harbour Porpoises (n=173) and Common Dolphins *Delphinus delphis* (n=101). The parasites found included 11 species of nematode, five cestodes (tapeworms), five digeneans (parasitic flatworms) and two acanthocephalans (intestinal worms). Digeneans occupy the gastrointestinal tract and may severely damage liver and pancreas of cetaceans (Geracia & St. Aubina 1987). Nematodes represent the broadest group of parasites. They often infect the respiratory system, causing sufficient damage to affect survival. Anisakine nematodes in the stomach are probably of little consequence to the host. Crassicaudinae are the largest nematodes in cetaceansand the damage they may cause in cranial bone, mammary tissue and the urinary tract may influence productivity and survival.

Between 1991 and 1996, Siebert *et al.* (2001) performed necropsies on 133 Harbour Porpoises, in states suitable for histopathological, immunohistochemical and microbiological examination The animals were found stranded on German coasts or accidentally caught by German fishermen and originated from the North and Baltic Seas. Most of the lesions observed in these porpoises were caused by parasites, in particular in the respiratory tract, two-thirds of the animals exhibiting pneumonia associated with the parasites.

In 55 Harbour Porpoises stranded along the Belgian and northern French coasts between 1990 and 2000 the most common findings were emaciation, severe parasitosis and pneumonia (Jauniaux *et al.* 2002). Between February 1990 and July 1991, 18 Harbour Porpoises found dead along the Belgian and German coasts, were examined for their burden of helminths. A total of six species were found (one trematode, one cestode and four nematodes). Adult porpoises were generally more heavily parasitised than juveniles. Four species of parasites had a pathological effect and *Torynurus convolutus* was responsible for the death of one animal from the Belgian coast and three from the German coast (Brosens *et al.* 1996). Wünschmann *et al.* (2001) compared pathological, microbiological and serological findings in Harbour Porpoises hunted in Greenlandic waters with the findings in animals accidentally caught in fishing gear in the German North Sea and Baltic Sea. The body condition of the Greenlandic animals was good, whereas nine of 23 German Harbour Porpoises were moderately to markedly emaciated. Both groups were infested with parasites.

Figure 43. Stomach parasites in a Harbour Porpoise (Noordwijk aan Zee, UT057 28 Nov 2007; CJ Camphuysen)

García Hartmann *et al.* (2004), studying 130 stranded Harbour Porpoises found in The Netherlands between 1990-2000, recorded the presence of parasites but did not report on their frequency of occurrence. Osinga *et al.* (2008), investigating stranded porpoises found between 1984 and 2006 in The Netherlands, recorded the presence of parasites but did not report on their frequency of occurrence. Leopold & Camphuysen (2006), after their study of 64 Harbour Porpoises that had washed ashore in 2006, reported that several different parasites were found and that they were encountered in virtually all organs. In some animals, severe infestations were detected in the lungs, in the digestive tract (**Fig. 45**), in the ears, in heart, kidney and/or in the liver, but the exact frequency of occurrence was not reported. The sampled material was sent to German specialists for further investigations. Wiersma & Gröne (2009), studying 92 porpoises collected between Dec 2008 and Nov 2009 in The Netherlands, sampled parasites but did not report on their frequency of occurrence.

Infestation with whale lice has rarely been observed in Harbour Porpoises from the North Sea (Lehnert *et al.* 2007), but some cases were reported from the Netherlands in 1991 (Fransen & Smeenk 1991). Lehnert *et al.* (2007) describe a case of *Isocyamus delphinii* infestation on a porpoise from German waters. At least a dozen of lice-infected Harbour Porpoises were found during the mass-necropsies in 2006-2008, but the results have never been analysed (Jauniaux *et al.* unpubl. data)

5.13. Morbillivirus

An epizootic of morbillivirus infection killed thousands of Harbour Seals in Europe in 1988 (Kennedy 1990), and again in 2002 (Müller *et al.* 2008). In two Harbour Porpoises, one found stranded in Kent (England), the other in the Moray Firth (Scotland), necropsied in 1990, the presence of morbillivirus antigen were at the time considered the first proof of morbillivirus infection in cetaceans from the British coast (Kennedy *et al.* 1992). Morbilliviruses isolated from cetaceans in the North Sea were shown to differ, however, from phocine distemper virus (PDV) isolated from European seals (Barrett *et al.* 1993). Dolphin and porpoise viruses are related but different from all other members of the virus group, forming a distinct lineage more closely related to ruminant morbilliviruses than to carnivore viruses. A virus isolated from a porpoise during the 1988 seal epizootic, shown to be a morbillivirus, contained several unique epitopes while certain epitopes present on canine (CDV) and phocine distemper viruses (PDV) were absent (Welsh *et al.* 1992). It was concluded that the porpoise virus was an antigenically distinct morbillivirus and it has been tentatively named as delphinoid distemper virus (DDV).

Viruses belonging to 9 families have been detected in cetaceans (van Bressem *et al.* 1999, Wohlsein *et al.* 2007). Cetacean morbillivirus (family Paramyxoviridae) induces a serious disease with a high mortality rate and persists in several populations (Forcada *et al.* 1994, Cebrian 1995, van Bressem *et al.* 1999). It may have long-term effects on the dynamics of cetacean populations either as enzootic infection or recurrent epizootics.

Morbillivirus antigen was not detected in 133 Harbour Porpoises studied in a German study, with animals originating from the North and Baltic Seas collected between 1991 and 1996 (Siebert *et al.* 2001). Similarly, Jauniaux *et al.* (2002) found no evidence of morbillivirus infection in 55 Harbour Porpoises stranded along the Belgian and northern French coasts between 1990 and 2000. Wünschmann *et al.* (2001) compared pathological, microbiological and serological findings in Harbour Porpoises hunted in Greenlandic waters with the findings in animals accidentally caught in fishing gear in the German North Sea and Baltic Sea. Four Greenlandic and 10 German porpoises had positive porpoise morbillivirus-specific antibody titres (i.e. the highest dilution of serum samples that cause a positive test reaction), suggesting that the virus was circulating in both populations.

García Hartmann *et al.* (2004), studying 130 stranded Harbour Porpoises found in The Netherlands between 1990-2000, did not report on viruses. Osinga *et al.* (2008), studying stranded porpoises found between 1984 and 2006, listed virology as an important aspect of the research, but did not report any results. Leopold & Camphuysen (2006) reported on a study of Harbour Porpoises most of which had washed ashore in 2006 in The Netherlands. All tissue samples taken tested negative for morbillivirus. In 92 porpoises collected between Dec 2008 and Nov 2009 in The Netherlands, Wiersma & Gröne (2009) sampled tissue for virology but did not report any results.

5.14. Potential biological removal (human caused mortality)

The U.S. Marine Mammal Protection Act (Sec. 117) requires that the National Marine Fisheries Service (NMFS) and the Fish and Wildlife Service (FWS) develop Stock Assessment Reports for all marine mammal stocks in waters under U.S. jurisdiction (Wade & Angliss 1997). These Reports are to be based upon the best scientific information available and they are only required for stocks that occur regularly in U.S. waters. The U.S. Marine Mammal Protection Act requires reports to include, among other things, information on how stocks were defined, a calculation of Potential Biological Removal level (PBR), and an assessment of whether incidental bycatches in fisheries are significant or not.

The term 'potential biological removal level' (PBR) means the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population. The potential biological removal level is the product of the following factors:

- The minimum population estimate of the stock.
- One-half the maximum theoretical or estimated net productivity rate of the stock at a small population size.
- A recovery factor of between 0.1 and 1.0.

The term '*net productivity rate*' means the annual per capita rate of increase in a stock resulting from additions due to reproduction, less losses due to mortality. The term '*minimum population estimate*' means an estimate of the number of animals in a stock that is based on the best available scientific information on abundance, incorporating the precision and variability associated with such information; and provides reasonable assurance that the stock size is equal to or greater than the estimate."

Potential Biological Removal (PBR) NMFS published guidelines for calculating PBR (Barlow *et al.* 1995). The Marine Mammal Protection Act defined PBR to be the product of a minimum population estimate (N_{MIN}), ½ the maximum net productivity rate (R_{MAX}), and a recovery factor (F_R). The U.S. Marine Mammal Commission requires that total annual human-caused mortality and serious injury should be less than PBR as follows (Taylor *et al* 2000):

$$PBR = N_{MIN} \, ½ \, R_{MAX} \, F_R \qquad (1)$$

Where N_{MIN}= (1) the 20th percentile (lower 60% confidence limit) of the log-normal distribution resulting from a point estimate of abundance and its CV. R_{MAX}= a default value of 0.04 for cetaceans, or a reliable stock specific estimate if available and accepted in a peer-review journal or accepted by a review groups such as the Scientific Committee of the International Whaling Commission. F_R= 0.1 for stocks listed as endangered, 0.5 for stocks that are listed as threatened or depleted or are of unknown status if the CV of the mortality estimate is less than or equal to 0.3 (should be adjusted to 0.48 if CV=0.3- 0.6, 0.45 if CV=0.6-0.8, and 0.4 if CV>0.8), and 1.0 for stocks known to be within OSP. The PBR guidelines describe circumstances that allow further adjustments of the recovery factor.

Scheidat & Verdaat (2009) considered the potential mortality limits for Harbour Porpoises in the Dutch North Sea applying different existing conservation aims. Underlying their calculations were point abundance estimates (N_{BEST}) obtained during dedicated aerial surveys in spring 2009. The calculations are reproduced here, and repeated for the outcomes of aerial surveys in sectors C and D in March 2010 and 2011 (**Table 5**). Note that these potential mortality limits are calculated for the season in which arguably the highest densities of Harbour Porpoises have been recorded during recent, dedicated aerial surveys and that they are based on censuses of part of the Dutch sector of the North

Sea only. In the absence of mortality estimates and stock assessments for the northern (offshore) part of the Dutch sector of the North Sea, it is unclear if additional (unnatural) Harbour Porpoise mortality currently exceeds any of these thresholds.

Table 5. Potential mortality limits (n) for Harbour Porpoises in the Dutch North Sea applying different existing conservation aims and using point abundance estimates obtained during dedicated aerial surveys in spring 2009-2011 (based on Scheidat & Verdaat 2009, Scheidat *et al.* 2011 and courtesy M. Scheidat; reproduced with permission of Ministry of Infrastructure and Environment).

Values used for calculations		**2009**	**2010**	**2011**
N_{BEST}	Point abundance estimate	36,825	55,750	60,350
CV	Coefficient of Variation	0.33	0.35	0.33
N_{MIN}	20^{th} percentile	28,092	41,873	46,037
R_{MAX}	Max net productivity rate (Wade & Angliss 1997)	0.04	0.04	0.04
F_R	Recovery rates depending on status of stock (Wade & Angliss 1997)	1.0, 0.5, 0.1	1.0, 0.5, 0.1	1.0, 0.5, 0.1
Application of different conservation aims and related (extra) mortality limits				
ASCOBANS "unacceptable" → 1.7% of N_{BEST}		626	948	1026
ASCOBANS "precautionary" → 1% of N_{BEST}		368	557	604
PBR "healthy status" → 0.5 R_{MAX} N_{MIN} 1.0(F_R)		562	837	921
PBR "uncertain status" → 0.5 R_{MAX} N_{MIN} 0.5(F_R)		281	419	460
PBR "endangered status" → 0.5 R_{MAX} N_{MIN} 0.1(F_R)		56	84	92

5.15. Discussion and conclusions

In a critique about studies and media reporting the cause of cetacean mass strandings, Bradshaw *et al.* (2005) did a plea for empirism. *"A series of mass cetacean strandings in stranding-prone regions of Australia and New Zealand and the ensuing speculation regarding their cause demonstrate that debates surrounding this phenomenon continue to be of issue. As most interested in these debates are aware, hypotheses addressing their causes range from the more biologically plausible to the less-supported, and even the suggestion that earthquakes are responsible."* Rather than supplying more fuel for conjecture in light of severe shortages of convincing data, they believed it would be more constructive to provide a scientific framework for testing hypotheses that seek to explain patterns observed and mechanisms responsible for strandings. These authors discussed the issue of mass strandings of cetaceans and the fact that researchers only just pieced together *"a probabilistic framework for the spatial and temporal variation in the propensity to strand"*, but that few contributed to insights into the mechanisms driving the behaviour of cetaceans just prior to a mass stranding. In the present document, a conservation plan for the Harbour Porpoise, we have attempted to use scientific evidence rather than plain speculations or uninformed suggestions to identify current threats.

Many of the observed threats in porpoises are derived, directly or indirectly, from stranded animals. That is a suspect subset of material. First of all, not all threats lead to instant death, and even severely weakened individuals may wash ashore eventually in another geographical area, blurring the picture. Secondly, Harbour Porpoises are not particularly long-lived and 'natural death' must be accounted for, one way or the other. Dead Harbour Porpoise are *expected* to wash ashore in fair numbers in coastal areas with a healthy population offshore.

We have tried to find evidence for anthropogenic and natural threats, but must highlight that many aspects have simply not adequately been studied to always draw firm conclusions. For example, if a detonation of old ammunition at sea (common practice in the Netherlands) would lead to the immediate death of nearby porpoises that wash ashore, would we be able to find the evidence? Current collecting procedures (including deep-freezing) and pathological protocols in use are probably inadequate to detect hearing deficiencies that led to the death of individual whales, even if they wash ashore fresh. Also, are emaciated porpoises washing ashore indicative for a structural problem in prey resources? What are the chances for a porpoise drowned in fishing gear 10km off the coast to wash ashore compared to an animal that drowned further offshore? These uncertainties should be kept in mind, while at the same time, the available evidence should be taken serious to address the issue we are facing: which are the obvious, imminent threats that would negatively affect the conservation status in the southern North Sea, and as such with repercussions for Harbour Porpoise stocks in management unit 9, (southwestern North Sea & Eastern Channel)? And secondly, what can we do about them? In this chapter, we have highlighted potential threats that are in fact global or general issues (e.g. marine litter, pollutants), for which local or regional mitigation measures would not reduce the population pressure at large. Other potential threats have a much more regional character, and even if the same threat is or will eventually become apparent in adjacent sea areas outside the Dutch EEZ, "local" solutions to the problem could enhance the conservation status of the Harbour Porpoise (e.g. bycatch rates, acoustic disturbance).

Missing information A substantial part of the most concrete evidence that certain threats are either prominent or not for Harbour Porpoises in the Southern Bight was derived from necropsies of stranded animals. Even if we assume that the collection (the subset from the total of stranded animals, and the stranded animals as a fraction of the Southern North Sea population) was representative to meet our goals, it must be concluded that many necropsies conducted within The Netherlands are in fact inconclusive. While some causes of death are examined with care and in depth, other potentially important factors are left or will perhaps be reported (much) later. For example, from Gröne & Begeman (2010), reporting on the most recent necropsies of stranded porpoises conducted on behalf of the Dutch Ministry of Economy, Agriculture and Innovation (EL & I), we note:

- Ageing was not considered as part of the project, additional funds would be required.
- Virology; samples stored, the presence of viruses can be demonstrated in future research.
- Parasitology Parasites (mostly from lung, mid-ear, stomach and liver) were sampled and stored in glycerol-alcohol at room temperature for later identification.
- Toxicology. Not considered as part of the project, additional funds would be required.
- Genetic studies. Not considered as part of the project, additional funds would be required.
- Hearing damage. 1 porpoise was sent to Spain.

What is missing is a well formulated scientific research question underlying the necropsies. Some boxes are ticked (characteristics indicating bycatch, total length, blubber layer, and stomach contents), other boxes remained blank. Obvious trauma is recorded, hidden trauma (such as hearing damage) is not investigated and by freezing corpses prior to necropsies (still common practice), the sensitive tissues are damaged preventing internal studies of hearing damage. We therefore cannot safely conclude that porpoises in the Southern Bight are unaffected by anthropogenic noise; one of the main concerns regarding a favourable conservation status. There is no data. No results on virology, parasitology, toxicology are reported or shortly foreseen. In a previous document commissioned by the Ministry of Economy, Agriculture and Innovation, the "unbalanced age structure" was seen as a concern (Jak *et al.* 2009). It is therefore striking that even the accurate assessment of age was not considered being part of the project by Gröne & Begeman (2010) and that additional funds would be required.

Current threats summarised With these remarks in mind, based on the material outlined and referred to in this chapter, we could conclude that with regard to the Southern North Sea population of the Harbour Porpoise, none of the demonstrated threats can be quantified satisfactory, given the slender factual data currently at hand. A clear example is the bycatch issue:

- we are sure that bycatches occur quite frequently (at least 100s rather than dozens per annum),
- we have insufficient data to exactly show *how* frequently
- we have no information on the type of fishing gear in which bycatch problems in Dutch waters occur most often,
- but, the "usual suspects" (passive gear, set nets; see international studies) were not commonly in use in the recent past but have gained popularity at a highrate after recent peaks in gasoline prices

It is obvious that further research is required, before effective mitigation measures can be proposed and the precautionary approach (UNESCO 2005) could be the safest way forward (i.e. fisheries restrictions on a broader scale than needed if good evidence were available). The threats discussed earlier are summarised in **Table 6** with emphasis on the available evidence worldwide, the available evidence in Dutch waters, and the possibility for mitigation measures on a regional scale (*i.e.* within the Dutch EEZ). It must be concluded that in fact for each and every factor further research is required. It should be remarked, therefore, that more exact research questions are required which might lead to a more cost-effective and satisfactory product. Each and every study should be scrutinised by external peer review. The installation of a scientific research committee is recommended to evaluate the quality of research proposals (including statistical power analysis), the urgency of research questions, and the publications resulting from these studies.

Table 6. Summary of observed threats for Harbour Porpoises within the Southern Bight (Dutch EEZ) with current research needs (cause/effect studies) and options for regional mitigation measures.

Evidence: XX = problematic, X serious concern, + issue observed, - issue not important, ? unknown
Research needs/Regional mitigation measures: XX urgent needs/total ban, X need/specific restrictions, + some urgency/pre-operation deterrents, - no immediate need/none recommended

	Evidence		Research	Regional
	Worldwide	Dutch EEZ	needs	measures
Incidental capture (bycatch)	XX	XX	XX	XX
Siting, land reclamation	+	+	+	+
Vessel strikes	+	+	+	-
Windfarms, pile driving	XX	XX	+	X
--------, operational	-	?	-	-
Acoustics, explosions	X	X	X	X
--------, seismic	XX	+	+	+
--------, shipping	-	?	-	-
--------, others	-	?	+	+
Mining activities	?	?	+	-
Marine litter	+	+	-	-
Marine pollution	+	X	X	-
Prey availability	+	X	X	-
Predators, competitors	+	-	-	-
Infectious disease	+	X	X	-
Morbillivirus	+	?	+	-
Parasites	+	X	X	-

6. Overview of existing mitigation measures

In this chapter guided by identified threats, current available measures for mitigation will be discussed based on literature and current expertise and experience from other countries, leading to challenges for future policy achieving and maintaining a favourable conservation. It is the aim of this conservation plan is to obtain and to maintain this favourable conservation status for the Harbour Porpoise in waters under Dutch jurisdiction, targeting the appropriate ecological scale for the conservation of the harbour porpoise ecological scale related to the distribution of the population. It is clear that not all threats can be dealt with on a national level only and certain threats such as marine pollution and litter call for an international, coordinated approach. Although some threats can or should be approached at national level, it should be clear as well that a conservation plan for the Harbour Porpoise in Dutch waters could not succeed without regional cooperation such as between countries adjacent to the southern North Sea, such as Belgium, The UK, Denmark and Germany. In that perspective the ASCOBANS conservation plan for the Harbour Porpoise in the North Sea (Reijnders *et al.* 2009) acts as a trigger to coordinate and streamline both national and international approaches. It is the ambition of this conservation plan to enhance such further cooperation. Based on the identified threats it becomes clear that there are two evident threats for the harbour porpoise which call for mitigation measures; Those threats are on one hand incidental capture, or bycatch in fisheries and on the other hand loud impulsive man-made underwater noise, i.e. seismic surveys, controlled underwater explosions and pile driving for among others the construction of offshore windparks.

6.1. Incidental capture (bycatch)

Even though the exact scale of fisheries bycatches is currently insufficiently known, a reduction of bycatch will enhance the conservation status of porpoises in the North Sea. Further information on the scale of this impact is urgently needed, however.

Mitigation measures - Fisheries mitigation measures can be roughly divided into general management measures such as freezing effort, establishing bycatch limits or fisheries periodical closures on one hand and more technical measures such as the use of acoustic devices, gear change and or adaptation of gear on the other hand.

CCTV monitoring

Before mitigating bycatch it needs to be allocated: where and when do bycatches occur most frequently. Therefore, the first recommendation is to establish an observer scheme by having independent observers on board. A second option could be camera monitoring. Remote electronic monitoring (EM) is based on a camera monitoring system to record bycatch of marine animals, such as marine mammals and birds, but also to document fisheries discards 24 hours per day, 7 days a week. In the case of monitoring bycatch in set-net fisheries, a system can be installed which documents only the hauling process. The electronic monitoring system automatically becomes activated when the hydraulic hauling system is activated and the nets are hauled. This significantly reduces the data to be stored, analyzed, but also it reduces the privacy impact of the fishermen on board. One of the reasons why observer monitoring is not required on vessels smaller than 15 metre under the Council

Regulation 812/2004 is the lack of space on small boats. For smaller vessels, a camera system could be a sensible option, given that the installation would take less space than an observer onboard. In Denmark, from May 2010 tot May 2011, six Danish commercial gillnetters under-15 metre having a remote Electronic Monitoring (EM) system installed onboard. The total catch and marine mammal bycatch registration is audited by use of a sensor system and 4 CCTV cameras, each filming different angles of the hauling of the gear and the catch handling. The quality of the video footage has until now shown that bycatch of marine mammals and birds easily can be verified. Preliminary results of this Danish study with gill-netters seem to reveal a significant higher bycatch than observed and reported by fishermen. After analyzing the footage it became clear that porpoises fell out of the nets just after reaching the water surface when hauling the nets (Lotte Kindt-Larsen pers. comm.). This study recommends to use at least more than one camera pointed at the hauled nets behind the boat, to prevent missing parts of the hauling process due to the sunlight or the position of the net. Currently a first CCTV system (closed circuit television system) is installed since December 2010 onboard of a Dutch set net fisherman (targeting Cod, Turbot and Brill). The challenge is to incorporate CCTV-monitoring into an independent observer scheme, according to international protocols as proposed to assess the impact of bycatch, combining the benefits of both observers onboard and a CCTV-monitoring system.

Acoustic devices

Although EC Regulation 812/2004 requires the use of acoustic devices and requires monitoring onboard for certain areas and gear types, this does not apply to most fisheries in waters under Dutch jurisdiction. According to a recent ICES advice, if it is not possible to cease using static nets, acoustic deterrents are the most efficient measure to reduce Harbour Porpoise bycatch in static nets (ICES 2010a). Acoustic devices, so called pingers, are a concrete measure to mitigate bycatch of porpoises. Pingers should deter or harass, depending of the acoustic signal, porpoises, preventing them from entanglement or entrapment in fishing gear. Based on an evaluation of acoustic deterrents ICES advises that acoustic deterrents, using basic tonal 10 kHz signals and more complex multi-signals, deployed on static gear are effective in reducing the bycatch of Harbour Porpoises (ICES 2010c). A Danish study based on the use of pingers in the Danish North Sea wreck net fishery concluded dat the use of pingers is the reason that the bycatch in the observed Danish North Sea wreck net fishery was eliminated in 2000 and 2001. The study showed a statistically significant reduction (Larsen *et al*. 2002). The reduction was shown in the *observed* fishery. However**,** further development work is needed to improve the reliability, durability and cost of pingers. Currently available acoustic deterrent devices are not reliable and therefore ineffective in minimising bycatch in many fisheries. It has proved difficult to monitor and enforce the use of acoustic deterrents required under Regulation 812/2004 given the difficulties in testing whether devices are operational or whether fishermen have properly deployed them on gear. When deploying pingers, observation schemes are essential in both determining whether mitigation measures are needed and whether mitigation measures that are deployed are working (ICES 2010c).

Another Danish study studying the effect of PAS-pingers (porpoise alerting signal) showed no reduction of bycatch of Harbour porpoises in the Danish hake gillnet fishery. The reason for the insignificant result could be due to the pinger signal regarding both composition and signal propagation (Kindt-Larssen 2008).

The UK studied an acoustic deterrent device, the DDD (Dolphin Dissuasive Device), which has a significantly louder output than the pingers required under EC 812/2004. Based on a test on gill- and tangle nets in the Western Channel and Celtic Sea, results so far suggest that this DDD device is a viable means of minimizing cetacean bycatch in these fisheries (Northridge & Kingston 2010). Note that a DDD03 reaches peaks of about 175 dB. Habitat loss is a concern for the use of acoustic devices in general, and especially for devices having loud outputs.

The National Marine Fisheries Service (NMFS) of the US, in consultation with the US Harbour Porpoise Take Reduction Team (HPTRT), trategy to ensestablished a sure compliance with HPTRP pinger requirements (NOAA 2010).

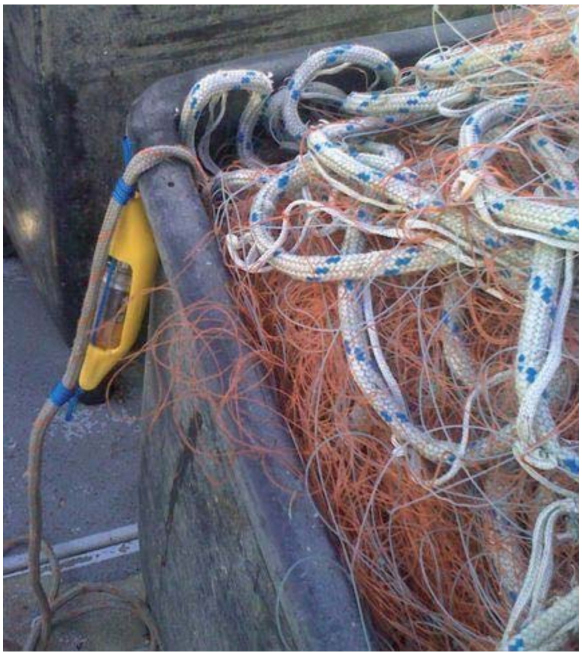


Figure 44. Fishtek BananaPinger on board of set-net fisher during trial (M.L. Siemensma).

At present a pinger trial is done in The Netherlands. The Coastal & Marine Union (Vereniging Kust & Zee) coordinates a project on bycatch mitigation in general. Part of this project is a pinger trial. The aim of the project is to investigate the workability and efficiency of several pingers (DDD and Fishtek BananaPinger, **Fig. 44**). The project aims to mitigate bycatch of Harbour Porpoises in the winter set net fishery on mainly Cod, Turbot and Brill. The study is a close collaboration between the Dutch Fisheries Association (Nederlandse Vissersbond), the expert group on set net fishery (Kenniskring staand want) and several Dutch winter season set net fishermen, which participate voluntarily. In cooperation with IMARES porpoise detectors (C- and T-pods) are installed on the nets. The study is supported by the Ministry of EL&I and the European Fisheries Fund.

In 2010, ICES evaluated mitigation measures currently in place including information on costs (ICES 2010c). Based on this evaluation, the cost of acquiring acoustic deterrents for static nets varies between about 60 and 134 Euro per 200 metre of net (e.g. between 6000 and 13 400 for 20 km of nets) depending on the brand purchased. Costs could decrease if market volume increased. Apart from the device itself, there are additional costs associated with periodic maintenance, the replacement of batteries and replacement of units due to loss. ICES also mentions difficulties encountered by control and enforcement agencies. In a number of countries they have indicated that relevant parts of Regulation 812/2004 are practically unenforceable given the difficulties in testing whether devices are operational or whether fishermen have deployed them on gear. For example, German and Danish authorities commissioned a project to develop a monitoring device, which would permit inspection of set nets to determine if acoustic deterrents were functioning properly. Monitoring without fishermen necessarily being onsite or retrieving their nets was an additional requirement. The costs for other mitigation measures including reduction in effort with static gear, displacement of effort and others have not been quantified and would be expected to vary depending on the fishery.

Summarising the use of acoustic devices, it is believed that pingers are of current available mitigation measures the best way to reduce porpoise bycatch in gillnet fisheries, apart from ceasing gears risking bycatch. However, concerns exist since there have been problems with the efficiency of pingers, both in their effectiveness and the safety and practical workability for fishermen. Also compliance of pinger requirements and monitoring the efficiency and practical workability need attention when considering the use of acoustic devices. Another concern is the effect of the pingers when deployed at large on the disturbance of porpoises from their preferred habitat. Also the costs are a challenging factor, not only for deployment, but also for testing the acoustic devices during their use.

Gear modification

Gear modification is based on increasing the acoustic reflectivity of the nets. Several efforts have been undertaken to explore this concept. In a study by Trippel *et al.* (2003) nylon nets have been impregnated with barium sulphate and reduced porpoise mortality, while there was no difference in catch. Kindt-Larssen (2008) provides an overview of work done experimenting on increasing the acoustic reflectivity of the net by attaching different kinds of devices and materials to gillnets. However it seems that these experiments have not given clear results and the effect of the devices is doubtful. During field trials by Northridge *et al.* (2003) the difference in bycatch rates between two nettypes has been tested. No difference was found in the bycatch rates between the two net types, multi-monofilament nets and monofilament nylon nets. A second trial involved comparing porpoise bycatch rates in standard skate monofilament nets (267 mm mesh size and 0.6 mm twine diameter) with a thin twined net of 0.4 mm monofilament. An order of magnitude difference was found in the bycatch rate of porpoises, with fewer animals, but more large holes, recorded in the thin twined nets. Northridge *et al*. (2003) speculate that thinner twines may be easier to escape or fall from. A third trial involved barium sulphate filled polyamide (nylon) nets in a comparison with standard nylon monofilament nets. These are intended to have a higher acoustic reflectivity and therefore to enable porpoises to detect them acoustically. The barium sulphate nets had a slightly smaller mesh size and a thicker twine diameter (0.67mm). The trial showed that the barium sulphate nets had a significantly higher bycatch rate of porpoises and a higher bycatch rate of seals, which might be because of the of the twine diameter and strength. A field study by Mooney *et al*. (2011) showed that metal oxide nets made from barium sulphate increased the detectability of gillnets by marine mammals when compared to nylon nets when approached at angles of incidence greater than normal incidence but less than 40 degrees. Hypothesized detection ranges indicate bottlenose dolphins should be able to detect metal oxide nets in time to avoid entanglement, but Harbour Porpoise may not be able to detect either net in time to avoid contact. Given the different research results the challenge is to further explore and investigate gear changes.

Gear switch

A switch from set-nets to other gear such as fish traps (pots) could be a potential measure to reduce bycatch of porpoises. For the Dutch fleet Cod traps might be an alternative for gillnetters targeting Cod. However, this needs to be investigated, as several factors might influence this type of fishing as is indicated by the fishers, like the current along the coastline, the risk of conflicts with other fisheries in the same area or the costs of gear switch. Furthermore, a gear switch might be an alternative for several cod fishers, for set net fishers on other target species such as turbot, brill or sole this might not be a feasible solution. Recent ICES advice evaluating EC 812/2004 mentions that costs for alternative measures other than pingers such as a reduction of fishing effort have not been estimated. ICES mentions conducted studies in a number of countries, however in most cases catch rates were lower than those of gillnets (ICES 2010c). Nevertheless, if such an alternative prevents depredation by seals or crabs, which is the case reported by several Dutch Cod targeting fishers, this might be another trigger to consider a switch to another gear type. The latest annual report of Sweden at the

ASCOBANS annual advisory committee meeting in 2011 reported on the studies carried out by the Swedish Board of Fisheries, investigating alternative fishing gear such as Cod pots and traps for species like Pike *Esox lucius*, Perch *Perca fluviatilis* and Herring. During the recent three years the Swedish Board of Fisheries has been studying Cod pots as an alternative to the gillnet fisheries for Cod in the central Baltic and the results are promising. Pots are selective and with a certain mesh size only catch fish in a particular size. No bycatch of birds and - when seal grids are used - of marine mammals occurs. The catch is gathered in a closed department, which makes it possible to develop a fishing gear preventing depredation by seals. Pots are used in a variety of different fisheries and are known to use less energy in operation than active gears. They are less destructive to the benthic habitat compared with gear and they can be left in the water for long time periods. They also deliver the catch alive, increasing its commercial value. The Swedish Board of Fisheries has studied the fishing efficiency of the "two-chamber" pots in a commercial fishery for a few years. Results show that the catch in pots are comparable to the catch in gillnet fisheries (Königson *et al.* 2010)

Investigate on alternative gear and gear adaptation to mitigate bycatch of small cetaceans is one of the recent adopted terms of reference of the ASCOBANS working group on bycatch is to focus on alternative gear and gear adaptation to mitigate bycatch.

Freezing fishing effort

Due to increasing petrol prizes and upcoming regulations for fisheries in Natura 2000 area's there is a concern that this may lead to an increase in fishing effort of gillnet fisheries. In the absence of further information, a further growth of gillnet fishing activities should be prevented or some system of bycatch prevention should be an integrate part of the license for newcomers. At present the effort of set net fisheries in Dutch waters has been ringfenced. This applies to both vessels over and under 10 metres in hull length. Standing measures for vessels flying the Dutch flag are limited to a total net length of 25 kilometres maximum. Any newcomer, disregarding its vessel length, has to fit in the current existing capacity and has to have set-net trackrecords.

Figure 45. Set net fishing vessel at sea, 10 April 2008 (CJ Camphuysen)

Time-area closure & take limit

Spatial and/or temporal closures may be effective in areas or at times where porpoise occurrence is particularly predictable and seasonal. In its advice on the special request on bycatch of small cetaceans in European waters ICES emphasizes that any closure requires a careful planning in order to avoid unwanted consequences such as displacement into other areas or to gears that may have other unwanted environmental effects (ICES 2010a). This concern can be illustrated by the experience from the US Harbour Porpoise take reduction plan, where consequence closure areas were established. These are specific areas of historically high levels of Harbour Porpoise bycatch that will seasonally close if bycatch rates over two consecutive management seasons exceed a specified bycatch rate. A review of the use of a time/area closure for the Gulf of Maine bottom set gillnet fishery showed that fishermen concentrated in unrestricted waters adjacent to the closed area (Murray *et al*. 2000). The review suggests that a restricted area needs to be large enough and the time needs to be long enough for an effective bycatch reduction.

Policy in practice

Under the Marine Mammal Protection Act in the United States, a Harbour Porpoise Take Reduction Plan (HPTRP) has been established in 1998 to reduce the serious injury and mortality of the Gulf of Maine and Bay of Fundy stock of Harbour Porpoises in commercial gillnet fisheries (Orphanides & Palka 2008, Orphanides 2010). Mitigation measures were established for several management areas comprising seasonal closures during the months of the year when Harbour Porpoises are most concentrated in these areas, pinger requirements for sink gillnet or gillnets capable of catching multispecies, and gear modification requirements. Within this management plan requirements for small and large mesh size gear have been set. A distinction has been made by large mesh gillnets, including gillnets with a mesh size of 7 to 18 inches (18–46 cm) and small mesh gillnets, including gillnets with a mesh size larger than 5 to less than 7 inches (13<mesh size>18 cm). Gear specification requirements for gillnets used in the Mid-Atlantic management area include measures specifying a net limit per net string, twine size, net size, number of nets per vessel, and tie-down provisions (Federal register 2009). Due to low compliance with its measures and bycatch occurring outside its original management areas the HPTRP has been revised in 2010 (Orphanides 2010). After the implementation of the HPTRP first the annual average bycatch decreased to a level below Potential Biological Removal (PBR; Waring *et al.* 2004). However a stock assessment report indicated an annual estimated bycatch exceeding PBR. (Waring *et al.* 2007). The National Marine Fisheries Service (NMFS) signalled two problems for the increase in Harbour Porpoise takes, involving non-compliance with the current HPTRP requirements and involving observed Harbour Porpoise takes occurring outside of existing HPTRP management areas (Federal Register 2009).

These data lead to outreach and enforcement efforts (development of outreach cards summarising requirements and management areas; outreach cards on pinger use, pinger training and permission to use pingers; industry outreach meetings, training local and federal enforcement staff, increasing coast-guard patrols). These efforts lead to an increase in compliance. However it didn’t address the bycatch outside the management area’s where no reduction measurements where in place (Federal register 2009).

6.2. Siting, land reclamation

Clark *et al.* (2010) stressed that governments should ensure that potential developers of all marine industries, including marine renewable energy, oil and gas, carbon capture and storage, aquaculture and harbour/marina (infrastructure and expansions, as well as new developments), and those conducting transient activities, such as shipping and the marine tourism industry, are aware of and take full account of legislated environmental requirements. They concluded further that the appropriate considerations for spatial sensitivities, and resulting siting of developments, should be identified early in the spatial planning process. Planning systems should be used to steer potentially harmful activities away from sensitive areas or sensitive periods in time, including sensitive areas outside of marine protected areas.

6.3. Vessel strikes

Although vessel strikes, in some cases, have a proven lethal impact on Harbour Porpoises, given some recorded incidents, it is at present not seen as a significant threat. No concrete mitigation measures are proposed but monitoring the scale and cause/effect is recommended. However, if there are signals that certain ship traffic (speedboats, fast ferries) do cause vessel strikes, seasonal restrictions should be considered when porpoises and shipping lanes overlap.

Figure 46. Windfarm off Egmond aan Zee, 10 April 2008 (CJ Camphuysen)

6.4. Windfarms

Mitigation measures used to avoid the effects of the construction of offshore wind farms are discussed in the next paragraph. No mitigation measures are proposed for the operational phase, but for the installation phase (pile-driving) and the decommission phase.

6.5. Acoustic disturbance; loud explosive sounds

The impact of anthropogenic underwater noise, depending on source and intensity is a major concern for the conservation of porpoises due to the adverse effects ranging from disturbance to injury or mortality. Acoustic disturbance and potential physical damage by seismic surveys as a result of oil and gas prospecting, military activities and pile-driving activities, are considered to have a significant impact on the conservation of porpoises in the North Sea. Both disturbance and physical damage may adversely affect the conservation of this species. The differences between underwater and abovewater sound definitions and the different ways to measure sound levels do make it complex to understand the effects of underwater noise on marine life. The field of noise mitigation measures underwater with the aim to protect marine ecosystems is far less advanced than the field of noise mitigation measures above water with the aim to protect humans. (Ainslie *et al.* 2009). A consequence of this is that in many cases the effectiveness of mitigation measures has not been proven yet. Therefore, monitoring the effectiveness of all mitigation measures should be a general requirement as long as its effectiveness has not yet been documented. Careful monitoring should also contribute to the development of the most effective but also cost-effective mitigation tools.

Mitigation measures - Ainslie *et al.* (2009) distinguish measures into three categories: measures at the source, measures that affect the propagation and measures at the receiver side. For example, changing the sound output of an airgun is a measure at the source, installing a sound barrier such as a bubble curtain is a measure that affects the propagation and acoustic deterrents can be seen as a measure at the receiver side.

Observing protocol

Prior to any action almost all, if not all current guidelines, literature and experts recommend to observe if any marine mammals are in the critical area. To optimize the effort it is recommended to work with skilled marine mammal observers in preferably both visual and acoustic detection. The reasons for not having only visual observation are that weather conditions (wind, fog) might reduce the observing effort or even reduce this to zero. Harbour Porpoises, unfortunately, are notoriously difficult to observe, even by trained observers under favourable conditions (see chapter 4.1; **Fig. 47**). Hydrophones and other acoustic devices do not always pick-up porpoise-sounds, because the animals are not always vocally active. The range for Harbour Porpoises to be detected cannot be expected to be more than 200 meter, due to higher sound absorption, and the high directionality of the porpoise clicks. Given the difficulties for in particular the Harbour Porpoise, an observer protocol cannot be seen as the ultimate mitigation measure, but should be seen as a minimum requirement to conduct any activity causing explosive underwater sounds. Although there might not be porpoises observed within a certain distance of the sound source, this does not mitigate any potential adverse effects at a larger distance.

Planning (pile driving; explosives; seismic surveys)

For all three explosive sound sources, pile driving, explosives and seismic surveys, it is recommended to minimise activities in areas or in time with high densities of animals. It is noted that for the removal of ammunition in most cases it is an urgent situation, which cannot always be guided by the distribution or abundance of Harbour Porpoises or other marine mammals.

Figure 47. Harbour porpoises at several distances (St. Lawrence, Quebec, Canada, 2008. M.L. Siemensma).

Mitigating physical disturbance and underwater noise

There is abundant evidence that the construction of offshore windfarms (i.e. pile driving) triggers avoidance behaviour of Harbour Porpoises within the North Sea at large. It is recognised that pile driving and other construction activities necessary to build offshore wind farms have an adverse effect on porpoises. In its resolution on the adverse effects of renewable energy ASCOBANS recognises the difficulty of proving detrimental effects of acoustic disturbance on cetaceans compared to bycatch evidence in fisheries, which necessitates a precautionary approach (ASCOBANS 2009). This counts also for other construction activities where pile driving or similar construction methods are used.

Acoustical implications related to offshore windfarms can be assessed in four phases providing several options to reduce potential damage. During the first phase, pre-construction, no effects are expected, except when seismic surveys are part of the preparatory phase. No measures are suggested. The second phase, construction, causes the most concern for the conservation of porpoises, since pile driving is the used or scheduled (for future projects) construction method. The noise created during pile driving operations involves sound pressure levels considered high enough to impair the hearing system of marine mammals near the source and disrupt their behaviour at considerable distance from the construction site. Pile driving should be avoided or only under controlled conditions such as with observers using both visual and acoustic detection in seasons of low abundance using mitigation measures such as pingers as deterrents and/or by ramping up the noise. During the operational phase no measures are proposed, as there are no significant adverse effects expected. The decommissioning phase should avoid underwater explosions, or only under controlled conditions with visual and acoustic detection schemes, in seasons of low abundance using pingers as deterrents and by ramping up the noise.

Current available mitigation measures are most if not all based on clearance of the area on one hand through deterring porpoises using acoustic devices and by slowly increasing the sound levels. On the other hand there are measures used and explored to reduce the sound levels by using technical tools such as bubble curtains or solid barriers, as described below.

Alternatives to pile driving at sea

Pile driving in general should be avoided, independent whether this is for constructing an offshore wind park or any other foundation. There are several types of foundations for offshore wind turbines. Variables of relevance for the different foundation methods are among others, water depth, weather conditions (maximum expected wave height), the soil condition and from economic perspective, the costs. Examples of piled foundations are the mono-pile, a steel pile which is driven approximately 32-64 ft into the seabed; the tripod foundation, which is based on technology used by the oil and gas industry. The piles on each end are driven 32-64 ft into the seabed, depending on the soil conditions. This technology is generally used at deeper depths; a third method based on pile driving is the jacket foundation, suitable for water depths from 20-50 metres. Tripod or jacket structures are generally accepted as the more feasible foundation solutions in water depths in the 30-45 metres range, both having smaller piles than mono piles (OffshoreMarine 2010).

Gravity based structures (GBS)

Gravity based structure consists of a large base constructed from either concrete or steel which rests on the seabed and is together with monopiles the most used foundation. Although both GBS and monopiles are less attractive options for larger turbines in deeper water depths. GBS has been used in water depth of around 10 metres or less, the deepest being constructed for the Thornton Bank wind farm 30 km off the coast of Belgium, around 20 metres water depth (OffshoreMarine 2010). The turbine is dependent on gravity to remain erect (offshorewind.net/Other_Pages/Turbine-Foundations).

Drilling

Another foundation method consists of concrete monopiles using a drilling method based on horizontal tunnel-drilling methods. Reasons for developing this concept are among others the fact that concrete monopiles are inexpensive compared to steel monopiles; the method can be used for various soil types and underwater noise can be prevented according to Ballast Nedam (www.bnoffshore.com). Weather conditions (expected maximum wave-heigths) might be a limiting factor for using this foundation method in the North Sea. Ainslie et al. (2009) refer to a report of the E&P Joint Industry project, providing an overview of various treatments and alternatives to pile driving (Spence *et al*. 2007).

Vibrodriving

Vibrodriving is an alternative for pile driving, developed to reduce harm to the environment. Rotating eccentric weights create an alternating force on the pile, vibrating it into the ground (Ainslie et al. 2009). Vibrodriving is only suitable for smaller piles (Elmer 2007). The BARD 1 offshore windpark has been constructed using this alternative vibratory pile driving method. This offshore windpark is fully exposed to the North Sea environment. BARD developed the patented 'Tripile' foundation system, which is suitable for water depths of 25 to around 40 metres and is, according to BARD, compacter, lighter and cheaper than other offshore foundation systems (www.bard.de).

Mitigation tools - There are several tools available to mitigate to some extent the sound of explosive sounds, however all measures still need to be studied to measure its effectiveness.

Modification piling hammer

Nehls et al. (2007) discuss potential options to reduce the piling noise for monopile foundations, such as modifying the hammer to reduce the strike. The physical principle of this approach is to prolong the impact time of the pile hammer, which results in a lower noise level. However, experiments showed so far not yet a feasible solution but further experimental work is recommended. An advantage of modification of the piling hammer is that it tackles the problem of noise at the source, rather than damping it afterwards. Furthermore no change is required in the equipment and techniques used currently, apart form a slight modification of the hammer settings.

Modify piling interval

A current study by SEAMARCO investigates the options using an interpuls interval while driving mono piles, providing time to recover for the hearing system in between piling (Ron Kastelein *pers. comm.*). Piling piles varying in diameter and numbers, results in different impact. It is worth therefore investigating which method causes more impact on the environment.

Bubble curtain (pile driving, explosives)

A measure to mitigate sound propagation is by creating a noise barrier that reflects the sound. This noise reduction method can be used for both pile driving and the removal of old ammunition. Using a bubble curtain or bubble screen as a noise barrier is a currently investigated measure to reduce the sound level. Bubble screen barriers can lead to a reduction of 3 to 5 dB (Würsig et al. 2000) or even up to 20 dB (Spence et al. 2007). Although it leads to a reduction of noise, there are many difficulties such as the maximum depth, which makes it only feasible in shallow waters or the time and effort necessary for construction. Ainslie et al. (2009) note that the bubble screen itself is a source of sound, which may for some low frequencies (order hundreds of Hz) be louder than the sound source it is supposed to suppress.

A study by Lucke et al. (in press) in Denmark, Kerteminde, resulted in decreasing sound levels of pile-driving after the installation of a bubble curtain as a sound barrier between porpoises in captivity and a pile driving site, decreasing to some degree at least acoustically induced adverse effects by impulsive sounds. During construction work replacing a harbour wall in Denmark, 175 wooden piles were piled into the waters edge. At the same time three Harbour Porpoises were housed in a marine mammal facility on the opposite of the harbour showing strong avoidance reactions. To reduce the sound exposure Lucke et al. (in press) constructed an air bubble curtain in a direct path between the piling site and the opening of the semi-natural porpoise pool. Pile driving impulses were simultaneously measured in front and behind the active air bubble curtain. Mean levels of sound attenuation were 14 dB for peak to peak values and 13 dB for sound exposure level values. As soon as the air bubble curtain was installed and operated, no further avoidance reactions of the animals to the piling activities were apparent (Lucke et al. in press). In the discussion Lucke et al. (in press) note that the effectiveness of such an air bubble system in open waters based on the results of this study remains difficult to assess. With stronger currents and greater water depths the efficiency of the present design may have to be optimized. Haemmerle et al. (2009) showed that uncontained bubble curtains in flowing water were not effective in attenuating pile driving sounds. Pile driving with contained bubble curtains (sleeve) were effective in attenuating pile driving sounds by 8-24 dB.

Solid barrier

Ainslie et al. (2009) refer to the use of solid physical barriers to reduce pile driving noise, filling a steel casing with foam instead of air. Attenuation up to 20 dB is reported. Another alternative is to remove water from a solid casing that surrounds the sound source. This expensive method effectively blocks the sound radiation into the water. This method is only feasible in shallow waters (Spence et al. 2007). The COWRIE report identifies two methods, which offer sufficient prospect for a technical realization in practice: the inflatable sleeve and the telescopic tube, both bases on layers of air or foam around the pile. Sound levels in 500 m are attenuated by 15 or 20 dB respectively and the radius in which harmful or disturbing effects on marine mammals may be expected is reduced considerably. Further work to develop noise mitigation measures and to make them ready for practice is recommended (Nehls et al. 2007).

Saleem (2011) provides an overview of alternatives and modifications of monopole foundation or its installation technique for noise mitigation. Several new technologies, yet unproven on large scale, are described. Some are based on an adapted piles, such as the use of screw piles or skirted monopiles. The latter would increase the lateral stability and therefore reduce the penetration depth of a monopile. Other technologies are based on new concepts, such as the concept of floating turbines, the guyed support structure, where a turbine is supported by guy-wires or guy ropes. Analysing the alternatives and modifications for noise mitigation, Saleem (2011) concludes that it would be impossible to find a perfect solution. Every foundation provides particular advantages and disadvantages. The report distinguishes between engineering solutions that can be used for noise mitigation in the immediate short term without significantly changing to the current methods. This includes changing the parameter for pile stroke, using a vibratory hammer for pre-installing the monopile. Other solutions that can follow to further reduce noise in the short and medium-term include the isolation or damping of the sound and adapting the pile toe-shape.

The comparative analysis by Saleem (2011) concludes that alternatives for the steel monopile can provide some effective solutions in the short term, such as currently used techniques as jacket foundation with vibratory pile driving and gravity based structures. Other alternatives that can play a significant role in noise mitigation include the drilled concrete monopile, the screw-pile, floating foundations or the suction caisson method, using hydrostatic pressure and the weight of the structure to penetrate the soil. Although some methods are in a concept phase and further development is needed, these can provide significant noise reduction.

Acoustic deterrent (pile driving, explosives)

The concept of using an acoustic deterrent device (ADD) prior to the activity causing the noise is to deter marine mammals, porpoises in this case, out of the area, which might cause a negative effect on the animals. It is assumed that animals dislike the sound enough to move to a safe distance, large enough for the noise to drop below unpleasant levels. There are several acoustic deterrents available all producing (ultra)sound in the frequency range of 5 to 160kHz. In theory ADDs have the potential to reduce the risk of causing injury to marine mammals, however in practice, not much is known about whether or not this assumption is correct. One can imagine that marine mammals get attracted by the sounds the deterrent produces, out of curiosity. There is a need for studies quantifying the efficacy of ADDs to determine the applicability as suitable mitigation measure (JNCC 2009a). It should be also noted that the use of acoustic deterrents adds on the total amount of underwater noise and that the deterrent devices might reach levels which might have adverse effects on porpoises as well. When frequently used, this might even cause a temporary or permanent habitat loss (Franse 2005). The duration of disturbance compared to the activity and the expected physical damage should be weighed.

Ramp-up / soft-start (pile driving, seismic)

A ramp-up scheme or soft-start means that the power source (sonar, airgun, hammer strikes) is started in a low-power mode after which the power is increased to a maximum level during a specified time. This time should be large enough for the animals to relocate to a 'safe' distance. The assumption is that the animals indeed respond in this manner to the sound, either instinctively or because they have learned to do so. At this time there is no information available that supports this assumption. An unwanted side effect of a ramp-up scheme is that it is likely to increase the total duration of an operation, thus increasing also the total acoustic energy transmitted by the source (Ainslie et al. 2009). Although ramp-up is mentioned as a mitigation measure, no studies have been done so far proving its effectivity so far.

Policy in practice – pile driving

The Dutch Government currently has restricted offshore pile driving from January-June. This decision is based on the distribution of fish larvae, birds and marine mammals. At present, subsidy has been granted to BARD-Group for the construction of two offshore windparks about 55 km above the Dutch Wadden island Schiermonnikoog. The two windparks, 'GWS Offshore NL 1' and 'BARD Offshore NL 1' together will have a capacity of 600 MW. Building activities are expected to start in 2013. During construction sound measurements are required. The foundation used for the construction of the two parks is the 'Tripile' foundation system (see chapter 6.5). In 2009 ASCOBANS recommends its Parties and Range States to consider a strategic approach to the siting of marine renewable energy developments; to include Strategic Environmental Assessments and Environmental Impact Assessments carried out prior to the construction of marine renewable energy developments and taking into account the construction phase and cumulative impacts (ASCOBANS 2009).

The UK enforced a protocol for minimising the risk of disturbance and injury to marine mammals from piling noise (JNCC 2009a). This document outlines a protocol for the mitigation of potential underwater noise impacts arising from pile driving during offshore wind farm construction. This protocol may also be useful to other industries in the marine environment, which use pile driving. The agencies recommend that all operations that include pile driving should consider producing an Environmental Management Plan (EMP), or an equivalent document that meets the requirements of the relevant regulator.

Summarising the UK piling protocol recommends a pre-piling search by skilled marine mammal observers (acoustic and/ or visual monitoring) for marine mammals with a minimum of 30 minutes before piling starts. According to the guidelines piling should not commence if marine mammals are detected within the mitigation zone or until 20 minutes after the last visual or acoustic detection. The mitigation zone is the area in which the observers will monitor either visually and/ or acoustically for marine mammals before piling commences. The extent of this zone should be agreed with the regulatory authority. The extent of this zone will be determined by factors such as the pile diameter, the water depth, the nature of the activities and the effect of substrate on noise transmission. In any situation the mitigation zone should have a radius of no less than 500 metres, measured form the pile location.

The German Federal Environment Agency (UBA) laid down a standard threshold for the construction of offshore windparks. This dual criteria threshold is based on TTS-data of a Harbour Porpoise gained by Lucke *et al.* 2009 (see chapter 5.5). Within 750 metre of the sound source it is not allowed to exceed a sound exposure level (SEL) of 160 dB re 1µPa and a sound peak pressure level (SPL) is 190 dB re 1µPa (Werner 2010). The threshold is mandatory for the construction of offshore windparks, and is included in the licenses of the German Federal Maritime and Hydrographic Agency (BSH).

Mitigation measures seismic surveys - Regarding seismic exploration, the marine mammal mitigation measures currently in use worldwide show considerable variation in parameters such as the exclusion zone radius, the marine mammal species included in mitigation, and delay/shut-down procedures. Relatively few aspects of current mitigation have a firm scientific basis and proven efficacy in the field, and there remains a total lack of effective mitigation during night and adverse weather (Weir & Dolman 2007).

Changing airgun output

Changing the output of frequencies is an example of a measure at the source. Hearing frequency ranges of among others porpoises are limited. Any change in the spectrum of a noise source towards a less sensitive part of the hearing threshold curve would be an improvement (Ainslie et al. 2009). The frequency range that is used for seismic exploration depends on the required image resolution and on the depth of interest. The usable bandwidth ranges from 10 Hz at the low end to 1000 Hz at the high end. However, if the depth of interest is more than 2 km, then the usable bandwidth typically ranges from 10 Hz to 200 Hz (Ainslie et al. 2009). A desk study by Arcadis shows that the desired frequencies for seismic survey on the NCP vary from 10 - 100 Hz. (Kater et al. 2011). An airgun does not only generate the 'usable' frequencies but also produces much higher 'waste' frequencies up to 10 kHz (Ainslie et al. 2009). Eliminating frequencies above the desired signal would reduce the impact. An example of an airgun which reduces the output (pressure and dB) is the GI airgun, which, due to a two chambers system has a reduced bubble pulse and a smoother spectrum than that of a sleeve airgun (MacGillivray 2006). Note that limiting high frequencies does mitigate disturbance, but does not prohibit any potential tissue damage.

Power-down

Another way to reduce the sound levels is organising a so-called 'power-down', which should be still loud enough to scare porpoises away but does have a lower impact. During a seismic survey with more ships sailing in parallel, the period when ships are heading for a new position, the number of active airguns could be reduced, keeping only one airgun active to keep animals away from the impact area (Kater et al. 2011).

Policy in practice

To address conservation concerns that have arisen in relation to seismic surveys, the UK government developed the first national guidelines in 1995 to minimise acoustic disturbance of marine mammals by oil and gas industry seismic surveys, which has been updated in 2009 (JNCC 2009b). As being the first, they became the basis of international mitigation measures for noise pollution during seismic surveys. In a critique on the existing guidelines (Parsons et al. 2009) remark that the guidelines do not offer adequate protection to marine mammals but offer a common sense approach to noise mitigation, which should be updated in light of recent research and ongoing concerns with broader measures needed to ensure adequate species protection.

The UK guidelines have requirements for operators at the planning stage and during the operation of a seismic survey. For example, for at least 30 minutes prior to using airguns, onboard observers should check for the presence of marine mammals within 500 meter of the airgun array; if any are detected then use of the airguns must be delayed until at least 20 minutes after the last sighting. Whether marine mammals are detected or not, a ‘soft-start’ or ‘ramp-up’ procedure needs to be employed, where airgun array power is gradually built up over at least 20 minutes from a low energy starting level (Stone & Tasker 2006).

ASCOBANS also underlined the need for guidelines for seismic surveys (ASCOBANS 2006b). Parties and Range States of the agreement are requested to introduce guidelines on measures and procedures for seismic surveys in order to minimise risks to small cetaceans following current best practice and to report on high energy seismic surveys per one degree by one degree rectangle using shot point density. The UK is not the only country having established guidelines for seismic surveys. Since 2006 New Zealand has guidelines for seismic surveys (Department of Conservation 2006). The US established guidelines in 2007 (US Department of the Interior Minerals Management Service 2007). In German waters seismic surveys require a permit issued by the mining authorities. At present there is neither a permit required for seismic surveys in Dutch waters, nor a set of guidelines.

Detonation, underwater explosives - Removing old ammunition using explosives causes a loud impulsive sound level, likely to cause adverse effects on porpoises. Mitigation measures to avoid the adverse effects of controlled explosions at sea can be a mixture of different measures, some clearing the area, others reducing the sound levels or taking into account abundance and distribution. The use of acoustic deterrents prior to detonation alerting animals and deterring them from the risk full area is a mitigation measure. Further measures could include timing (reduce efforts in periods of high abundance) or an associated observer scheme to check for the presence of marine mammals immediately around the impact zone. Consideration of alternative ways to remove old ammunition reducing the sound level should be encouraged.

Policy in practice

In June 2009 guidelines for minimising the risk of disturbance and injury to marine mammals whilst using explosives haven been established in the UK. These guidelines, have been written for activities on the United Kingdom Continental Shelf, and aim to minimising the risk of injury and acoustic disturbance from explosive activities to marine mammals including, seals, whales, dolphins and porpoises (JNCC 2009c). The UK guidelines require among others a planning stage and prescribe protocols to follow during the explosive activity. A pre-detonation search for marine mammals by a marine mammal observer is requested. At least 1 hour before any type of detonation, a visual search and, if required due to weather conditions, acoustic monitoring, should be carried out in the mitigation zone (1 kilometre measured from the explosive source and with a circular coverage of 360 degrees). UK guidelines for ammunition removal also prescribe that detonation should not be undertaken within 20 minutes of a marine mammal being sighted within the mitigation zone. If a marine mammal is observed, or acoustically detected, within the mitigation zone, it has to be monitored and tracked until it moves out of range. If the marine mammal is not detected again within 20 minutes, it can to be assumed that it has left the area and the detonation may begin. The guidelines also recommend sequencing the explosive charges. A progressive increase in charge size (soft-start or ramp up) may reduce the risk of injury by allowing time to move out of the impact area. In case of grouped detonations, it is recommended to delay the second detonations with a fraction to reduce the cumulative effect of the charges and lessening the impact of the shock wave. Acoustic Deterrent Devices (ADDs) could be used

Mitigating the effects of sonar - The use of sonar for military exercise or actions is not recognized as a significant threat to porpoises in Dutch waters. Nevertheless, the available measures mitigating the effect of sonar for other cetaceans have been evaluated. The sonar research group of TNO developed a software package, SAKAMATA, providing sonar operators with some information on the likelihood of the presence of species of marine mammals in the operating area. A database in this software caters for the audiotory monitoring of marine mammals and gives some clues for the visual field identification. The system generates advice for using sonar in operating areas, but has not been evaluated for usefulness with regard to Harbour Porpoises. Part of the SAKAMAT advice is a 'ramp-up scheme' (also known as 'soft-start') that takes account of sonar specifications, and environmental (sound propagation) conditions. The SAKAMATA system could serve as a frame of reference when considering mitigation instruments for other ound sources other than sonar, but its effectiveness need to be investigated.

6.6. Mining activities

There are no measures proposed. Currently nothing is known about the effects of mining activities at sea on Harbour Porpoises. Further studies would be needed to monitor the scale and cause/effect.

6.7. Marine litter

Marine mammals are mostly affected as a result of entanglements and by ingestion of plastic materials. Marine litter is a global rather than a regional issue. Due to the long life of plastics in marine ecosystems, it is evident, however, that severe measures have to be taken to address the problem at both international and national level. The Marine Strategy Framework Directive (MSFD) addresses marine litter, aiming at a good environmental status for European seas in 2020.

6.8. Marine pollution

Marine pollution is a serious threat calling for an international, coordinated approach as it a global rather than a regional. It is imperative that severe measures have to be taken to address the problems caused by marine pollution at both international and national levels. The Marine Strategy Framework Directive (MSFD) addresses marine pollution, aiming at a good environmental status for European seas in 2020.

6.9. Reduced prey availability

Prey availability is not something that can be easily influenced at a regional scale. However, at present certain fish species are managed by the Total Allowable Catch (TACs) & Quota Regulation under the Common Fisheries Policy (CFP). When having sound knowledge on the feeding ecology of the Harbour

Porpoise, TACs & Quota of relevant fish species for the Harbour Porpoise can be proposed for adaptation. Current knowledge, however, would suggest that most Harbour Porpoise prey species have limited commercial value and are therefore are not managed under the Common Fisheries Policy (see chapter 4.2).

6.10. Natural predators, competition

Predator presence or levels of competition for resources of prey with other natural apex predators cannot be influenced by measures at a regional scale. No measures are proposed.

6.11. Infectious disease

Infectious disease might be related to marine pollution and nutritional status and is probably a general rather than a regional issue. Specific measures are recommended. However, based on stranded animals, studying the occurrence of infectious disease is recommended and should be encouraged.

6.12. Parasites

No specific measures are recommended. Parasitosis may be related to nutritional status, marine pollution or other factors and is probably a general rather than a regional issue.

6. 13. Morbillivirus

No specific measures proposed. Epizootics of morbilivirus infections are potentially hazardous for a species as the Harbour Porpoises, therefore virological investigations should be a part of the standard protocol for autopsies on stranded animals, but there is currently no cause for immediate action.

7. Policy and legislative context

This chapter is meant to give the policy and legislative context of relevance for the conservation of the Harbour Porpoise. It is not a comprehensive legal analysis, but an overview based on available literature dealing with Harbour Porpoises and policy, on international, European and national level. The recommended policy measures, which will be given in chapter 9 are bound by the current legal framework and the compliance of it.

7.1. Introduction

The Harbour Porpoise is, just 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. However, the species conservation regime for the North Sea is complex, and conflicts arise when it comes to adequate protection (Trouwborst & Dotinga 2008). While the nature conservation legislation of the European Union (EU), together with international treaties, imposes a strict protection of the porpoise, one of the main threats, bycatch, is only touched marginally and in general terms under the Habitats Directive of the EU. Fishing activities in EU waters and by EU fleets are mainly managed by the European Commission (EC) in its Common Fisheries Policy (CFP). We will explore the discrepancies between the environmental policy on one hand and the fisheries policy on the other hand, showing the patchiness of current policy, not of benefit for an adequate conservation of the Harbour Porpoise.

7.2. Geographical scope

The Dutch species conservation plan for the Harbour Porpoise applies to the Dutch part of the North Sea consisting of the Exclusive Economic Zone (EEZ) beyond 12 nautical miles from shore and the territorial waters within 12 nautical miles from shore. The aim of this conservation plan is to target the appropriate ecological scale for the conservation of the Harbour Porpoise, i.e. on a scale relevant to the favourable conservation status (FCS) of the population. As a migratory species the Harbour Porpoise does not stop at jurisdictional borders. The Netherlands exercises jurisdiction in its respective part of the North Sea, which covers an area of about 57,000 square kilometres. The territorial sea of the Netherlands extends to 12 nautical miles measured from the baselines defined in the 1985 Act on the Limits of the Territorial Sea (Wet grenzen Nederlandse territorial zee, Staatsblad 1985, Arts 1 and 2). An (exclusive) fishery zone was established by the Netherlands in 1977 (Machtigingswet visserijzone, Staatsblad 1977, 345). Reference to the Dutch continental shelf (Nederlands Continentaal Plat - NCP) and the fishery zone remains relevant, because national legislation still refers to these zones. The fishery zone also differs spatially from the EEZ, because it comprises both the territorial sea and the EEZ. Although the EEZ initially was established by the Netherlands to exercise jurisdiction in relation to vessel-source pollution and dumping in the EEZ for which national legislation was amended, the Dutch Government has recognized that it also offers opportunities to enhance the protection of species and habitats in the EEZ (Dotinga & Trouwborst 2009).

7.3. International legislation

Cetaceans are popular marine animals and cetaceans were among the first animals to have been legally protected. The IUCN Red List (Hammond et al. 2008, IUCN 2010) mentions the Harbour Porpoise generally as of 'least concern'. Since most cetaceans are wide-ranging, often displaying far-ranging migration patterns, protection measures should be coordinated at an international level. There is a variety of international conventions, agreements and action plans dealing with the protection and conservation of cetaceans (Trouwborst & Dotinga 2008). 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.

United Nations Convention on the Law of the Sea (UNCLOS) - Overarching global legal instruments are the United Nation's Convention on the Law of the Sea (UNCLOS), the Code of Conduct for Responsible Fisheries of the Food and Agriculture Organisation of the United Nations (FAO), the Convention on Biological Diversity of the United Nations (CBD). Another overarching legal instrument, with a regional scope as it covers European wildlife and natural habitats is the Bern Convention. UNCLOS (1982) represents the constitution of the oceans and sets out the global legal framework for human activities at sea. This convention is based on the idea that the problems of the oceans are closely interrelated and therefore must be addressed as a whole. UNCLOS, which entered into force in 1994, requests all UN members, inter alia, to cooperate in the conservation of marine mammals in the EEZ and in high seas, and to work through the appropriate international organizations for the conservation, management and study of cetaceans.

FAO Code of Conduct for Responsible Fisheries - The FAO Code of Conduct for Responsible Fisheries, adopted in 1995 provides a non-legally binding framework for the international and national efforts towards a sustainable use of living aquatic resources, in harmony with the environment. It sets an obligation to fish in a responsible way, in order to ensure the conservation of target species and species belonging to, or associated with the same ecosystem. States should minimise bycatch of non-target species, and undertake research into the selectivity of fishing gear and their environmental impact.

Convention on Biological Diversity (CBD) - The Convention on Biological Diversity (CBD), entered into force in 1993, aims at the conservation of biological diversity and the sustainable use of its components. For The Netherlands, The 1992 Convention for the protection of the marine environment in the North-East Atlantic (OSPAR), and the European Directives can be considered as the most important instruments for implementing the marine aspects of the CBD.

Bern Convention - For the member states of the European Community, the obligations under the 1979 Convention on the Conservation of Wildlife and Natural Habitats in Europe (Council Decision 82/72/EEC), also known as the Bern Convention, have been largely taken up into the European Habitats and Birds Directives. The regional Bern Convention is intended to promote cooperation between the contracting parties in order to conserve wild flora and fauna and their natural habitats, listed in its appendices I & II, and to protect endangered migratory species, listed in its appendix III.

The international conventions and agreements following below have been signed and ratified by The Netherlands.

The International Whaling Commission (IWC) - The IWC was set up in 1946 by the International Convention for the Regulation of Whaling (ICRW) to work on the conservation and management of whale stocks. Although the application of the ICRW to small cetaceans is still questioned by some Parties, they have been a focus of study and management advice within the Sub-Committee Small Cetaceans of the IWC Scientific Committee. Several IWC resolutions have been adopted concerning directed and incidental catches of small cetacean species, and a reduction of bycatch levels of porpoises in the North-Atlantic has been recommended.

The Convention on the Conservation of Migratory Species of Wild Animals (CMS) - The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention) is a global convention concluded in 1979 under the United Nations Environment Programme (UNEP) and entered into force in 1992. It aims to conserve migratory species throughout their range. Appendix I to the Convention lists migratory species that are threatened with extinction. Species that need, or would benefit from international co-operation are listed in Appendix II. For these species (inc. the Harbour Porpoise), CMS encourages states to conclude regional Agreements, such as ASCOBANS (see below). CMS has repeatedly adopted resolutions dealing with the assessment of human impacts on cetaceans and the limitation of incidental catches, such as resolution 6.2 on Bycatch which as adopted at the 6^{th} CoP in 1999 and Resolution 8.22 on the adverse human impacts on cetaceans, adopted at the 8^{th} CoP in 2005. Such resolutions however, do not specifically refer to Harbour Porpoises; they are very general, and only impose a moral obligation upon Parties.

Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) - The Bonn Convention acts as a framework convention. Under the auspices of the Convention on Migratory Species (CMS), ASCOBANS, the regional Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas was concluded in 1991 and entered into force in 1994. The agreement area has been extended in February 2008, which changed the name to "Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas." The current ASCOBANS area also covers waters under the jurisdiction of Ireland, Spain, Portugal, Norway, Estonia, Latvia and the Russian Federation, although these range states have not yet chosen to become a party to the agreement. ASCOBANS aims to promote close cooperation amongst Parties with a view to achieving and maintaining a favourable conservation status for small cetaceans, including the Harbour Porpoise. Since migrating cetaceans such as the Harbour Porpoise regularly cross national boundaries, their effective protection can only be achieved by international cooperation. A conservation and management plan in the annex of the agreement calls on the contracting parties to work towards: (1) Habitat conservation and management, including the reduction of pollution and bycatch, the regulation of activities with an indirect impact on small cetaceans, the prevention of significant disturbance, especially of an acoustic nature and the establishment of protected areas; (2) Surveys and research, which should particularly focus on improvement of existing and development of new methods. To identify present and potential threats, studies should include research on the effects of pollution, disturbance and interaction with fisheries, including work on methods to reduce such interactions. Contracting Parties are encouraged to work towards the establishment of an efficient system for reporting, retrieving and studying by-catches and stranded specimens; (3) Effective national legal protection; (4) Information and education of the general public on the species and issues and of fishermen to facilitate and promote the reporting and delivery of bycaught specimens.

ASCOBANS defines in its resolutions on the Incidental take of small cetaceans, limiting levels of anthropogenic removal to no more than 1.7% for local populations, provided they are healthy (population size at least 80% of carrying capacity; ASCOBANS 2006a, ASCOBANS 2000). Bycatch, the incidental entanglement in fishing gear, is considered to be the most serious threat to cetacean populations in the ASCOBANS area, as is acknowledged in this document, revealing that bycatch is one of the main threats for the conservation of the Harbour Porpoise in waters under Dutch jurisdiction, as will be described in chapter 5, discussing threats. The agreement underlines the intermediate precautionary objective to reduce by-catches to less than 1% of the best available population estimate and has the general aim to minimise bycatch (i.e. to ultimately reduce to zero). It also notes that if available evidence suggests that a population is severely reduced, or where there is significant uncertainty in parameters such as population size or by-catch levels, then "unacceptable interaction" may involve an anthropogenic removal of much less than 1.7 %.

At the 5th International Conference on the protection of the North Sea (North Sea Conference), held in March 2002 in Bergen, Norway, it was agreed that the porpoise bycatch level should be reduced. As an interim objective, the Ministers of North Sea riparian states, along the lines of ASCOBANS, agreed to reduce annual bycatches to below 1.7 % of the best population estimate. On the same basis the Ministers agree on a precautionary objective to reduce by-catches of marine mammals to less than 1% of the best available population estimate, and urge the competent authorities to develop specific limits for the relevant species (OSPAR 2009a). At the 6th North Sea Conference, held in May 2006, this 1% by-catch threshold (but not the 1.7% interim objective) was again stated and it was agreed that special attention should also be given to the development of fishing gear and fishing methods that will help to reduce bycatches of marine mammals to less than 1% of the best population estimate. The 5th North Sea Conference also called for the development of a conservation plan for the Harbour Porpoise in the North Sea. In 2009, at the 6th Meeting of Parties to ASCOBANS, the Conservation Plan for the Harbour Porpoise in the North Sea (Reijnders *et al.* 2009) was adopted by all contracting parties. The ASCOBANS conservation plan aims at achieving and maintaining a favourable conservation status of the Harbour Porpoise in the North Sea, specifically by suggesting a series of priority actions. Six out of the twelve actions involve dealing with incidental bycatch in fisheries. The development of a Conservation Plan was taken up by ASCOBANS, building on the experience with the creation of a recovery plan for the porpoise in the Baltic (the Jastarnia Plan). The actions of the ASCOBANS conservation plan are:

- ACTION 1: implementation of the Conservation Plan: co-ordinator and Steering Committee
- ACTION 2: Implementation of existing regulations on bycatch of cetaceans
- ACTION 3: Establishment of bycatch observation programmes on small vessel (<15m) and recreational
- fisheries
- ACTION 4: Regular evaluation of all fisheries with respect to extent of Harbour Porpoise bycatch
- ACTION 5: review of current pingers, Development of alternative pingers and gear modifications
- ACTION 6: Finalise a management procedure approach for determining maximum allowable bycatch limits in the region
- ACTION 7: Monitoring trends in distribution and abundance of Harbour Porpoises in the region

- ACTION 8: Review of the stock structure of Harbour Porpoises in the region
- ACTION 9: Collection of incidental porpoise catch data through stranding networks
- ACTION 10: Investigation of the health, nutritional status and diet of Harbour Porpoises in the region
- ACTION 11: investigation of the effects of anthropogenic sounds on Harbour Porpoises
- ACTION 12: collection and archiving of data on anthropogenic activities and development of a GIS

Convention for the protection of the marine environment in the North-East Atlantic (OSPAR) - The 1992 Convention for the protection of the marine environment in the North-East Atlantic (OSPAR), which came into force in 1998, is managed by the OSPAR Commission, which consists of representatives of the 15 OSPAR Parties (Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and The United Kingdom) and the European Commission (EC). Annex V of OSPAR requires from its Contracting Parties (Art. 2), including The Netherlands, to take the necessary measures to protect and conserve the ecosystems and the biodiversity in the North-East Atlantic. It is thus the duty of the OSPAR Commission, the forum through which the Contracting Parties cooperate, to develop means, consistent with international law, for instituting protective, conservation, restorative or precautionary measures related to specific areas or sites or related to particular species or habitats (Art. 3).

In the scope of Annex V, OSPAR developed the OSPAR list of threatened and/or declining species and habitats (OSPAR Agreement 2008-6). The Harbour Porpoise is one of the species on the OSPAR list. The purpose of the list is to guide the OSPAR Commission in setting priorities for its further work on the conservation and protection of marine biodiversity and to define criteria for marine protected areas. The list is not legally binding and species and habitats can be added or removed in the light of changes to their conservation status and to the threats they face and in the light of the latest scientific assessments, according to the so-called Texel-Faial Criteria (OSPAR 2003-13), however recommendations and decisions such as this list under OSPAR do form an important legal body of interpretation. In an article on the generic species conservation in the North Sea by Trouwborst (2011) the importance of OSPAR decisions is further explained. As contracting party, The Netherlands has the obligation to take 'necessary measures' to protect and conserve the biodiversity of the North Sea. This seems to give some space in judgement to the contracting parties with regard to the required action. Nevertheless it is clear that measures pointed at the generic protection of species can take part of the prescribed 'necessary measures'. Further more, the above mentioned space is more and more defined as a result of the decisions of the OSPAR Commission related to the protection of specific species. Although decisions concerned in itself are not legally binding, when interpreting the concerning legal agreements concerned, they are of high importance (Trouwborst 2011).

The OSPAR programmes and measures in the framework of the reduction of pollution are beneficial to the Harbour Porpoise, but they are generic, and not aimed specifically at marine mammals. OSPAR is not competent to adopt measures in the field of fisheries management. Nevertheless it can and does draw the attention of the relevant authorities, including the European Commission, to issues where it considers that action is desirable. One of these issues is bycatch in fisheries.

In a background document for the Harbour Porpoise, OSPAR proposes a set of actions and measures that could be taken to improve the conservation status of the species, based on an assessment of the most recent information on its status (distribution, population, condition) and the key threats. Reducing the incidental capture remains top priority for management. In the context of monitoring, OSPAR recommends addressing the regional differences in abundance and overall trends, fisheries bycatch rates and the effects of other anthropogenic pressures, in particular pollutants and noise disturbances (OSPAR 2005).

To help fulfil its commitments in applying an ecosystem approach to the management of human activities that may affect the marine environment, OSPAR developed Ecological Quality Objectives (EcoQO's) for the North Sea as a test case. These EcoQO's can be considered as objectives for a number of indicators, which are related to environmental problems. One of the Ecological Quality Objectives that OSPAR has put forward requires that annual bycatch levels of Harbour Porpoises should be reduced to below 1.7 % of the best population estimate, along the lines of ASCOBANS and North Sea Conference recommendations (OSPAR 2006). In 2010, OSPAR evaluated this EcoQO and concluded that the monitoring of by-catch of Harbour Porpoises in the North Sea was inadequate to assess whether or not the EcoQO was being met (OSPAR 2009b).

7.4. European legislation

EU instruments which are relevant for the protection of the Harbour Porpoise at species level in the North Sea are the EU Habitats Directive (92/43/EEC), the Common Fisheries Policy (CFP; EC 2371/2002) and the more recently adopted Marine Strategy Framework Directive (MSFD; 2008/56/EC).

EU Habitats Directive - The European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (commonly know as the Habitats Directive, Directive 92/43/EC) was adopted in 1992. It contains a list of species of community importance that have to be strictly protected (Annex IV). Next to this, a number of species have been listed for which protected sites need to be selected by the member states to contribute to conserving their habitats (Annex II). These Special Areas of Conservation (SACs) should constitute, together with the areas listed under the European Birds Directive (with its Special Protection Areas or SPAs), a network of sites which will act as the backbone of the European policy concerning habitat protection: the Natura 2000 network of protected areas. The Harbour Porpoise has been awarded the highest protective status by being listed on both Annex II and Annex IV of the Habitats Directive.

Maintenance or reaching a favourable conservation status (FCS) for natural habitats and species of wild fauna and flora is the primary objective of the Habitats Directive. All measures taken under the directive must aim to reach or maintain a favourable conservation status. Conservation status of a species depends on the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations within its territory. The conservation status will be taken as 'favourable' when: population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats; the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future; there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis (European Commission 2007).

The criteria for determining the conservation status have been further refined by the Habitats Committee as executive committee of the Habitats Directive. The main thrust is to look at these refined categories as guidance to assess the conservation status. Once the Habitats Directive is transposed into the national law of all EU member states, the Harbour Porpoise is legally protected in all EU waters. Article 4(1) of the Habitats Directive specifically states that "for aquatic species which range over wide areas, Special Areas of Conservation (SACs) will be proposed only where there are clearly identifiable areas representing the physical and biological factors essential to their life and reproduction." Given the lack of detailed data on the distribution and reproduction of the Harbour Porpoise, the migratory nature of the animal and its irregular occurrence in certain areas, it has not been possible so far to identify areas in accordance with article 4(1) (see chapter 4.9). It is now more and more acknowledged that it might not even be relevant to identify SAC's for this wide-ranging species.

Article 6 of the Directive asks for protective measures in special areas, when they can be identified in accordance with art 4(1). Article 12 asks for protective measures in the entire distribution area. Following both Article 6 and 12, the directive demands a two-tier approach, aiming at a species conservation approach on one hand, and an area protection approach on the other hand, however an area protection approach so far seems not to be applicable (see chapter 4.9). This conservation plan therefore is a generic species conservation plan and its measures for research and mitigation aim at the conservation of the Harbour Porpoise in Dutch waters at large and beyond, given its migratory nature.

European nature conservation legislation, together with international treaties, imposes a strict protection of the Harbour Porpoise. Nevertheless fisheries activities, causing one of the main threats – bycatch – to the species, are mainly managed with by the European community in its Common Fisheries Policy (CFP). The Habitats Directive only touches fisheries and the bycatch problem marginally and in general terms (in Article 11, Article 12(1), Article 12(4), Article 15, and Annex VI).

Article 11 of the Habitats directive requires surveillance of the conservation status of the species. In 2005 the European Commission launched infringement proceedings against member states for not adequately monitoring how effectively their populations of cetaceans - whales, dolphins and porpoises - are being protected. The Commission did consider the monitoring frequency by The Netherlands, once every 10 years insufficient (European Commission 2005).

Article 12(1) requires member states to take requisite measures to establish a system of strict protection for the Harbour Porpoise (as it is listed in Annex IV) in their natural range, prohibiting all forms of deliberate capture or killing in the wild and deliberate disturbance of these species. Trouwborst & Dotinga (2008) in an article on the species conservation in the North Sea emphasize that article 12 (1) of the Habitats Directive not only applies to fisheries activities. It might also apply to other forms of disturbance such as underwater noise, which is one of the main identified threats, together with bycatch, for the Harbour Porpoise. Nevertheless at present, the issue of underwater noise and its adverse effects on the marine environment is not adequately covered and addressed. However, the European Marine Strategy Framework Directive (MSFD) does aim to address the issue of underwater noise.

Under Article 12(4) member states have to establish a system to monitor the incidental capture and killing of the Harbour Porpoise (Annex IV species) and are required to undertake further research or conservation measures to ensure that the incidental capture and killing does not have a significant impact on the species concerned.

Article 15 states that member states should prohibit the use of all indiscriminate means capable of causing local disappearance, or serious disturbance to, populations of species of Annex IVa for which a derogation is applied [according to Article 16]. In Annex VI prohibited means of capture and killing are listed, among which, nets which are non-selective according to their principle or their conditions of use.

The implementation of above-mentioned obligations under the Habitats Directive of relevance for the conservation of the Harbour Porpoise in national legislations will be described and discussed in the paragraph on national legislation.

Marine Strategy Framework Directive (MSFD) - In 2008 the European Marine Strategy Framework Directive (Directive 2008/56/EC of the European Parliament and of the Council - MSFD) has been adopted. The MSFD is seen as the environmental pillar of the EU Maritime Policy. The Marine Strategy Framework Directive provides the parameters within which the member states must shape their policy for the marine environment. The overall objective of this strategy is to promote the sustainable use of the seas and to conserve the marine ecosystems. In 2020 a Good Environmental Status (GES) of all European seas has to be achieved at the latest. The Framework Directive obliges the member states to maintain or restore the good condition of their marine environment. Eleven Quality Descriptors for determining this GES have been laid down in Annex I of the Directive. In September 2010 the Commission adopted a decision outlining the criteria necessary to achieve GES for Europe's seas (2010/477/EU). A major stepping-stone to establish the precise objectives for the achievement of GES within the implementation of the MSFD.

In achieving a good environmental status for Europe's seas the eleven quality descriptors are used to describe GES. The eleven descriptors are generic and not specifically aim at cetaceans. Nevertheless they address issues affecting cetaceans as well, such as the issue of marine pollution and litter, the maintenance of biological diversity and food webs. One of the descriptors of relevance for the conservation of Harbour Porpoises is descriptor 11, addressing the "Introduction of energy, including underwater noise, which should be at levels that do not adversely affect the marine environment". A sub-technical working group under the working group of GES, specifically addresses this issue. Since underwater noise is, together with bycatch, considered one of the main threats for the Harbour Porpoise in Dutch waters, the implementation of The Netherlands, but also of other member states, under this descriptor is of particular importance.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) - The 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, also known as CITES or the Convention of Washingto, which entered into force in 1975, aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival in the wild. In several appendices, CITES sets varying regulations for the international trade in species: in live and animals, as well as in parts of them. The Harbour Porpoise is included in Appendix II, which lists species that are not necessarily threatened with extinction, but may become so unless trade is closely controlled. International trade in specimens of Appendix II species may be authorised by the granting of an export permit or a re-export certificate. No import permit is necessary for these species under CITES. Within the European Union CITES has been implemented since 1 January 1984 through regulations known as the Wildlife Trade Regulations (Currently CITES is covered by Council Regulations (EC) 338/97, 1332/2005, 865/2006 and 605/2006, and Recommendation 2007/425/ EC). The provisions in the EU Wildlife Trade Regulations are stricter at some points than CITES. All cetaceans are listed in Annex A of Council Regulation 338/97, which effectively treats them as if they were CITES

Appendix I species. Commercial trade of these species within the European Community is therefore not allowed.

7.5. European Fisheries regulations

Fish move across borders and seas, and fishing fleets have done the same for centuries. As the activities of each fishing fleet affect the opportunities of other fleets, EU countries decided to manage their fisheries in collaboration, through the common fisheries policy (CFP). This policy brings together a range of measures designed to achieve a thriving and sustainable European fishing industry. Regarding legislation concerning fisheries and the bycatch of cetaceans, there are synergies in the objectives of different international instruments dealing with the protection of small cetaceans. The responsibilities for conservation of porpoises and management of activities influencing porpoises are shared between member states and the different Directorates of the European Commission. The management of professional fisheries is mainly dealt with in the European Common Fisheries Policy (CFP), whereas recreational fisheries are for a large extent being dealt with at a local (national) level.

Until recently, bycatch mitigation was virtually inexistent in a European context, due to a lack of effective measures, and a gap between the European environmental and fisheries regulatory frameworks. The Harbour Porpoise is a protected species under the European Habitats Directive. However the main threat for the species is bycatch, occurring during activities administered through the CFP. The CFP used to focus on the management of individual commercial fish stocks, but it is moving towards an integrated management of fishing activities based on the goals of the ecosystem approach, in which also attention is paid to the non-commercial elements of the marine environment.

Council Regulation 812/2004

For the Harbour Porpoise EC Council Regulation No 812/2004 of 2004 laying down measures concerning incidental catches of cetaceans in fisherieries and amending Regulation EC No 88/98, is of most relevance. It is also known as the so-called pinger regulation. In order to prevent bycatch of small cetaceans, the European Commission issued Council Regulation 812/2004, which acknowledges the threat of incidental take of small cetaceans, and the insufficiency of measures so far. Regulations, other than directives, can also require obligations from citizens. This is the case for Regulation 812/2004, which contains obligations for national governments and fishermen (Trouwborst & Dotinga 2008). The regulation is part of the CFP, although it has been created to implement the Habitats Directive given its preamble, seemingly referring to article 11, 12(1) and 12(4) of the Habitats Directive (Trouwborst & Dotinga 2008):

> Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (3) gives strict protection status to cetaceans and requires Member States to undertake surveillance of the conservation status of these species. Member States should also establish a system to monitor the incidental capture and killing of these species, to take further research and conservation measures as required to ensure that incidental capture or killing does not have a significant impact on the species concerned.

Regulation 812/2004 is built on three pillars. The first is the mandatory use, and the assessment of the effects of acoustic deterrent devices in specific static and mobile gear fisheries to prevent bycatch. These acoustic deterrent devices, also called pingers specifically aim at keeping porpoises (and other small cetaceans) away from fishing gear. The Regulation gives technical criteria of the pingers, on both signal and implementation characteristics. Vessels smaller than 12 metre are not required to use pingers. Note that almost the entire Dutch gill net fleet, suspect of risking bycatch is below 12 metre in length.

The second pillar applies to independent surveillance of fishing activities. Independent observations of fishing activities are essential to provide reliable estimates of the incidental catch of cetaceans. Regulation 812/2004 prescribes the development and implementation of independent on-board observer schemes in specific fisheries to assess bycatch. However, this only applies for vessels over 15 metre length. For small scale fishing vessels less than 15 metre overall length, due to the difficulties in taking an observer on board, member states should collect data on bycatch through scientific studies or pilot projects, but they are not obliged to do so. With regard to the Dutch gill net fleet, the Regulation does not ask for monitoring.

The third pillar of this EC 812/2004 applies to the use of driftnets, which are through EC 812/2004 banned in the Baltic Sea, but which is irrelevant for the North Sea. Member states have to report annually on the implementation of the Regulation. With regard to Dutch waters, and as mentioned above this Regulation is hardly of relevance for the current static gear fisheries, due to the specifications of gear types, periods of the year and areas where obligations exist. In other parts of the Harbour Porpoise distribution area, the implementation of EC 812/2004 faced several difficulties. The implementation of the mandatory use of pingers has been problematic, as well as the control and enforcement. Also assessing the effects of pingers faced and still faces difficulties. It has equally been very difficult to assess bycatch, due to a lack of information on relevant fleets and on the level of bycatch.

In 2010 ICES, based on a request of the European Commission, evaluated the aspects of EC Regulation 812/2004 (ICES 2010d). Summarizing, the advisory body signals that a review of ongoing mitigation measures in Europe suggests that the measures required under regulation 812/2004 are being poorly implemented in general. While current registered fishing effort levels do not suggest unsustainable take levels, there is enough uncertainty about overall average bycatch rates to warrant further monitoring of fisheries in the North Sea, which have received very little bycatch monitoring since the 1990s. A large variation in data implies a possible conservation threat to Harbour Porpoises. Also, the unknown scale of recreational fishing effort remains a concern, as does the possibility that static net effort may increase due to a rise in fuel prices or eased landing restrictions on certain fish species.

Council Regulation 199/2008 - The data collection requirements under Council Regulation 199/2008, concerning the establishment of a Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy, is closely linked to some of the provisions in Regulation 812/2004. EC 199/2008 requires member states to set up coordinated programmes for collection, management and use of biological, technical, environmental and socio-economic data, on professional and on recreational fisheries. Ecosystem data should be included to allow for an estimation of the impact of fisheries on the marine ecosystem. However, concerns have been raised about the feasibility and the costs involved with the collection of certain data.

Summarizing the conservation of Harbour Porpoises under EU law, it can be concluded that despite incidental measures such as EC 812/2004, albeit irrelevant for the Dutch gill net fleet, a member state does meet the requirements under the CFP. However, at the same time, under article 12(1) of the Habitats Directive an infringement is made. It seems that a direct linkage between the Habitats Directive and the Common Fisheries Policy is lacking, however a recent communication of the European Commission to the Dutch Government gives guidance how to deal as a Member State with this obvious discrepancy in legislation. This will be further discussed under National legislation in the paragraph below.

As Trouwborst & Dotinga (2008) indicated, article 12(1) of the Habitats Directive also applies to other forms of disturbance such as underwater noise. Under the MSFD, aiming at a Good Environmental Status for European sea's in 2020 underwater noise, but also other issues such as pollution, foodwebs, biodiversity and marine litter need to be addressed and in principle should address the conservation of Harbour Porpoises as well, although it is not yet specified how and to which extent member states will implement this directive.

It is the aim of this conservation plan to address the most significant threats for the Harbour Porpoise, to comply with the Habitats Directive, in achieving and maintaining a favourable conservation status. Nevertheless, not all threats can be addressed by this conservation plan and are more generic, such as marine litter and marine pollution, but those issues will be addressed under the MSFD, aiming at a good environmental status of European seas by 2020.

7.6. National legislation

Dutch legislation imposes a strict protection of the Harbour Porpoise, guided by article 2 of the Habitats Directive asking for a favourable conservation status. However several geographical discrepancies, limitations of national fisheries regulations and a simple lack of regulations related to mitigation of the effects of underwater noise do not facilitate adequate protection. It can be said that at present The Netherlands do not meet the requirements for the conservation of the Harbour Porpoise in their waters of both national and European law. It is the aim of this conservation plan to fill these current gaps, where possible by recommending policy measures for both research and mitigation.

Flora and Fauna Act & Nature Conservation Act - In general, Dutch legislation applies to Dutch territory and Dutch territorial waters (to 12 nautical miles offshore). In The Netherlands the Harbour Porpoise is legally protected under the 1998 Flora and Fauna Act and the 1998 Nature Conservation Act. The Harbour Porpoise is protected through Article 4, 9, 10 and 11 of the Flora and Fauna Act. It is listed as a species requiring the strictest protection. According to this legislation it is illegal to kill, wound, catch, and obtain protected species, to track them with the above-mentioned intentions, or to disturb them on purpose.

Both the Flora and Fauna Act and the Nature Conservation Act apply to the territorial sea and therefore don't apply to the Dutch EEZ beyond 12 nautical miles. This is a considerable gap in the two acts in the North Sea. If The Netherlands wishes to designate protected conservation sites outside its territorial sea, the Nature Conservation Act must apply to the Dutch Exclusive Economic Zone. For this reason, the Minister of Economic Affairs, Agriculture and Innovation has decided to amend the Nature Conservation Act so that it applies to the whole of the Dutch North Sea. In the summer of 2009, a proposed amendment to the Nature Conservation Act, and also the Flora and Fauna Act, was submitted to the Lower House (Nota van Wijziging 2009, 32 002 nr. 7). This extension of the geographical scope to the EEZ is expected for a few years now (Dotinga & Trouwborst 2009). It is still unclear when this extension will follow. The fact that the Nature Conservation Act still hasn't been extended makes it impossible to establish Natura 2000 sites outside the 12 nautical miles zone. Given the generic species approach for the Harbour Porpoises the fact that there can be no Natura 2000 sites established outside the 12 nautical miles zone is of less relevance for the conservation of the Harbour Porpoise as migratory species.

Although the Flora and Fauna act neither does apply to the Dutch EEZ beyond 12 nautical miles, there is an exception in article 12 (a) of the Flora and Fauna act that it is prohibited for all vessels flying the Dutch flag, without a permit, to catch, kill or to process cetaceans on board. This applies to all Dutch ships, no matter where they are, and therefore this prohibition includes Dutch vessels in the Dutch EEZ (Trouwborst 2011).

Article 12(4) of the Habitats Directive about "incidental catch and killing" requires member states to establish a system of monitoring of bycatch and issue certain conservation measures to ensure that bycatch does not have a negative impact on the species concerned (Dotinga & Trouwborst 2008, Trouwborst & Dotinga 2008).

A guidance document on the strict protection of animal species under the Habitats Directive (European Commission 2007) mentions that it should be stressed that Article 12(4) could be of relevance in defining the requirements of both a "strict protection system" and an "appropriate surveillance system". A system of strict protection can also make provision for recording the incidental capture and killing of species (for Article 12(4)). In this context, the strict protection measures may ultimately need to include conservation measures required to offset the negative impact of incidental capture and killing. As an example for the application of the provision for recording bycatch, the guidance document refers to the monitoring of the by-catch of cetaceans in the fisheries sector and the technical measures taken to avoid such incidents (e.g. attachment of pingers to fishing nets).

In both articles on species protection in the North Sea, Trouwborst & Dotinga (2008) and Dotinga & Trouwborst (2008) emphasize that besides article 12(4) also the obligation under article 12(1) – to take requisite measures to establish a system of strict protection for the Harbour Porpoise in their natural range, prohibiting all forms of deliberate capture or killing in the wild and deliberate disturbance of this species – does apply to bycatch, when taking into account the case law of the High Court of the EC. As it is well known bycatch occurs in set-nets and is cause of death number one for the Harbour Porpoise, this does fall under 'intentional'. As a consequence of this, set-netting in the North Sea in principle is not acceptable, only under the strict conditions of Article 16 of the Habitats Directive: Provided that there is no satisfactory alternative and the derogation is not detrimental to the maintenance of the populations of the species concerned at a favourable conservation status in their natural range, the intentional catch or killing is acceptable when inter alia the fisheries involved has imperative reasons of overriding public interest. However, when fishermen take *effective* measures to prevent the bycatch of porpoises in set-nets the conclusion as above, that set-netting is not acceptable can be different (Trouwborst & Dotinga 2008; Dotinga & Trouwborst 2008). As the derogation under article 16 of the Habitats Directive is only applicable when it is not detrimental to the maintenance of a favourable conservation status, which is, given the current unknown impact and scale of bycatch unknown. This means that a proper monitoring system assessing the impact of bycatch is necessary.

According to national legislation, article 9 of the Flora and Fauna Act is of relevance for the relation between bycatch and passive species conservation. Article 9 prohibits to catch, kill and wound any protected species. Following 'any protected species', every bycaught porpoise in fishing gear is illegal, which on annual basis causes many punishable acts (Dotinga & Trouwborst 2008). However the Dutch government repeatedly refers that this can be handled through the principle of opportunity, which implies that the public prosecution does not penalize regular violations but only serious ones (Trouwborst & Dotinga 2008). Trouwborst and Dotinga (2008) mention that on one hand one should avoid an absurd situation, however on the other hand one has to meet the criteria demanded by the International and European species conservation law. Above mentioned partially is related to the fact that the Flora and Fauna Act prohibits the *unintentional* killing of porpoises, which makes it stricter than the Habitats Directive, which only 'asks' for *intentional* killing (Trouwborst & Dotinga 2008).

The Porpoise is listed on a non legally binding list, which acts as a guidance for the Dutch Nature policy. On the Red List of mammals of The Netherlands the Harbour Porpoise is currently listed under "Vulnerable" (kwetsbaar; VZZ 2007).

7.7. National Fisheries regulations

With respect to fisheries regulations in the Dutch part of the North Sea, regulations for fisheries in the coastal waters and the fisheries zone (12 nautical miles) are for a part regulated through the CFP, but for the larger part by national regulations. Both commercial and recreational fisheries are regulated with the 1963 Fisheries Act (Visserijwet, houdende nieuwe regelen omtrent de visserij) and more specific regulations, rules for sea- and coastal fisheries, that entered into force in 1977. Since January 2011 all recreational fisheries with static gear in coastal waters and the fisheries zone in The Netherlands are forbidden.

National implementation EC 812/2004 - EC 812/2004 is hardly of relevance in Dutch waters. It only applies to vessels over 12 metre in length, using gear as defined below. The current Dutch set-net fleet has about 70 vessels, 30 of which vessels are over 12 metres length. Under EC 812/2004 within ICES subarea IV, which does cover the Dutch part of the North Sea, the use of acoustic deterrent devices is mandatory in fisheries with vessel lengths over 12 metres, using a) any bottom-set gillnet or entangling net, or combination of these nets, the total length of which does not exceed 400 metres. Acoustic deterrents are mandatory from 1 August – 31 October; b) any bottom-set gillnet or entangling net with mesh sizes > 220mm. Acoustic deterrents are mandatory all year. As far as it is known no Dutch fishers meet these criteria. No use of pingers is therefore required under EC 812/2004.

Monitoring is required for vessels over 15 metre in length. According to EC812/2004: "Member states shall design and implement monitoring schemes for incidental catches of cetaceans using observers on board the vessels flying their flag and with an overall length of 15 metres or over for fisheries which are defined in Annex III of the Regulation". The monitoring schemes need to be designed to provide representative data of the fisheries concerned. For vessels with an overall length less than 15 metres and involved in fisheries defined in Annex III point 3, member states shall take the necessary steps to collect scientific data on incidental catches of cetaceans, by means of appropriate scientific studies or pilot projects. For both vessels over, and less than 15 metres no monitoring of fisheries using bottom–set gillnet or entangling nets is defined for the Dutch part of the North Sea.

The evaluation of EC 812/2004 by ICES based on a request of the European Commission signals that a review of ongoing mitigation measures in Europe suggests that the measures required under regulation 812/2004 are being poorly implemented in general. The ICES advice specifically addresses the situation in the Southern North Sea, e.g. Belgian and Dutch waters. ICES recommends that it would be sensible to monitor gill- net fisheries especially in the southern North Sea to determine whether ongoing gillnet fisheries there have higher than 'usual' bycatch rates. It would be of equal importance to get some quantification of unregistered gillnet activity to help defining the likely scale of the threat.

Summarizing the obligations under EC 812/2004 for Dutch waters, at present no vessels have to use pingers or monitoring is required. An interesting observation is that member states, under the Habitats Directive article 12(1) have to prevent bycatch. However this leads to a discrepancy as under EC812/2004, which notably has been established to help member states to meet the requirements under the Habitats Directive, almost nothing, as for the use of pingers, and nothing as for monitoring has to be done. Since certain types of gill nets are worldwide known to pose a threat to cetaceans this is rather ineffective.

Frequent bycatches of Harbour Porpoises in near shore fisheries, as were demonstrated to occur during necropsies of stranded individuals, have so far not led to specific measures. Since 2005, several projects commissioned by the Ministry of Economics, Agriculture and Innovation (EL&I) commenced. The objectives were to assess the number of porpoises in Dutch waters by means of dedicated aerial surveys, to observe and sample bycatch with observers onboard set-net fishing vessels, and to assess the number of bycatches during systematic necropsies of stranded individuals. While the aerial surveys have produced novel insights in numbers of Harbour Porpoises present in part of the Dutch sector of the North Sea in some seasons, future temporal planning should be discussed in terms of research needs and the area covered should be expanded. The observer scheme has not been adequate in its set-up and the necropsies have so far provided only few answers on numerous questions. Therefore, adapted research protocols (after scientific discussions of research needs) have to be developed for future studies and are recommended in chapter 9 and 10.

Since 2009 the Ministry of Economics, Agriculture and Innovation (EL&I) encourages a pilot pinger project with several large mesh-size set-net fishermen being involved on a voluntary basis. In 2011 a small pilot with onboard camera monitoring started with only one set-net fisherman involved. All the above is insufficient considering requirements under the Habitats Directive, article 12. Considering obligations under Dutch law, current studies are also insufficient given the lack of concrete information currently provided about the scale of bycatch and the responsible fishing gear involved.

When applying measures to both Dutch and foreign fishermen, these measures must be issued by the European Union and cannot be issued by a Member State. Only the EU is authorised to impose conditions or restrictions on all fisheries activities within the North Sea. This issue has been addressed by Trouwborst & Dotinga (2008): if, and to what extent, a member state could limit set-net fisheries in the Dutch part of the North Sea to minimize bycatch to, meet the obligations of international and European species conservation. Measures to protect wide-ranging species such as Harbour Porpoises require a coordinated community procedure at EU level. Nevertheless under the CFP there are some delegated rule-making powers for member states to regulate fisheries independent (Art. 8, 9 and 10 Basisverordening Visserij; Trouwborst & Dotinga 2008). National measures to reduce bycatch that are only applicable for Dutch fishermen are not desirable. This would not only discriminate Dutch fishermen, but it might also be ineffective to target a bycatch issue when foreign fishermen exploiting Dutch Waters are excluded. At present the occurrence of Dutch versus foreign fishers on the NCP is fifty-fifty.

A letter of the European Commission directed at the Ministry of Economics, Agriculture and Innovation (EL&I) of 23 July 2010 states that "Measures affecting fisheries should as a general rule be taken under the Common Fisheries Policy (CFB), even where they have nature protection as their objective. However, for the moment the CFB does not provide the kind of measures you must take in order to comply with other EU legislation, in particular the Habitats and Birds directives. The CFP has to be adapted to better integrate the requirements put on member states though the Birds and Habitats Directives and the Commission will address this in the framework of the CFB reform. For the time being, however, until protection measures have been incorporated into the CFB, the Commission is ready to assess and accept national measures proposed on the basis of the Birds and Habitats Directives". This statement of the European Commission provides the opportunity for member states to comply with the Habitats Directive and to regulate fisheries, including set nets of both national and foreign fleets.

Mining Act (Mijnbouwwet) - The exploration, production and mining of minerals, such as oil and gas, is regulated in the 2002 Mining Act (Mijnbouwwet). This legislation and the various rules based on the 2002 Mining Decree (Mijnbouwbesluit) and Mining Regulations (Mijnbouwregeling) determine what is required to obtain a license. The Mining Act applies to the continental shelf and the territorial sea under the responsibility of the Ministry of Economics, Agriculture and Innovation under the State supervision of Mines (Staatstoezicht op de mijnen). The Mining Decree (Mijnbouwbesluit) describes the rules for seismic acquisition offshore the Netherlands. In general there is no license required for seismic acquisition. Only when shipping lanes or military areas are involved should special permission be required. Acquired data has to be supplied to the Minister of Economic Affairs, Agriculture and Innovation according to article 108 of the Mining Decree.

The only specific measure for the environment for seismic acquisition in surface water is taken in Article 12 of the Mining Decree: "During seismic surveys measures are taken to prevent disturbing effects of sound on marine mammals". In the 'Nota van Toelichting' of the Mining Decree it is stated that marine mammals and cetaceans which are possibly in the area of the survey area will be alerted in an animal friendly way (NvT bij Mbb Stb. 2002/604, p. 84). The technical realisation of this requirement can be found in Art. 2.1.1. of the Mining Regulation: "When seismic acquisition is carried out in surface water using artificial sound impulses with a low sound intensity and progresses the amplification of that sound intensity gradually." Only a soft-start is required and no further measures are compulsory, such as noise reduction or the input of observers on board. Moreover, a license is not required for seismic exploration. It just needs to be reported after the survey to the Ministry of EL&I (Kater *et al.* 2011).

Water act (Waterwet) - The new Water Act, since December 2009, has created a framework for the modernisation of Dutch water management required for the coming decades. The integration of a number of authorisations will reduce administrative burden for citizens and businesses. Licenses for offshore windparks fall under the Water Act. Licenses for offshore windparks require monitoring. An Environmental Impact Assessment (EIA) prior to the license procedure is obligatory. Once implemented as policy, this conservation plan and its measures have to be taken into account and considered in the EIA. The regulatory body for this is Rijkswaterstaat, Dienst Noordzee, under the Minstry of Infrastructure and Environment (I&M). When the Nature Conservation Act has been extended to the EEZ the appropriate authority most likely will be the Ministry of EL&I.

7.8. Discussion and conclusions

The Harbour Porpoise, as a wide-ranging, migratory species, is not bound by any legal zones in the North Sea. This makes its conservation a complex matter. On all three levels of regulation – international, European and national – different legal instruments are applicable at the same time. There are several obstacles impeding an adequate conservation of the Harbour Porpoise. One of the obstacles is the current geographical scope of the Flora and Fauna Act: not reaching beyond the 12 nautical mile zone. Another obstacle is the existing gap between fisheries regulations and nature conservation instruments. A Member State can now fulfil criteria required under the Common Fisheries Policy, while at the same time infringing with both the Habitats Directive, article 12(1) and the Flora and Fauna Act article 9. This discrepancy is further worsened by the fact that fisheries regulations have to be dealt with at European Community level rather than at national level. Member states do have opportunities and obligations to address certain threats at national level, but measures are only effective and politically acceptable when they apply to both national and foreign fisheries fleets. Effective because of the fact that foreign fleets also have an impact on the conservation status of the Harbour Porpoise dwelling in waters under Dutch jurisdiction. Politically acceptable because of the principle of a level playing field / non-discrimination. This means that effective measures will always have to be established at Community level, which leaves national measures very inefficient compared to focussed measures at Community level. Moreover, procedures for arriving at Community regulation, at the initiative of a single member state trying to comply with European nature protection law, often involves cumbersome and lengthy procedures.

Currently, The Netherlands do not meet the demanded "system of strict protection" under the Habitats Directive, requiring "concrete and specific conservation measures" and "coherent and coordinated preventive measures" (Dotinga & Trouwborst 2008). Also it has to be questioned if current monitoring of the Harbour Porpoise in Dutch waters guarantees "systematic and permanent monitoring" of the conservation status of the species. Deficiencies such as insufficient monitoring of the conservation status and the impact of threats such as fisheries indicate the need to improve compliance of the Habitats Directive and the Flora and Fauna Act at national level.

A challenge for the future, given the current legal discrepancies, are the gaps between regulatory regimes for nature conservation and fisheries policy, the current inadequate conservation status, the gaps in ecological knowledge, the unknown scale of identified threats and their impact on the conservation status of the population. However, when taking into account the legal commitments and the precautionary approach contained in the Habitats Directive, it is obvious that action of both government and industry is required. The current regulatory situation is insufficient. In the case for bycatch in set-nets for example, although the CFP will be reformed and fisheries measures have to be dealt with at Community level, the burden of proof for allowing this activity to continue lies with set-net fisheries. Taking into account the precautionary principle and because of the current unfavourable conservation status, the burden of proof is on the fishing industry to show how and why their activity is allowed to be continued, e.g. by demonstrating that there is no negative influence on the favourable conservation status (FCS) of the Harbour Porpoise population. This implies that fishing techniques, known for risking bycatch, should be obliged to quantify their influence on the population. This is in fact also proposed in the research measures section of this report.

Given the strict protection required under the Flora and Fauna Act for the Harbour Porpoise, and the requirements under the Habitats Directive article 12(1) it should be emphasized that the legal requirements under both National and European law do *not only* apply to bycatch in fishing gear. The Netherlands also has the obligation to address other activities causing disturbance or killing, such as underwater noise or ship strikes. For this reason, activities causing explosive underwater sound should be also monitored and regulated, assessing the impact and mitigating the adverse effects.

Implementing the research and mitigation measures, as adviced in this species conservation plan, aims to achieve/maintain favourable conservation status for the Harbour Porpoise. As such, it serves as a strategy to fulfil the requirements of The Netherlands under the relevant international legal treaties. Measures should be concrete and specific and need to be implemented and complied with. This does require an active and also flexible management approach, turning this conservation plan into an action plan.

8. Stakeholder consultation

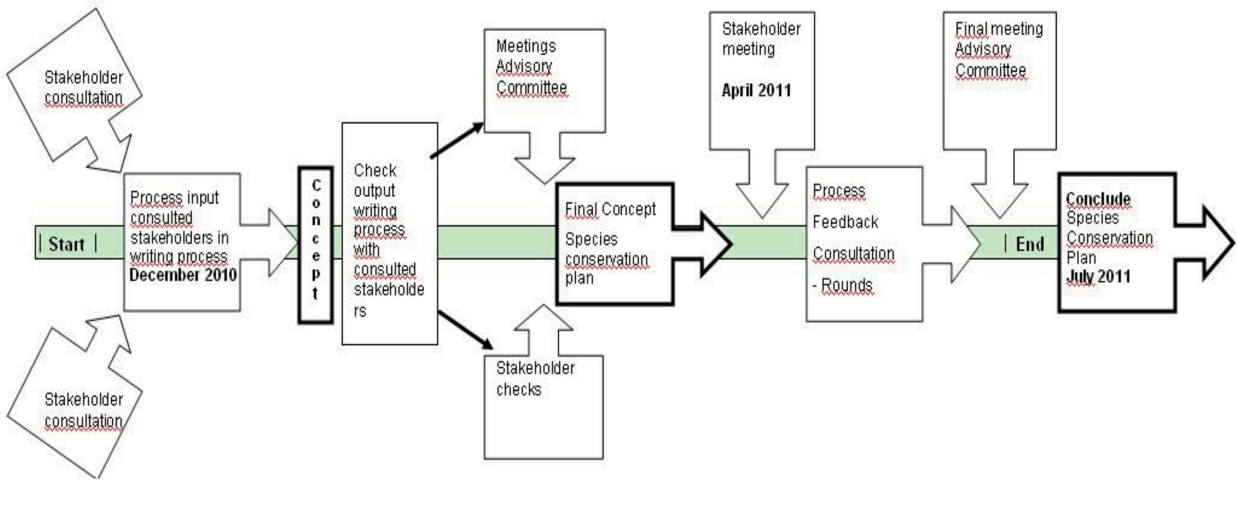
Commissioned by the Ministry of Economy, Innovation and Agriculture (EL&I) Kees Camphuysen (Royal NIOZ) and Marije Siemensma (Marine Science & Communication), both with their own expertise related to Harbour Porpoise conservation, have been appointed to write the conservation plan. At the request of the Ministry of EL&I, the writing of this report has not been a process of writing behind closed doors. As much as possible actors from all identified stakeholder groups have been invited for consultation and information in order to get a plan which does reflect the knowledge, expertise and commitment of all those stakeholders.

8.1. Advisory committee

To guide the authors in the writing process an advisory committee (begeleidingscommissie) chaired by EL&I has been established. Members of the advisory committee were representatives of the Ministry of EL&I, from both the Nature and Fisheries directorates (Hans Nieuwenhuis (chair); Folchert van Dijken (focal point ASCOBANS); Tim Masselink (project secretary) Hans van den Heuvel (Natuur Landschap & Platteland – NLP) and Dirk Jan van der Stelt (Agroketens en Visserij – AKV)), fisheries representatives (Derk Jan Berends -Dutch Fisheries Association 'Nederlandse Vissersbond' (secretary), representing the Dutch professional Dutch gillnet and cutterfleet and representing the Kenniskring Staandwant visserij (chair); and Rems Cramer gillnet fisherman, representing a larger group of gillnetters), the offshore industry (Eric Arends, Pondera Consult, NGO representatives (Joop Coolen and Marchien de Ruiter, North Sea Foundation), a representative of the Ministry of Infrastructure and Environment (I&M; Wim Urk, DG Water), and a science representative (Mardik Leopold, IMARES

8.2. Stakeholder proces

Apart from this committee, 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. The following figure depicts the process of stakeholder involvement:



Apart from the interviews, through a call in the Dutch journal for the fisheries sector 'Visserijnieuws' all fisheries have been asked to contact the authors, helping them to identify threats for the Harbour Porpoise. One reaction followed on this call. Also through the Dutch Mammal Society (Zoogdiervereniging), via a call on the website www.natuurbericht.nl all people feeling involved with the Harbour Porpoise have been invited to contact the authors. Several reactions followed.

8.3. International experts

Both authors consulted their international network of experts in this field for judgment, advice and feedback and proof-reading: Stefan Bräger, Jan Haelters, Simon Northridge, Mark Tasker, and others. Apart from this informal consultancy, the conservation plan and the process of stakeholder involvement have been announced at the annual ASCOBANS Advisory Committee meeting (October 2010). At the FIMPAS workshop (February 2011) in Den Helder the conservation plan has been presented in plenary and a break-out group on the Harbour Porpoise discussed with representatives of adjacent member states the approach of Harbour Porpoise conservation in relation to Natura 2000. At the ICES working group on bycatch of protected marine mammal species (February 2011) the conservation plan, focusing on the impacts of fisheries has been presented and discussed.

8.4. Stakeholder meeting

A draft of the conservation plan has been presented at a stakeholder consultation day (April 7th 2011). All stakeholders at large have been invited to attend. Focus of this consultation was on the identified threats by the authors and on the proposed mitigation and research measures. All stakeholders have been given the opportunity to comment in writing on the draft conservation plan as well. Apart from general a agreement or at least understanding of the proposed future research and proposed mitigation measures (not after some debate), concerns were raised about some of the aspects prioritised in future work. Concerns were expressed regarding the resources of Harbour Porpoises within the North Sea at large (factors triggering the shift in distribution) and within Dutch waters in particular. All stakeholders were invited to provide exact comments on the draft text and all comments were carefully evaluated and processed.

9. Concrete measures: research proposals and mitigation measures

9.1. Scientific research

With a substantial part of the North Sea stock in waters under Dutch jurisdiction, even if this is only during part of the year, we share the responsibility for the general well-being of the Harbour Porpoise with other North Sea states (Habitats Directive, the Oslo-Paris Convention and the ASCOBANS Agreement under the Bonn Convention (Convention on Migratory Species). Updated status reports and a (national) conservation plan, to keep or bring the species in a favourable conservation status, are required. For as long as the animals are with us, they should be safe, or at least as safe as possible.

Population status In terms of status assessments, there are improvements regarding the quality of census techniques. State of the art aerial surveys have been conducted in 2009 and 2010 (Scheidat & Verdaat 2009, Scheidat *et al.* 2010). Inadequate techniques (both aerial and ship-based) have been in use much longer, and even if trends in relative abundance could be derived from these censuses (Witte *et al.* 1998), a reliable population estimate based on such data for all those years is not possible. Aerial surveys are costly, but state of the art surveys are not necessarily much more expensive than ordinary flights or ship-based surveys. Unfortunately, there is no central co-ordination or a general scientific plan; surveys are conducted more or less ad-hoc, on request, when funds are made available. In fact, a research plan is required that would address questions such as: are area wide surveys needed every year, or perhaps even more times per year? In what season(s)? What should be the resolution/sample size? Or simply, what is it we wish to know (e.g. distribution, total numbers, age composition, habitat characteristics)? And, which are the most suitable research techniques to address these research questions? How could they be cost-effective? Currently the population is in a state of flux; to keep a finger on the pulse, more research effort may be needed than otherwise, but stock assessments need be conducted at least annually and there is an urgent need for studies of spatial and temporal patterns in abundance through the year.

- Assessments of Harbour Porpoise population through state of the art aerial surveys, including analysis of seasonality and spatial patterns

Acoustic monitoring Modern sonar technology has provided the means to (acoustically) detect porpoises under water. Acoustic methods could be used for studying behavioural responses to anthropogenic activities, e.g. in the proximity of fish nets or sound sources. Passive acoustic monitoring (PAM) systems, like T-pods, C-pods and towed hydrophone arrays have been deployed for some time to study the presence of porpoises (Tougaard *et al.* 2009, Gerrodette *et al.* 2010, Rojas-Bracho *et al.* 2010). The challenge for detecting echolocation clicks is the high ultrasonic frequency band used by porpoises. Due to higher sound absorption, and the high directionality of the porpoise clicks the detection range for porpoises cannot be expected to be more than 200m. The main advantage of acoustic monitoring sensors is that they can be deployed stationary for a long time while monitoring continuously. Passive acoustic monitoring can extend, verify or interpolate other (visual) ship- or air-based sampling methods. Current research questions include: What is the coverage of present sensors? How can different sensors (visual and acoustic), most effectively be combined?

- Develop techniques to combine visual and acoustic detection opportunities

Strandings In terms of the documentation of strandings, we are in the luxury position to have a nearly unbroken series of well-documented cetacean strandings records since the early 20th century (with a data gap between 1964 and 1970). Unfortunately, Harbour Porpoises have not been part of this monitoring programme until the late 1950s. Strandings of porpoises were considered too common to be of interest. Since 1970, however, strandings data on Harbour Porpoises have been systematically collected, with the help of a large volunteer network (40 years worth of data). The strandings data are now stored (and made publicly available) by *Naturalis* (Leiden) at www.walvisstrandingen.nl. This dataset is invaluable and it should be treasured. The help of volunteers ensures that costs are low. A strandings network, however, can only be maintained at strength, if a dedicated researcher, or a dedicated research institute, is able to put effort into it. A volunteer network requires maintenance: volunteers need instructions and feedback, may loose interest, newcomers don't know where and how to report their finds, some don't wish to co-operate and compromise even coverage. Facilities and finances to maintain this volunteer network at strength are therefore required. The quality of the information could be at stake, while working with volunteers, so that some basic training and instructions of "persistent volunteers" (individuals end local or regional organisations with ongoing interest) could be recommended. Also, a standardised record form (available online) would help improve the data collected by volunteers. Currently, of stranded animals the date, location, species, total length and sex are logged. Remarks on peculiarities are stored in a non-systematic way, together with photographs when made available. As a result, a lot of useful information is lost and one could question why certain observations are done systematically (size, sex), while others are ignored or reported in a non-systematic way (e.g. nutritional status (girth), state of the carcass, bycatch marks, exact age from some collected teeth,..). Again, a scientific evaluation of the type of observations made (or that volunteers could be *expected* to make reliably) on stranded carcasses is lacking. Critical information is: species, date, location, name and contact details of reporter. Important data are: total length (measured or estimated), sex, condition of corpse, and any external peculiarities that could point at the cause of death. The production of a simple manual would certainly help improve data collection, including the proper treatment of stranded mammals that may not be dead yet.

- Continuation and strengthening of a co-ordinated strandings network
- Production of guidelines for volunteers to enhance data quality

Necropsies, assessement of the cause of death Pathological studies of porpoises stranded on the Dutch coast (necropsies) have been conducted at least since 1983 (Van Nie 1989), when we ignore animals (usually aberrant specimens) incidentally examined by Van Deinse in earlier decades. Research protocols in pathology have been developed and improved. While Van Nie, for example, considered it difficult to diagnose 'bycatch' as a cause of death and refrained from specifications in that direction, protocols have been developed following which the likelihood of bycatch as a cause of death could be ranked (Kuiken & Hartmann 1992, 1993, Kuiken 1994ab). Addink *et al.* (1995ab) were particularly interested in the reproductive status of stranded individuals, and several of the earlier researchers have supplied tissue samples to other institutes, around the North Sea, to study the genetic background, toxicology, virology, age composition, and diet in an international context. Pathological studies can be important to reveal certain aspects of the life-history, ecology, parasitology, and causes of death of stranded cetaceans, but specific scientific research questions (if at all clearly formulated) and necropsy protocols have varied, following the specific interests of individual researchers over the years. A research plan based on a scientific research question for pathological studies could make these studies much more effective and conclusive. We therefore recommend that a scientific steering committee has to be installed to provide advice on (1) what is it that we need to know now, and (2) what is it that would be nice to know? Hypotheses need to be formulated which could be supported or rejected following (pathological) research results, rather than a non-question such as "what is the cause of death in stranded animals". It is clear that with gaining insights, research questions may need to be adjusted over time.

- Develop concrete research questions for research in pathology, and adjust when needed (supervision by a scientific steering group)

The material provided through a strandings network (reporting carcasses of stranded animals) can be important, but requires facilities for transportation and storage. Samples should be representative for what does wash ashore, however, if serious scientific research questions are addressed. This is currently not the case (Leopold & Camphuysen 2006, Wiersma & Gröne 2009, Gröne & Begeman 2010). Research questions could address for example the sexratio and age-composition of the stranded animals, biometrics, their reproductive status, their general health and nutritional status at death, stomach contents, genetics, burden of (chemical) pollutants, physical abnormalities, parasites in lungs, ears, liver and digestive tract, the presence of whale lice, and/or causes of death. Some of these aspects have immediate relevance for a conservation plan, others have not. Some of these aspects require necropsies (sampling of carcasses), other aspects can be assessed *in situ*, prior to destruction of the carcass. It all requires scientific research questions and standardised research protocols.

- Prioritise systematic, representative sampling of stranded carcasses

The conservation status of Harbour Porpoises in Dutch waters has recently been evaluated as "Vulnerable" (VZZ 2007) and "Inadequate" (Jak *et al.* 2009). Concerns regarding the reproductive condition and age structure of "the" population have been raised. Current research in pathology should therefore provide top-quality data on these issues (reproductive condition of the animals, and as exact as possible estimates of the age of stranded animals).

Bycatch issues have been raised as an issue of concern and research in pathology should (as it currently does) investigate the likelihood that stranded animals drowned in fishing gear, or not (external lesions, general pathology, histopathology). New techniques are required to assess the likelihood of bycatch of even rotten corpses washing ashore, and research proposals to enhance forensic techniques should be stimulated and rewarded.

Also, concerns were raised regarding the *origin* of animals that have 'invaded" Dutch waters in recent years, possibly pointing at deteriorating foraging conditions in the areas where the animals came from. Concrete information on nutrition and diet of stranded animals is an other aspect that should be ranked as high priority. The occurrence of infectious disease and perhaps even parasite burdens have been linked with environmental contaminants (pollutants) with varying success (Kuiken *et al.* 1994, Kleivane *et al.* 1995, Larsen 1995, Jepson *et al.* 1999, Siebert 2004, Bull *et al.* 2006, Law *et al.* 2010, Weijs *et al.* 2010). There are regional differences in the trend of PCB concentrations over time but, despite controls, they are declining only slowly. Their toxic impacts in porpoises is likely to continue for some time and further efforts to limit or eliminate PCB discharges to the marine environment are still needed (Law *et al.* 2010). Law *et al.* (2006) found a sharp increase in hexabromocyclododecane (HBCD) concentrations, a high volume brominated flame retardant from about 2001 onward. Concentrations in porpoises are currently double that reported in earlier studies and this was considered to result from changing patterns of use of HBCD within the EU. Jauniaux *et al.* (1992) discussed the value of cetacean necropsies as a tool to evaluate chemical pollution of the sea; a missed opportunity in current Dutch research in pathology. A clearly specified research in pathology plan would be required to examine interrelationships between environmental contaminants and animal health. Uncertainties regarding possible connections between pollutant burdens, parasites and infectious deseases are important enough to be the focus of scientific research in several institutes and countries around the North Sea. Within The Netherlands, even if just as a membership of an international research team, this type of research should be strengthened. Finally, of the observed or expected threats, the more prominent issues were bycatch, and loud “explosive”, anthropogenic underwater sounds (pile driving, explosions, seismic surveys). Current research in pathology is biased, because it is focused on bycatch characteristics, and does not investigate any damage or perhaps even lethal effects caused by loud underwater noise.

- Prioritise investigations of reproductive condition and (exact) age during necropsies
- Prioritise investigations of hearing damage (including tissue sampling protocols)
- Carefully assess evidence for drowning (bycatch) during necropsies
- Development of novel forensic techniques to demonstrate the likelihood of bycatch
- Studies of nutritive status and diet → linked with demographic parameters and strandings locations
- Specific investigations or liaisons with other research institutes to investigate the effects of pollutants on Harbour Porpoises
- Monitoring of pollutants burden and/or tissue banking
- Conservation status should be re-evaluated

Fisheries responsible for bycatch There is sufficient evidence from studies around the North Sea that passive gears, notably gill nets (set nets) are responsible for numerous bycatches of Harbour Porpoises. Within The Netherlands, there are no recent appropriate assessments of bycatch rates in national and foreign fleets working North Sea waters under Dutch jurisdiction. A better co-operation between scientist and fishermen to obtain more first-hand information on bycatch would be needed.

Assessments of gear- and season-specific Harbour Porpoise bycatch rates by observers on board, according to statistically sound research protocols (supervised by an international scientific steering committee) are urgently required. Following a statistical analysis of all available data (nearshore sightings, strandings, and fleet effort; this report), it has been concluded all set-net fleets (all gear types) should be monitored for bycatch rates, but winter fisheries in the northern region (north of IJmuiden) with the highest priority.

- Prioritise an observer scheme on all fleets with passive gear to assess bycatch rates according to internationally accepted protocols
- Continue to assess bycatch rates in the most important fisheries (regarding bycatch) and evaluate the effectiveness of mitigation measures

Field studies of age composition VZZ 2007 and Jak *et al.* 2009 raised concerns regarding the current status and age composition of "the" [Dutch] population. Models of source-sink population dynamics make assumptions about whether, and how, demographic parameters in source habitats are dependent on the demography in sink habitats (Gundersen *et al.* 2001). Good knowledge of the degree of density- or habitat-dependent dispersal and of demographic parameters is critical for predicting the dynamics of source-sink populations. Secondly, it was argued that "under good conditions, the animals will reproduce and the age-structure will be balanced". Both concerns call for demographic parameters, notably the age structure of the population. The presence of (small) calves in pods of porpoises should therefore be recorded and reported in a more systematic manner from current, ongoing aerial, ship-based and coastal surveys We highlight these issues here as just another mismatch between conservation concerns and current, ongoing scientific research, where the presence of calves in pods is considered a "difficult" thing to ascertain, certainly when less sufficiently trained professionals or volunteers are involved. Guidelines for ageing are required, to standardise and improve the data.

- Development of an ageing protocol for field studies
- Emphasis on the presence/absence of (small) calves during field studies

Resources and habitat requirements Historically speaking, Harbour Porpoise went and came back, at least within the past 5 or 6 decades. There is no explanation for this and no ongoing research to investigate the issue. What is crucially lacking are studies of the ecology and migratory movements of Harbour Porpoises. There is an urgent need to deepen our understanding of habitat requirements, natural resources (prey), and the trophic position of porpoises within the ecosystem of the Southern Bight. Even if ecological studies may not be ranked as a top-priority in the Harbour Porpoise conservation plan, our lack of knowledge is striking and innovative research should be stimulated. Tracking studies could be one way forward, observational studies (field studies) coupled with hydrographical investigations and studies of prey resources could be another track. At the stakeholder meeting, these research topics were strongly recommended. If a reduction in prey resources has triggered a shift from north to south through the North Sea, it would be important to know if resources in the south are sufficient to sustain a population numbering at least several tens of thousands of animals during part of the year. If area protection would enhance the conservation status of Harbour Porpoises in the southern North Sea, evidence should be provided of the existence and characteristics of important areas.

- Innovative studies of the (foraging) ecology and habitat requirements of Harbour Porpoises in the Southern North Sea

Behaviour studies in captivity Studies of the avoidance behaviour, detection capacities and auditory thresholds including the effects of acoustic deterrents are the subject of ongoing research on Harbour

Porpoises in captivity Kastelein *et al.* (1995abcd, 1999, 2000, 2005, 2006, 2010). These and similar studies are critical to enhance our understanding on the behavioural responses of Harbour Porpoises in the wild, when confronted with fishing gear of various types of underwater noises. Ongoing research and future funding should be supervised by a national scientific steering group Harbour

- Stimulation and funding of innovative studies of the behaviour of Harbour Porpoises in captivity

Reporting of results, quality control There is a striking lack of refereed, scientific publications on Harbour Porpoise research in The Netherlands. A substantial part of the evaluation of status and threats in this conservation plan has been based on foreign research, often on animals from different parts of the North Sea (or different management units for that matter). Strandings reports are published with some frequency (the last being Smeenk 1995, Addink & Smeenk 1999, Smeenk 2003, and Camphuysen *et al.* 2008). Results of pathological studies have been published only twice (Van Nie 1989, Osinga *et al.* 2008). There are no recent publications of the diet of porpoises in Dutch waters, few of the abundance at sea (e.g. Witte *et al.* 1998, Dutch participation within SCANS; Hammond *et al.* 2002), some on the return in coastal waters (Camphuysen 1994, 2004). There are some publications on pollutants in Dutch Porpoises (Van Scheppingen *et al.* 1996), morbillivirus infections (Barrett *et al.* 1993, Visser *et al.* 1993), some highly specific verterinary results and a fair number of papers on for example hearing thresholds in porpoises and behavioural aspects of porpoises in captivity (Kastelein and co-workers), but none on bycatch issues (observer schemes included) or for example the effect of the construction windfarms on porpoises (two offshore parks became established meanwhile). There is a large number of reports, however, of highly variable quality, that would suggest that some research is ongoing. It is not clear how many of these reports would sustain the rigorous scrutinity of a serious (external) peer review. We would therefore recommend that *every* study commissioned by the Dutch government should result in a peer-reviewed publication as a proof of value for money.

- A stronger emphasis of publications in peer-reviewed literature

We propose that only a national scientific steering group can address all these issues in an independent way. The terms of reference of this group should be such that high quality science is stimulated, investigating research questions and hypotheses that are currently important. This committee should include at least one statistician to assess and evaluate the statistical power of research proposals. Preferably, the members of the committee should be fully independent of any of the research proposed and of the research institutes involved.

- Formation of a national, scientific research steering group to evaluate research needs, research questions, and research proposals

Harbour Porpoise conservation plan research needs

*****(Priority – scale 1 highest to 5 lowest)

Research topic	Research activity	Need for activity	Priority*
Population status	Assessments of Harbour Porpoise population through state of the art aerial surveys, including analysis of seasonality and spatial patterns	Population assessments are needed to evaluate potential impacts on population level effects; given the current seasonality in sightings, the timing of (aerial) surveys should be discussed.	**1**
	Develop techniques to combine visual and acoustic detection opportunities	Passive acoustic monitoring can extend, verify or interpolate other (visual)- sampling methods.	**2**
	Re-evaluate conservation status	With new knowledge at hand and with developing trends, the conservation status needs to be assessed again.	**2**
Strandings	Continuation and strengthening of a co-ordinated strandings network (including Rapid Alert System)	Strandings data provide an independent series of data on relative abundance, sexratio, age composition, and causes of death.	**2**
	Production of guidelines for volunteers to enhance data quality	The quality of strandings could be improved with better instructions.	**3**
Necropsies	Develop concrete research questions for research in pathology, and adjust when needed (supervision by a scientific steering group)	Necropsies should be guided by clear research questions, in response to the observed threats.	**2**
	Prioritise systematic, representative sampling of stranded carcasses	Representative sampling is required to produce unbiased data (spatial patterns, state of corpse)	**2**
	Prioritise investigations of reproductive condition and (exact) age during necropsies	Better knowledge of the age structure of porpoises in the Southern North Sea is required.	**2**
	Prioritise investigations of hearing damage (including tissue sampling protocols)	Evidence for lethal effects of loud anthropogenic underwater noise is currently lacking.	**1**
	Carefully assess evidence for drowning (bycatch) during necropsies	Bycatch in fishing gear is currently the prime suspect for many porpoise strandings; further evidence is needed.	**2**
	Development of novel forensic techniques to demonstrate the likelihood of bycatch	Novel techniques could provide evidence for bycatch, even in carcasses that are decomposed (enlarging the sample size).	**3**
	Studies of nutritive status linked with demographic parameters and studies of pollutants	Numerous stranded Harbour Porpoises have a poor nutritive status. The effect of pollutants may be considerable, even lethal, in poorly nourished animals. Our understaning of the factors leading to starvation and death is very incomplete.	**1**
	Meta-analysis of occurrence and seasonality of infectious disease in porpoises	Infectious disease is an important cause of death; investigations into the causes, but also into the	**4**

Research topic	Research activity	Need for activity	Priority*
		frequency of occurrence in certain age/sex groups and times of year are needed	
	Specific investigations or liaisons with other research institutes to investigate the effects of pollutants on Harbour Porpoises	Cetacean necropsies as a tool to evaluate chemical pollution of the sea (a missed opportunity in current Dutch research in pathology)	**4**
	Monitoring of pollutants burden and/or tissue banking	Cetacean necropsies as a tool to evaluate chemical pollution of the sea (a missed opportunity in current Dutch research in pathology)	**4**
Fisheries responsible for bycatch	Prioritise an observer scheme on all fleets with passive gear to assess bycatch rates according to internationally accepted protocols	Fishing gear specific Harbour Porpoise bycatch rates need to be known, including seasonality and spatial patterns.	**1**
	Continue to assess bycatch rates in the most important fisheries (regarding bycatch) and evaluate the effectiveness of mitigation measures	Fishing gear specific Harbour Porpoise bycatch rates need to be known, including seasonality and spatial patterns.	**1**
Field studies of age composition	Development of an ageing protocol for field studies	Better knowledge of the age structure of porpoises in the Southern North Sea is required.	**4**
	Emphasis on the presence/absence of (small) calves during field studies	Better knowledge of the age structure of porpoises in the Southern North Sea is required.	**4**
Resources and habitat requirements	Innovative studies of the (foraging) ecology and habitat requirements of Harbour Porpoises in the Southern North Sea	The cause of an increase of Harbour Porpoises in the Southern North Sea is unknown, but may be food or habitat related. [Priority ranking elevated in response to stakeholder meeting]	**2**
Behaviour, studies in captiviy	Stimulation and funding of innovative studies of the behaviour of Harbour Porpoises in captivity	In order to develop novel or more refined mitigation measures (acoustic deterrents or other instruments)	**3**
Reporting of results, quality control	A stronger emphasis of publications in peer-reviewed literature	The quality of Harbour Porpoise research should be higher.	**2**
National scientific steering group	Formation of a national, scientific research steering group to evaluate research needs, research questions, and research proposals	The quality of Harbour Porpoise research should be higher, research questions should be more specific, research projects should provide answers rather than remain inconclusive as a result of inappropriate methodolgy.	**1**

Main action points (scientific research)

- Formation of national scientific steering group, including quality control of research proposals and independent peer review of project results and publications
- Assessments of Harbour Porpoise population through state of the art aerial surveys, including analysis of seasonality and spatial patterns
- Re-evaluate conservation status
- Continuation and strengthening of a co-ordinated strandings network
- Prioritise systematic, representative sampling of stranded carcasses
- Develop concrete research questions for research in pathology, and adjust when needed
- Development of novel forensic techniques to demonstrate the likelihood of bycatch
- Monitoring of pollutants burden and/or tissue banking
- Investigate the cause of low nutritive status and the role of pollutants
- Prioritise an observer scheme on all fleets with passive gear to assess bycatch rates according to internationally accepted protocols, especially in winter/northern regions
- Assess bycatch rates in the most important fisheries (regarding bycatch) and evaluate the effectiveness of mitigation measures
- Innovative studies of the (foraging) ecology and habitat requirements of Harbour Porpoises in the Southern North Sea
- Innovative studies of the behaviour of Harbour Porpoises in captivity

9.2. Policy measures and mitigation

We recommend a set of policy and mitigation measures, aiming at achieving and maintaining a favourable conservation status for the Harbour Porpoise in North Sea waters under Dutch jurisdiction. Under the ASCOBANS agreement, there are separate management plans for the conservation of the Harbour Porpoise in the North Sea (Reijnders *et al.* 2009) and in the Baltic Sea, the so called Jastarnia plan (2009), respectively. Actions contained in both these plans have been taken into account for the measures in this conservation plan. Vice versa this conservation plan might be guidance for those or other conservation or recovery plans for the Harbour Porpoise. The scientific research measures as presented above and the outcome of that research will influence both policy and mitigation measures. Both the policy and the mitigation measures can be categorized into measures which should be applied at present and measures which depend of further knowledge depending on the outcome of the suggested scientific research measures. The latter, with the consequence that the measures below aren't set in stone, but might be adapted given scientific research. This is the reason that not all measures need to and can be applied at present.

As the most important currently identified threats to maintaining a favourable conservation status of the Harbour Porpoise in North Sea waters under Dutch jurisdiction are bycatch in fishing gear and the adverse effects (disturbance, physical trauma) of loud, explosive underwater noise, our recommendations focus on these two. Nevertheless, some other threats may pose significant effects on Harbour Porpoise populations, but these would require international cooperation and adjustment rather than national measures (e.g. marine pollution, litter, viruses and other factors). Bycatch in fisheries and loud underwater noise can be addressed on a national level and changes on a national scale would benefit porpoises in waters under Dutch jurisdiction. Nevertheless, also these threats need international cooperation and regulations at European community level or beyond. Several of the threats that have not been identified as major threats, but still of relevance, will be addressed under general recommendations.

General recommendations - Several observed or potential threats are global rather than regional issues and these, generally, cannot be addressed effectively at a national level. Marine litter, for example, resulting in entanglements and ingestion of plastic materials, is a global problem. Indicating and signaling the effect of marine litter on marine mammals through pathological findings and stranding records is important and measures to reduce the dumping of waste materials into the marine environment should be encouraged, but any particular measures on a national scale will not solve the marine litter problem as a whole. The same is true for marine pollution, which is a serious or at least potential threat not only to Harbour Porpoise health and reproductive success, but also to the marine ecosystem as a whole, calling for a coordinated international approach. It is imperative that the problems caused by marine litter and marine pollution should be addressed simultaneously at both national and international levels. The monitoring of chemicals in porpoises should be included in the Coordinated Environmental Monitoring Programme of OSPAR (CEMP) as porpoises are widely available apex predators at the top of the food chain of the North Sea (and of the OSPAR area) ecosystem. Currently marine mammals are not yet part of this monitoring programme, although they are frequently available through strandings and bycatch.

Harbour Porpoises should also be included in the monitoring programmes under the Marine Strategy Framework Directive (MSFD), for the same reasons as mentioned above (i.e. apex predator; frequently available through strandings and bycatch). For other threats such as mining activities at sea, the effects on marine mammals are unknown, however this does not necessarily mean that there is no adverse effect. Results of current or future research might call for policy or mitigation measures, which should then be considered. Regarding prey availability, which cannot be easily influenced at a national level, we recommend nevertheless to suggest, once having sound knowledge on the feeding ecology of the Harbour Porpoise adaptation of Total Allowable Catch (TACs) & Quota under the Common Fisheries Policy (CFP) (i.e. if such relationships were to be established). Regarding siting and land reclamation, we recommend, based on Clark *et al.* (2010) to identify appropriate considerations for spatial sensitivities and resulting siting of developments early in the spatial planning process and to steer potentially harmful activities away from sensitive areas or sensitive periods in time. Taking into account vessel strikes, which can have a proven lethal impact on Harbour Porpoises, we suggest that if there are signals that certain ship traffic (speedboats, fast ferries) do cause vessel strikes, seasonal restrictions should be considered when porpoises and shipping lanes overlap. When new shipping zones are established, sensitive areas or sensitive periods in time should be avoided, defining temporal and or spatial restrictions for certain ship traffic.

A general recommendation which does apply for the mitigation of all identified threats and more in general applies to the conservation of Harbour Porpoises and the success of a conservation plan is to involve stakeholders in the process of establishing a conservation and management plan, but especially in the process of implementing the policy recommendations therein. Involvement should be preferably bottom-up instead of top-down. Laying a package of measures on someone’s desk is not the most ideal way to get commitment and to efficiently implement measures. Stakeholders provide (practical) knowledge and insight. When addressing bycatch, for example, newly developed devices that would prevent entanglements in fishing gear may turn out to be not long-lasting and strong enough for everyday use, or the may be unsafe to handle on board. Early involvement of the fishing industry could prevent the development of tools that may work in theory, but not in practice. Promoting the cooperation and debate between scientists, NGO's, policymakers and industry would enhance a mutual understanding and acceptance of measures taken to protect the Harbour Porpoise.

There are many ways to communicate and inform stakeholders and also the general public. ASCOBANS has a Communication, Education and Public Awareness plan (CEPA) (ASCOBANS 2010), supporting and facilitating communication and education. In The Netherlands several institutions and organisations at present do work on communication and education related to the Harbour Porpoise, which can serve as an intermediate in reaching several stakeholder groups. At present SOS Dolfijn displays an exhibit of the work of ASCOBANS in its research and rehabilitation centre in Harderwijk (www.sosdolfijn.nl). It is recommended to communicate and inform stakeholders, but also the general public on activities related to the conservation of the Harbour Porpoise.

Policy measures mitigating incidental capture (bycatch) - Before going through available mitigation measures one of the most effective mitigation measure is to cease fishing using gears that pose a risk to cetaceans (ICES 2010a). However it might be clear that this may have unacceptable social and economic consequences. It also assumes that the gears posing a risk to cetaceans are identified, which is not the case for the Dutch situation, although there are several, by fishermen reported bycatches, in the large mesh size fisheries on mainly Cod, Turbot and Brill. A challenge to address bycatch lays ahead, given the current legal discrepancies between environmental and fisheries legislation, the current inadequate conservation status (see chapter 4.10) and the gaps in ecological knowledge and the unknown impact and scale of bycatch. Since fisheries measures for foreign fisheries have to be dealt with at European Community level, national measures would only affect the Dutch fleet and discriminate Dutch fishermen, while the problem might not even be addressed if foreign fleets do have impact on it or when they displace their fisheries to Dutch waters. However, recent guidance of the European Commission does allow Member States, for the time being, to propose to the European Commission to initiate community level regulations, to be proposed on the basis of the Birds and Habitats Directive obligations of a Member State. This statement of the European Commission provides the opportunity for Member States to comply with the Habitats Directive and to regulate fisheries, including set-nets of both national and foreign fleets. However, procedures for arriving at Community regulation, at the initiative of a single Member State trying to comply with European nature protection law, often involves cumbersome and lengthy procedures.

Nevertheless, when taking into account the legal commitments and the precautionary approach contained in the Habitats Directive it is obvious that action of the fisheries industry is required. The current regulatory situation is insufficient. In the case for bycatch in set-nets, although the CFP will be reformed and fisheries measures have to be dealt with at European Community level, the burden of proof for allowing this activity to continue lies with set-net fisheries. Taking into account the precautionary principle and because of the current unfavourable conservation status, the burden of proof is on the fishing industry to show how and why their activity is allowed to be continued, e.g. by demonstrating that there is no negative influence on the favourable conservation status (FCS) of the Harbour Porpoise population. This implies that fishing techniques, known for risking bycatch, should be obliged to quantify their influence on the population. This is in fact also proposed in the research measures section of this report.

Despite the evidence that set-nets pose a threat to porpoises, it has still to be confirmed which types of fishing gear, when and where, are responsible for high bycatch rates. Further, specific mitigation measures can only be considered when these studies have been completed or are well under way. Therefore, we recommend an independent, non-voluntary, observer monitoring program, according to international protocols, to assess the impact of bycatch, involving both CCTV-monitoring and observers onboard. Following the outcome of a statistical analysis of strandings data, sightings data and fisheries effort, such an observer programme should probably focus on winter fisheries, irrespective of set-net gear type, in the northern part of the country (IJmuiden – Oostergronden/Friese Front region) (see chapter 5.1). However, some non-research dependent measures can be applied at present.

Figure 48. Set-net fisher close to the beach in The Netherlands (J. Versfelt)

Measures to apply at present

Facilitate the landing and reporting of bycatch - Since only a few fishermen have a temporal exemption under the Flora and Fauna act (article 75) to land bycaught porpoises, it is recommended to provide an exemption and to make it obligatory for *all* fisheries to land bycaught porpoises. Reported bycaught animals can in that case be investigated (to investigate feeding ecology, pollution, infectious diseases, physiological hearing damage etc.). Apart from exempting the fishing fleet, an infrastructure needs to be created to accept carcasses in the harbours. An anonymous registration system is necessary to facilitate the fishermen. Fast transport to the Department of Pathobiology of Utrecht University that is in charge of performing necropsies on stranded and bycaught animals should be arranged. A reason for this is the need to investigate physiological hearing damage, which is only possible on fresh carcasses. Simultaneously, a procedure for reporting incidental bycatch of porpoises should be established to collect data on the incident. At the moment all fishermen participating in the bycatch mitigation project of the Coastal & Marine Union have an exemption to land bycaught animals. In cooperation with the EHBZ network, transport is facilitated to Utrecht University for necropsy (and extraction of the inner ear). The EHBZ network of the Seal Rehabilitation & Research Centre 'Zeehondencreche Lenie 't Hart' is a network of volunteers, set up in 1980 as a Seal First Aid-Network along the entire Dutch coast. They also collect stranded porpoises along a substantial part of the Dutch coast.

Prohibit all recreational gillnetting in Dutch waters - There is an unknown fishing effort by recreational fisheries using gillnets set from the beach in shallow coastal waters. This has been forbidden since 1 January 2011. We recommend keeping recreational set-net fisheries forbidden. However, we are aware of the debate in the Dutch Lower Chamber, regarding potential exceptions from this prohibition. If criteria for allowing exceptions to this general prohibition on recreational set-net fisheries were to be considered, the following would be advisable, partially based on current criteria for recreation fisheries in Belgium: (1) A license should be required to be able to register those exceptional cases for which recreational fisheries is allowed; (2) The maximum total net length should be 50 metre per license and maximum 80 cm in height; (3) In case of a bycatch of a Harbour Porpoise (or any other marine mammal or bird) this needs to be reported at the relevant authority; (4) trammelnets (meerlagige netten/ spiegelnetten) are prohibited; (5) It is obligatory to haul nets at least every 24 hours; (6) An up to date administration of fisheries activities is obliged (providing information on gear type, net length, soak time; fishing area) fishing effort data; (7) All cases of lost nets should be reported; (8) The use of acoustic devices should be prohibited unless under controlled conditions as described under acoustic devices; (9) The former fisheries inspection ('AID') should control if rules are complied with.

Control illegal fisheries - A peer control system might provide more insight into the scale of illegal fisheries in Dutch waters. Illegal fisheries so far is not known to exist other than based on hear and see. We recommend installing a facility ('klik-lijn') to anonymously report illegal fisheries practices. In fact, such a facility to report illegal fisheries practices (visstroperij) exists. The former fisheries inspection ('AID'), which is now integrated into the Food and Consumer Product Safety Authority (nieuwe Voedsel en Waren Autoriteit - VWA), does have a special number to report illegal fisheries (meldpunt visstroperij). The number - 045 54 66 23 0 - can be reached 24 hours per day, 7 days a week. Making people aware of this facility to report on illegal fisheries is therefore recommended. Furthermore it is also recommended to encourage control by the former fisheries inspection ('AID') for illegal fisheries.

Amend EC 812/2004 - EC 812/2004 regulation has been evaluated on request of the European Commission in 2010 by ICES. EC 812/2004 does not cover the set-net fisheries fleet on the Dutch NCP. Hardly any mitigation measure nor monitoring is required for the Dutch NCP. Moreover vessels smaller than 15 metre of hull length do not require monitoring and vessels smaller than 12 metre do not have to use acoustic deterrence devices, despite the fact that almost all gillnet vessels of the Dutch fleet are below 12 metre while using the same nets. We strongly recommend that EC 812/2004 will be amended in order to address the problem, bycatch of small cetaceans, for which it was established in the first place. We recommend that: 1) The set-net fleet under 12 metre hull length, fishing with large mesh sizes >220 mm are required to use pingers in a controlled way as described below; 2) Monitoring the set-net fleet will be an obligation (with an observer scheme according international standard) for the entire fleet, irrespective of hull length of the boats; 3) Monitoring as suggested in chapter 9.1 is mandatory for set-net fisheries in ICES area IV; 4) More detailed information on the métier (differentiating between gill- and trammelnets) and preferably soaktime should be required in the log-books and should be also copied in the Dutch VIRIS database. In general we recommend that, given the current gaps as a matter of regular procedures, these have to be addressed at the reform of the CFP in order to make it possible to take quick and efficient measures under the CFP framework, applicable to all Member States. This should avoid situations that Member States have to investigate issues themselves and to prevent them having to create their own national license system, with the consequence that a fisherman might need several licences when fishing in European waters of several Member States. Measures at Community level would be more effective in the light of the problem at hand.

Gear switch – We recommend that gear switches to other gear types, causing less impact on the marine environment and porpoises in particular, will be explored through existing fisheries innovation or expert groups such as the 'Kenniskring staand want', involving fishermen but also scientists and manufacturers of fishing gear. When switching to other gear types, this should be monitored carefully for efficiency in bycatch mitigation and to prevent other unwanted environmental effects.

Gear modification - The modification of gear to reduce bycatch of porpoises should be continued and encouraged by both fishermen and scientists, through existing fisheries innovation or expert groups such as the 'Kenniskring staand want'. So far, a focus has been on improving the (acoustic) visibility of the nets (e.g. by including barium sulphate in the netting) and/or altering deployment techniques (hanging ratio). Other gear modifications aim to reduce bycatch by altering the properties of the netting (height, mesh size etc.). We recommend to exchange expertise and experience with other fisheries institutes or fishermen.

Investigate bycatch in hook and line fisheries - We recommend a reporting and registration obligation of all cases of bycatch with a hook and line, occurring onshore and at sea, to allow for an assessment of the scale and impact.

Controlled use acoustic devices - The controlled use of acoustic devices (pingers) is recommended only, if there is a certain gear type, certain period in the year, or certain area defined which does pose a risk for porpoises. Randomly deploying pingers is not recommended, for several reasons. There are concerns, when deployed at large, acoustic devices cause disturbance of porpoises from their preferred habitat. Also the costs, for deployment and for testing the devices during their use have to be taken into account. Furthermore, it is emphasized that when requiring the use of pingers this should be in a controlled way such that it is registered which fisher is using pingers, and the effect should be monitored continuously as well as the compliance. Guided by the US Harbour Porpoise Take Reduction Plan (HPTRP), we recommend training and a controlled use of pingers. A controlled distribution and a controlled use allows for proper assessment of the effects of pingers. To specify the controlled use of pingers, this means that the fishermen should: (1) only use pingers when they received a training from the organization in charge of the coordination. This training should provide information on: how to use and attach the pingers; how to check if they work; registration of data; what to do in case of bycatch, what to do in case of loss. A training should also include some background information related to pingers and bycatch; (2) only use pingers when distributed and registered by a responsible organisation in charge of coordinating the use of pingers; (3) receive a certificate mentioning their participation in the training and which allows them to use pingers under conditions as mentioned on the certificate (reporting of any bycatch, reporting when a pinger does not work, reporting loss of a pinger). The certificate should refer to a distributed manual how to use the pinger (attachment, battery check, replacement of battery); the number and type of pingers they received or purchased and the type of gear (mesh size, gear specification and gear length); fisheries data such as GPS coordinates of the fishing location, soak time) they use with pingers, Based on current knowledge a pinger type should be choosen to work with.

Current projects as referred to in the chapter on mitigation measures should be used to serve as pilot projects, the above mentioned criteria should be integrated into these pilot projects including the current projects referred to. Such projects serve a dual purpose, combining mitigation and research. What should be taken into account is that monitoring programmes might interfere with the use of pingers which does undermine a scientific observer scheme, which in that case, should be discussed with those involved how to deal with that situation. The recommended Scientific Steering Group (see chapter 9.1), once established, would be the appropriate forum for such considerations.

As mentioned before, pingers so far are believed to be, of the current available mitigation measures, the best way to reduce porpoise bycatch in gillnet fisheries, apart from ceasing gears risking bycatch. However, concerns do exist since there have been many problems with the efficiency of pingers, both in their effectiveness and the safety and practical workability for fishermen. Also compliance of pinger requirements and monitoring the efficiency and practical workability need attention when considering the use of acoustic devices. Another concern is the effect of the pingers when deployed at large on the disturbance of porpoises from their preferred habitat. Also the costs are a challenging factor, not only for deployment, but also for testing the acoustic devices during their use.

Further measures are dependent of further research and these could include

Freeze total effort - At present the effort of Dutch set net fisheries has been ring-fenced (see chapter 6.1) and freezing total fishing effort would therefore not make a difference. What could be a potentional bycatch reduction measure, is not only to freeze but also decrease the total effort of set net fisheries.

Time and/or area closures - When observing surveys reveal a certain time or area with a particularly high risk of bycatch, exceeding the precautionary level of 1% of the best population estimate of ASCOBANS a closure of a certain area for a certain time period could be established [to be defined]. Such a closure needs to be carefully enforced and also displacement of effort or changes of gear should be monitored. Such a recommendation can only be dealt with at European community level affecting all member states fisheries in the defined area and time frame or one would risk discriminating Dutch fisheries and be ineffective.

Establish a take limit - It is recommended that when a certain threshold such as the ASCOBANS 1% of the best population estimate of bycatch incidents based on observed bycatch a set of mitigation measures should be used or a time and or area closure should be set as described above. This should comprise of a restriction of fisheries for the type of fisheries having exceeded the maximum take limit for a certain period and/or a certain area. The length and the scale of the area need to be carefully considered. Note that such a restriction should be carefully decided upon (time/area) and monitored. Displacement of effort might not reduce, or even increase bycatch. Ideally a system of bycatch monitoring by all Member States bordering the Northwestern North Sea and Eastern Channel (i.e. Management Unit 9) Sea will be established, keeping track of all reported bycatches and as soon as the 1% limit has been exceeded MU9 will be closed for a certain time and period or other mitigation measures will be required for the fisheries responsible of bycatch.

Monitoring and control - An appropriate monitoring and enforcing scheme should be established in order to check compliance to the prescribed measures. Procedures to assess the effectiveness of any mitigation measures introduced should be developed and implemented by the appropriate body.

Policy measures acoustic disturbance; loud explosive sounds When designing measures to mitigate adverse (disturbance, temporary physical damage) and potential lethal effects of loud impulsive sounds under water, a precautionary approach to management and regulation of underwater noise is recommended. Given large degrees of uncertainty of the effects of both underwater sounds and the effects of mitigation measures this may result in restrictions for operational practices, but these could be relaxed if key uncertainties are clarified by appropriate research on the adverse effects of explosive sounds under water. The difficulty of proving detrimental effects of acoustic disturbance on cetaceans compared to bycatch evidence in fisheries, which necessitates a precautionary approach is recognized by ASCOBANS (ASCOBANS 2009).

Measures to apply at present

Guidelines are proposed to mitigate the effects of loud explosive sounds. It should be noted that the recommendations below indicate the necessary measures within these guidelines. However, these guidelines need to be finalized and fine-tuned, preferably in cooperation with the regulatory body, who is responsible for the implementation and compliance of the guidelines. Such a set of guidelines should also be adapted whenever new knowledge, developments and insights become available. A general measure applicable to all loud explosive sounds should be the requirement of an EIA, including a BACI study (before and after control impact) using aerial surveys prior to operations. Another general measure which should apply to all loud explosive sounds is the development of a system of standards, setting thresholds for loud explosive sounds under water, taking the German standards into account as an example (see chapter 6.5).

License requirement for seismic surveys - Under the Mining Act a license system for seismic surveys has to be established. Without this license seismic surveys should not be allowed. A set of guidelines (see below) should be one of the criteria to be able to get a license. Given the seasonal and spatial distribution of porpoises this license has to apply for a specific area and only for a certain time frame based on available and relevant abundance and distribution data of Harbour Porpoises in Dutch waters.

Establish guidelines for seismic surveys - The appropriate body such as the Ministry of EL&I should establish a set of guidelines requiring (1) time and area of seismic survey activities need to be reported to the national stranding network prior to a survey, (2) only in daylight hours and under good sighting conditions to detect porpoises, (3) At least 30 minutes prior to the operations skilled observers on board (visual and acoustic) should check for the presence of marine mammals within 500 meter of the airgun array. Taking into account the array is at a certain distance from the survey ship, in sea conditions of more than 2 Bft., the observation needs to be done from an independent vessel as well. If any are detected the operation must be delayed until at least 20 minutes after the last sighting. After a break in survey, this procedure needs to be repeated, (4) Detection or not, a so-called soft-start procedure should be used to deter animals from the impact area, (5) the newest available techniques reducing the output of airguns should be used, (6) after a seismic survey the impact area should be observed by skilled observers for a certain, but at least 5 minutes, [to be defined] period.

Controlled explosions under water - A set of guidelines should be established by the appropriate body (Ministry of Defense, Directie Ruimte, Milieu en Vastgoedbeleid (DRMV) in agreement with Rijkswaterstaat, Dienst Noordzee), similar to that proposed for seismic surveys, to reduce the still unknown, but foreseen effects of any explosion under water, such as disturbance and physical damage such as hearing damage. Such guidelines should comprise of (1) time and location of a scheduled explosion needs to be reported to a stranding network contact prior to the activity, (2) only in daylight hours and good sighting conditions to detect porpoises, (3) at least one hour before the explosion a pre-detonation search by skilled observers on board (visual and acoustic) should be done. When detection is positive within a certain range the operation should be put on hold. 20 minutes after the last observation the operation should continue, (4) proper use of acoustic deterrents prior to detonation to deter animals out of the impact zone, (5) continue observing and only start detonation when detection (visual and acoustic) is negative, (6) after a survey the area should be observed by skilled observers for at least 5 minutes. Guidelines should also contain requirements to (7) use of the best available technical noise reductions tools at that moment, (8) Include timing (reduce or do not act in periods of high abundance based on distribution and abundance data), (9) consideration of alternative ways to detonate old ammunition reducing the sound level of should be encouraged.

Pile-driving – Pile-driving is well known from the construction of offshore windfarms, however pile-driving of other foundations should be treated equally. An environmental impact assessment (EIA) is already required prior to any permission of constructing an offshore windfarm. Nevertheless pile driving is a permitted foundation technique. Therefore several mitigation measures are proposed in order to mitigate the adverse effects of pile driving: (1) avoid pile-driving and use alternative foundation methods available. Taking precedence over alternative foundation methods causing less impact on the marine environment should be part of the permit system and should be a balancing factor against extra costs of alternative foundation, (2) when pile-driving, only in daylight hours and under good sighting conditions to detect porpoises, (3) only permit pile-driving in seasons of low porpoise abundance to limit the number of animals exposed. Such a restriction should be based on latest insights in seasonal distribution, (4) a pre-piling search 30 minutes prior to the start of piling should be undertaken by skilled marine mammal observers. Piling should not begin, if porpoises (or other marine mammals) are detected within the mitigation zone [to be defined but no less than 500 metres based on the UK piling protocol] or until 20 minutes after the last detection, (5) when pile-driving, mitigation measures such as acoustic deterrents or a ramp-up procedure should be properly used to alert porpoises and other marine mammals. First, note that acoustic deterrents might cause adverse effects as well when to close to the animals. It is not guaranteed that using deterrents or a ramp-up scheme do deter porpoises, and if so, note that animals are disturbed from their natural behaviour. (6) Technical measures proven to reduce the sound emission during construction works should be used whenever possible, (7) the decommissioning phase should avoid underwater explosions, or only be allowed under controlled conditions using bubble curtains or similarly effective mitigation measures to achieve minimum emittance of noise into the marine environment.

Monitoring and control - An appropriate monitoring and policing scheme shall be established to ensure compliance to required measures for the above mentioned activities (seismic surveys, controlled explosions at sea and pile-driving). Protocols for the assessment of the effectiveness of all used mitigation measures should be implemented by the appropriate bodies.

National & international cooperation - There are several working groups related to underwater noise and its effects on the marine environment. In The Netherlands, at present there is the 'interdepartementale werkgroep GiZ - Geluid in Zee'. Recommendations or proposals for guidelines should be fine-tuned with this working group. International fora to tune and discuss such processes are ASCOBANS, having a working group on underwater noise and the working groups under the Marine Strategy Framework Directive (MSFD), such as the sub technical working group on underwater noise, chaired by both the UK and The Netherlands or the working group on Good Environmental Status. Spatial and temporal planning of acoustic activities at sea should be discussed within such for a, addressing issues such as harmonising units and standards.

In the table below an overview of mitigation measures is given. In the discussion and conclusion of this conservation plan a short list of action points can be found.

Harbour Porpoise conservation plan mitigation measures

Observed threats	Mitigation measures	First indication for responsibility
Bycatch Commercial fisheries	Facilitate landing & reporting bycatch	Ministry of EL&I
	Control illegal fisheries	Fisheries inspection
	Amend EC 812/2004	European Commission (EC)/ Ministry of EL&I
	Controlled use acoustic devices	Fisheries required using acoustic devices
	Gear switch	Fisheries, Kenniskringen
	Gear modification	Fisheries, Kenniskringen
	Freeze total effort	Ministry of EL&I / EC
	Time and/or area closures	Ministry of EL&I / EC
	Establish a take limit	Ministry of EL&I / EC
	Monitoring and control compliance to required measures	Fisheries inspection
Recreational fisheries	Prohibit all recreational fisheries with gillnets from the coast	Ministry of EL&I
Underwater noise		
General	Develop a system of standards for loud explosive sounds	Ministry of I&M / Rijkswaterstaat
Seismic surveys	Establish licence requirements for seismic surveys	Ministry of EL&I / State supervision of mines
	Establish and implement guidelines for seismic surveys	Ministry of EL&I / State supervision of mines
	Notify stranding network prior to seismic survey	Seismic survey coordinator
	Observer scheme before, during and after activity (visual and acoustic)	Person responsible for marine mammal observation
Controlled explosions under water	Establish & implement guidelines for ammunition removal	Ministry of Defense
	Notify stranding network prior to survey	Detonation coordinator
	Observer scheme before and after explosion (visual and acoustic)	Person responsible for marine mammal observation
	Consider alternative to detonation methods	Ministry of Defense
Offshore construction (windfarm, …)	Avoid pile driving where possible and consider alternative foundation structures	Ministry of I&M/ Rijkswaterstaat
	When pile driving, notify stranding network prior to piling	Piling coordinator
	When pile driving use an observer scheme before and after activity (visual and acoustic)	Person responsible for marine mammal observation
Offshore windfarm demolition	Avoid explosives and use an alternative method for demolition	Ministry of I&M/ Rijkswaterstaat

Main action points (mitigation measures)

Regarding these action points it should be emphazised that measures on itself can be effective, but that in most cases, if not all, a combination of measures addressing a problem will be more effective.

Bycatch

- Observer scheme for set-net fisheries (international protocols, random sampling)(see main action points scientific research)
- Investigate alternative gear other than set-nets and/or investigate modification of set-nets.
- Controlled use of pingers when bycatch is identified
- Facilitate bycatch landing
- Restrictions in recreational fisheries, control illegal fisheries
- Amend EC 812/2004
- Monitor and control compliance fisheries restrictions

Underwater noise (detonation, seismic, piling)

- Develop a system of standards for loud explosive sounds
- License and guidelines seismic surveys, pile-driving, underwater explosions
- Establish porpoise observer schemes before during and after
- Notification strandings network prior to acoustic impacts
- Reduce noise using bubble curtains, solid barriers, other solutions if proven to be effective
- Alert animals ramping up sounds, use acoustic deterrents
- Avoid explosives and use an alternative method for windfarm demolition
- Research plan to monitor the effects of mitigation measures

10. Discussion and conclusions

There was only one thing I wanted to know. "What effect will this dam have on the baiji?" I asked. She paused, her smile tightening. She frowned slightly. "Ah..the baiji." Her voice had a gentle, musical lilt. Then here smile grew. "The baiji..the baiji will be *fine*."

Samuel Turvey (2008)
Witness to extinction. Oxford Univ. Press

The baiji, the Yangtze River Dolphin *Lipotes vexillifer*, is gone forever. Everyone knew it was at risk, and much was made of the threat of extinction. Urgent appeals for effective action were made time and time again. Too late. Other (economical) priorities had prevailed. The Yangtze River was polluted, overfished, dammed, modified and one of it's natural inhabitants simply could not adapt.

There seem only few parallels with this sad story and the Harbour Porpoise in the Southern Bight, but lessons could be learned. The Baiji's problems were ignored for long, or at least they were not taken serious. Sound research was lacking, until the animal was so rare that a serious study was impossible. "The baiji..the baiji will be *fine."*

When the Harbour Porpoise declined in Dutch coastal waters, the first signals were ignored by authorities at the time. Viergever, Appelman, Verwey, Monsees, Van Heurn, Van der Veen and Kristensen, all field people (referred to in strandings reports produced by Van Deinse, 1940-1964), had reported declines in their sightings rates for years. However, the established authorities at the time, Van Deinse (1957) and Vader (1956), openly denied and even disqualified the evidence and argued that (non-systematically recorded) strandings were plentiful. The porpoise?..the porpoise will be *fine*. It was already in the 1960s that we could just as well call the Harbour Porpoise locally extinct and in the absence of sound research we have no idea why that was. Harbour Porpoise were used in early (pre-historic) coastal human settlements, they had been highly valued and therefore harvested (and overfished) in the Middle Ages, they were considered greedy competitors of us, fishermen, in the early 20th century. They had, in other words, always been around. The only other truely indigenous cetacean, the Bottlenose Dolphin, disappeared from our coastal waters at roughly the same time.

The Harbour Porpoise returned, or *a* Harbour Porpoise returned. We do not know if it is representatives from the same stock that returned, or that perhaps another population became established. Good science is lacking. The population that entered the Southern North Sea, for as far as currently understood, is highly dynamic and mobile. Higher numbers every year, present for longer periods every year (but see Camphuysen 2011), invading long abandoned areas and apparantly establishing small, locally resident stocks in some estuaries. Few scientists have seriously tried to answer the question: "*Why did they return*?". They left Dutch waters, virtually without a trace, they were virtually extinct for decades, and they returned again, and we don't know why. Nobody studied it.

The main lesson from the Baiji story should be: effective conservation starts with a high level of knowledge and understanding of the ecology of the animal in question, plus a proper monitoring programme. One could ignore early warning signals of population distress and decline *only* when proper data show that there is no problem at hand. Species conservation may not be the immediate interest of all stakeholders and it is even quite likely to bring conflict between certain industries and conservationists, if only that some industries may need to work more responsibly or carefully than before. Information on Harbour Porpoises could therefore be strongly biased: while some claimed "*the porpoise is fine, no problem*", others were of the opnion that they are perhaps not in immediate danger of extinction, but certainly vulnerable and at risk. Clearly, facts needed to be separated from personal expectations and believes. Many stories were told, and our answer was standard: "give us the data, show us your log, hand us the paper, give us more evidence". Few stories appeared to have a strong factual basis. They therefore played an insignificant role, if any, in the result now presented.

Throughout this Conservation Plan we strived to prioritise sound data over unsubstantiated stories. And many stories about porpoises were told to us, some of which were clearly plain nonsense, while others may have held considerable truth. Yet, peer reviewed papers were considered more authoritative than reports (grey literature), and the reports were even more or less ignored when "proper science" was available. Science should be scrutinised and critised and many reports we have seen had not been reviewed by an independent, critical scientist.

The Harbour Porpoise featured on the conservation agenda for decades, but it took a while before the first serious population assessments (counts) became available. A quarter of a million animals were found within the North Sea area in mid-summer surveys in 1994 and 2004 (Hammond *et al.* 2002, SCANS II 2008). Aerial surveys in Dutch waters in spring 2009 and 2010 (the time of peak occurrence) revealed that in approximately half the Dutch EEZ as many as 40-50,000 animals (15-23% of the North Sea stock) occurred (Scheidat & Verdaat 2009, Scheidat *et al.* 2010). Plenty (meaning *enough*) according to some of the stakeholders consulted during this project, but in fact a historical reference is lacking. It could be more than ever before, now that most stocks of other apex predators have been depleted or even completely removed from the North Sea. It could be much less than ever before, but again, we have no reference. Fishermen at the time (and many still) did not even know the difference between dolphins and porpoises, so most historical accounts on sightings are inaccurate to say the least (Camphuysen & Peet 2006). Counts were never made.

With a substantial part of the North Sea stock in waters under Dutch jurisdiction, even if this is only during part of the year, we share the responsibility for the general well-being of the Harbour Porpoise with other North Sea states (Habitats Directive, the Oslo-Paris Convention and the ASCOBANS Agreement under the Bonn Convention (Convention on Migratory Species). Updated status reports and a (national) conservation plan, to keep or bring the species in a favourable conservation status, are required. For as long as the animals are with us, they should be safe, or at least as safe as possible.

This document has re-evaluated the current status of the Harbour Porpoise in the Dutch sector of the North Sea, its current threats, research needs and possible or optional solutions to safeguard the general well-being of the species in this part of the world. Preferably, levels of monitoring and research should be such that any significant population trends should be recorded and could trigger timely action. For an elusive species such as the Harbour Porpoise (not many people ever even see the animal in the wild), this may be less straightforward than it seems. Populations censuses (basically 'counts' or stock assessments) alone will be inadequate to monitor the condition of a population. Age composition and sexratio, reproductive success and the effects of particular threats cannot be studied by counts only. At the same time, a lesson of the past could be: certainly do not just rely on the number of *strandings* as an indicator of the presence and abundance of the species in the Southern North Sea. Stranded animals are a biased subset of the offshore population, even if he cetacean strandings record faithfully reflects patterns of richness and relative abundance in living communities

(Pyenson 2011). Lockyer & Kinze (2003) discussed potential bias introduced by certain discrete datasets, including data from strandings and animals retrieved from bycatch observer schemes.

In terms of status assessments, there have been substantial improvements in the quality of census techniques. State of the art aerial surveys have been conducted in 2009, 2010, and again in 2011 (Scheidat & Verdaat 2009, Scheidat *et al.* 2010, plus IMARES unpublished material), and should be continued in years to come. There is scope for improvement in the exact *planning and frequency* of surveys, and a scientific research steering committee could discuss the needs and provide planning advice.

A so-far underexplored source of information were seabird observations from coastal headlands, originally co-ordinated by the Club van Zeetrekwaarnemers (Dutch Seabird Group), currently filed by www.trektellen.nl, a joint venture between Stichting Trektellen, SOVON Nijmegen and the Dutch Seabird Group. It were these counts that gave us an early warning of the return of porpoises in Dutch coastal waters and it is even today one of the best sources of information regarding seasonal trends in abundance in nearshore areas (this document, Camphuysen & Leopold 1993, Camphuysen 1994, 2004, 2006, Camphuysen 2011). This work is conducted by specialised volunteers (bird-watchers), but provides excellent data, without the need for additional funding for as far as the field work is concerned. Some financial support to stimulate specific analyses of Harbour Porpoises sightings data within certain time-intervals (e.g. every five years) should be recommended.

In terms of the documentation of strandings, an online representation of recent reports (www.walvisstrandingen.nl) is a step forward in comparison to the old-fashioned paper-files of strandings data. However, a glossy website is by no means a guarantee that high-quality data are collected in a systematic manner. The dataset is invaluable and should be treasured, but the strandings network should be maintained by a dedicated researcher, or a dedicated research institute, willing to put significant effort into it. Volunteers (people reporting stranded marine mammals) need instructions and feedback. Facilities and finances to maintain this volunteer network at strength are therefore required.

Currently, of stranded animals certain basic data are logged: date, location, species, total length and sex. A scientific evaluation of the type of observations made (or that volunteers could be *expected* to make reliably) on stranded carcasses is lacking, and guidelines to instruct volunteers on beaches and forms to emphasise the need to provide certain data could improve the quality and completeness of the collected data.

Pathological studies of porpoises stranded on the Dutch coast (necropsies) have been conducted at least since 1983 (Van Nie 1989), and are currently conducted at the Veterinary Faculty of the University of Utrecht. Pathological studies are important to reveal certain aspects of the life-history, ecology, parasitology, and causes of death of stranded cetaceans, but the underlying research questions should be clear, concrete, and adjusted when needed, to accommodate current (or future) research needs. Current research in pathology is biased, studying "cause of death" with some focus on bycatch characteristics, and does not (yet), for example, adequately investigate (lethal) effects caused by loud underwater noise, even after international collaborations initiated in 2006 (Leopold & Camphuysen 2006). A clearly specified research plan for pathological studies and/or a change in priorities of research could enhance our understanding of interrelationships between environmental contaminants and animal health, the age structure and breeding success of the population, and multiple other issues. A central scientific research plan could make these studies more effective and more conclusive as a monitoring programme. Again, a scientific research steering committee could discuss the research needs, formulate hypotheses and help set priorities for future research.

Of the observed threats, some require immediate action (mitigation measures have been proposed), others require additional research to be able to propose specific mitigation measures. The bycatch issue, at the moment, cannot be addressed in an appropriate way: too many factors are unclear. Where the volunteer input of stakeholders (fisheries in case of the bycatch) does not lead to rapid solutions, high quality research may need to be enforced in order to find out where the problems are most prominent. Within this document, the conclusion is reached that in order of priority, the most important threats are (1) bycatch, (2) pile-driving during the installation of windfarms, (3) underwater explosions, and (4) other particularly loud underwater sounds (e.g. sonar, seismic surveys). Additional research is needed for the first, immediate mitigation measures are proposed for the other impacts. All aspects require future monitoring, to assess the scale, the exact impact, but also the effectiveness of mitigation measures.

Bycatch is a critical source of mortality for Harbour Porpoises throughout their distribution area (Hammond *et al.* 2010). Progress at reducing the scale and conservation impact of cetacean bycatch has been slow, sporadic, and limited to a few specific fisheries or circumstances. As a result, bycatch remains perhaps the greatest immediate and well-documented threat to cetacean populations globally (Reeves *et al.* 2005). Within The Netherlands, the incidence of bycatch is currently best known from the necropsies (on a non-random selection of stranded animals). Even in the most "clear" examples of bycatch (except animals that were actually taken from a net and could be studied during a necropsy) are not completely free of doubt. Could it be something else? Also, necropsies give no idea of the fishing gear in which the animals may be most at risk. Adequate measurements of at-sea mortality is therefore a necessary component of any management framework, and independent observers at sea are the most reliable source of information. A top-priority in the near future would thus be the implementation of an observer scheme to assess bycatch rates. The amount of observer effort, when not financially constrained, is usually set to achieve a desirable level of precision, assuming that the observers sample the fleet randomly (Babcock *et al.* 2003). The assumption of random sampling has thus far been unjustified in Dutch observer schemes and the issue of bias in bycatch estimates has not been addressed adequately, despite the fact that observer programs allocated sampling effort opportunistically to vessels that volunteered to carry observers. The bias introduced by non-random sampling, and by the possible changes in fishermen's behavior in the presence of observers, must be addressed (Northridge 1996, Babcock *et al.* 2003, Northridge & Thomas 2003, Northridge & Kingston 2010).

Historically speaking, Harbour Porpoise went and came back, at least within the past five or six decades. There is no explanation for this and no ongoing research to investigate the issue. What is crucially lacking are studies of the demography, ecology and migratory movements of Harbour Porpoises, and studies of the ecology and general well-being of the animals further offshore. There is an urgent need to deepen our understanding of habitat requirements, natural resources (prey), and the trophic position of porpoises within the ecosystem of the Southern Bight. In this conservation plan, considering the observed status and expected or demonstrated threats (e.g. our lack of knowledge with regard to the types of fisheries in which bycatches are most frequent), ecological studies are not ranked as being of the highest priority. In a way this is odd, and the low ranking will possibly reduce the possibilities to have ecological research plans funded at all. How can we conserve a species we know fairly little or near-nothing about? By putting emphasis on what we *can see* (e.g. evidence for accidental drowning in fishing gear), while ignoring possibly major but less visible impacts (habitat detoriation, shifts in prey abundance, effects of climate change), we might as well bet on the wrong horse. Future fundamental research to enhance our understanding of the demography, life-history, and ecology of Harbour Porpoises in the Southern North Sea is therefore essential.

Repeatedly, we have proposed that a **national scientific research steering group** would be a suitable instrument to deal with aspects such as research needs, research quality and an evaluation of the quality and conclusions of reports. Such a steering group should be sufficiently authoritative, but also sufficiently "distant" from the ongoing research, to address all these issues in a fully independent way. The terms of reference of this group should be such that high quality science is stimulated, investigating research questions that are currently important or that may become important in future. We propose that such a committee should meet and advice annually, and be composed of at least two foreign marine mammals experts, one Dutch Harbour Porpoise expert, and (vitally) one statistician.

Main action points (research needs)

The current Harbour Porpoise conservation plan is a generic plan rather than area-orientated: recent research in Dutch waters failed to identify areas or regions of particular ecological significance for Harbour Porpoises for any significant length of time. Harbour Porpoises are highly mobile, aquatic organisms moving through the Southern North Sea, with offshore abundance during the greater part of the calendar year, but with nearshore peaks in abundance in winter and spring. Fisheries restrictions within areas of special protection alone (Lindeboom *et al.* 2005), or restrictions regarding the use of loud underwater noise only within such designated areas, would not enhance the conservation status of this marine mammal. Reducing potential threats such as fisheries within protected areas (displacements towards unprotected areas rather overall reductions) would simply transfer the bycatch risks towards other sea areas. Similarly, the impacts of explosive sounds under water are not restricted to certain areas of special protection, but would be equally harmful outside designated areas. It is not impossible that, given the constant changes in numbers of animals utilising Dutch waters, future insights would be different. With regard to the current needs for proper scientific research, the following points have been highlighted and prioritised:

- Formation of national scientific steering group
- Quality control of research proposals and independent peer review of project results and publications
- Assessments of Harbour Porpoise population through state of the art aerial surveys, including analysis of seasonality and spatial patterns
- Re-evaluate conservation status
- Continuation and strengthening of a co-ordinated strandings network
- Prioritise systematic, representative sampling of stranded carcasses
- Develop concrete research questions for research in pathology, and adjust when needed
- Development of novel forensic techniques to demonstrate the likelihood of bycatch
- Monitoring of pollutants burden and/or tissue banking
- Prioritise an observer scheme on all fleets with passive gear to assess bycatch rates according to internationally accepted protocols, especially in winter
- Assess bycatch rates in the most important fisheries (regarding bycatch) and evaluate the effectiveness of mitigation measures

- Innovative studies of the (foraging) ecology and habitat requirements of Harbour Porpoises in the Southern North Sea
- Innovative studies of the behaviour of Harbour Porpoises in captivity

Main action points (mitigation measures)

The concrete mitigation measures proposed in this conservation plan are meant to reduce demonstrated threats to Harbour Porpoises in the Southern North Sea. Emphasis is on threats with a *regional* character for which sufficient evidence of potential population level exists. Several other potential threats have more global characteristics (e.g. pollutants, morbillivirus), and although mitigation measures have not been proposed, it would be unwise to exclude such aspects completely from ongoing monitoring schemes, for example during research in pathology. The establishment of a scientific steering group would provide facilities to re-evaluate certain factors and trends and respond accordingly.

Several of the proposed mitigation measures are in fact research dependent, others could be implemented immediately, or when needed. The research plan described earlier should guarantee that developing threats, or new insights, should be taken into account in future work. For the moment, the most urgent issues regarding a favourable conservation status of Harbour Porpoises are seemingly bycatch issues and loud (explosive) underwater noise, both with regional or local characteristics (km scales). The first are basically research dependent, and gear-specific mitigation measures (other than draconic steps such as complete closures of entire fisheries) cannot be implemented at the moment. For underwater noise, even if studies of the effectiveness of proposed measures are highly important, the mitigation measures could be implemented directly.

Bycatch

- Investigate alternative gear other than set-nets and/or investigate modification of set-nets.
- Controlled use of pingers when bycatch is identified
- Facilitate bycatch landing
- Restrictions in recreational fisheries, control illegal fisheries
- Amend EC 812/2004
- Monitor and control compliance fisheries restrictions

Underwater noise (detonation, seismic, piling)

- Develop a system of standards for loud explosive sounds
- License and guidelines seismic surveys, pile-driving, underwater explosions
- Establish porpoise observer schemes before during and after
- Notification strandings network prior to acoustic impacts
- Reduce noise using bubble curtains, solid barriers, other solutions if proven to be effective
- Alert animals ramping up sounds, use acoustic deterrents
- Avoid explosives and use an alternative method for windfarm demolition

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