Ministry of Economic Affairs

Framework for assessing ecological and cumulative effects

of offshore wind farms

Part B:

Description and assessment of the cumulative effects of implementing the Roadmap for Offshore Wind Power

Version 1.1

Contents

Underlying reports:
In this document:
'Cumulative effects of impulsive underwater sound on marine mammals'
(*Cumulatieve effecten van impulsief onderwatergeluid op zeezoogdieren*);
Netherlands Organisation for Applied Scientific Research TNO 2015

As a separate document:
'A first approach to deal with cumulative effects on birds and bats of offshore wind farms and other human activities in the Southern North Sea' (including 9 Annexes);
IMARES 2015

For the references, terms and definitions, see Part A.

Summary of FAECE

Introduction

The nature conservation legislation includes an obligation to assess the cumulative effects of new initiatives with possible adverse effects in combination with other plans and projects. The Framework for Assessing Ecological and Cumulative Effects (FAECE) has been drawn up to determine how to deal with the cumulative ecological effects of the development of offshore wind farms in the southern North Sea. These wind farms are now being rolled out according to the Roadmap for Offshore Wind Power, as included in the letter to the lower house of the Dutch Parliament of 26 September 2014. The scale of these developments in the Netherlands and surrounding countries and their associated ecological risks further underline the need for this assessment framework. Moreover, the measures taken so far to prevent significant adverse cumulative effects based on the precautionary principle are no longer considered to be adequate in the light of the preferred development of offshore wind farms. A suitable method for describing and assessing these cumulative effects was lacking..

Purpose and target audience

The FAECE provides a method based on existing publicly available scientific knowledge and applies it to the Roadmap to identify the cumulative effects, in combination with other developments in the biologically relevant regions, and assess how serious they are. The national policy strategy for offshore wind power (Structuurvisie Windenergie op Zee) and the draft Second National Water Plan (NWP2) prescribe the use of this method for describing and assessing the cumulative effects to support decision-making on the development of offshore wind farms. The FAECE does not apply to location-specific effects.

The FAECE has been prepared in the first instance for use by the government authority responsible for decisions on the development of offshore wind power (such as strategic planning (scoping) documents (structuurvisies) and wind farm site decisions (kavelbesluiten)). This also makes it relevant to consultancies preparing the environmental impact assessments (EIAs) and appropriate assessments (AAs) in support of these decisions and for stakeholders in offshore wind power. The FAECE will be regularly updated to include the latest developments and knowledge.

Method

The FAECE first describes in general terms how cumulative effects can be identified and described. It then focuses on applying this to the development of offshore wind farms, drawing a distinction between a legal and an ecological approach. This is because simply meeting the legal requirements of the Nature Conservation Act (*Nbw*) will not always adequately protect the ecological values of the North Sea. In some respects, the North Sea requires a different approach. The wildlife of the North Sea comprises a wide variety of species, several of which migrate across the North Sea or over longer distances each year, while the distribution of other species within the North Sea is difficult to predict. National borders are largely irrelevant, but the legislation places considerable importance on area protection and is only applicable within the national territory. For this reason it was decided to assess the effects at the level of the biogeographic regions. This also satisfies the requirements of the nature conservation legislation, although assessments of specific planning decisions, such as EIAs/AAs for wind farm site decisions, must also address location-specific aspects.

The description and assessment of the cumulative effects of a proposed activity take place in a step-by-step procedure. The first two steps are carried out at the same time and are interrelated.

1. Identify the relevant pressures the envisaged activities could cause.
2. Identify the habitats and species that may be affected by these pressures.
3. Describe all other activities that could affect the same species.
4. Describe the nature and scale of the cumulative effects of all the activities selected in Step 3 on the selected habitats and species.
5. Evaluate the significance of the effects on the selected habitats and species.
6. If necessary, adapt the activity by taking measures to prevent the activity causing significant effects.

Calculation of effects

The effects are calculated for those species that are expected to experience significant effects:

1. Harbour porpoise. The effects of underwater sound have been calculated in a series of steps to identify the numbers of harbour porpoises that will be disturbed and for how many days, and what this means for the population during the implementation period of the Roadmap.

2. Birds (seabirds, coastal breeding birds and migratory birds). The calculation of cumulative effects on birds took account of collisions with wind turbines in combination with the barrier effect and habitat loss resulting from the presence of wind farms.

3. Bats. Knowledge of the presence, behaviour and therefore the sensitivity of bats at sea to operational wind farms is still in its infancy. Indicative estimates of collisions have been made based on expert judgements.

Assessment

The assessment of effects on species is based on the principle that there must be no structural decline in population numbers. If there is, the natural resilience of the population will have been damaged. If recovery is not possible, the species will eventually become extinct or disappear from part of its range. The FAECE assesses bird and bat species against potential biological removal (PBR), a measure of the maximum number of individuals of a species that may be removed from the population in addition to natural mortality and emigration without the population undergoing a structural decline. Population characteristics such as capacity for growth and recovery and the trend in population size are incorporated into this measure. As long as the PBR is not exceeded, there will be no significant – and therefore unacceptable – effects. Effects on the harbour porpoise are assessed against the threshold values in ASCOBANS (Agreement on the Conservation of Small Cetaceans in the Baltic, North-East Atlantic, Irish and North Seas). There is no usable PBR for harbour porpoise because of the type of effect caused by pile driving (disturbance).

Evaluation of the results when applied to the Roadmap

The evaluation of the effects shows that the implementation of the Roadmap could lead to significant effects, particularly on harbour porpoise, lesser black-backed gull, greater black-backed gull, herring gull, Nathusius's pipistrelle and possibly two other bat species. For the harbour porpoise population, other activities (certainly seismic research and fisheries) are already likely to exert an excessively high pressure on the population. Under the nature conservation legislation, due care should also be given to limiting the number of deaths of migratory birds. This means that additional measures will be needed to provide adequate protection for these birds. Part A of the report mentions measures that can be used.

The FAECE draws no conclusions about the measures to be taken. Decisions on whether measures should be taken and, if so, which ones will be made when the site decisions and any other planning or environmental decisions are made about the development of offshore wind power.

1 Introduction

1.1 Background

There has been a need to describe and assess the effects of human activities on natural ecosystems since at least the 1970s. In the 1980s we realised that it is not enough to describe and assess the effects of specific proposals and activities, but that it is also necessary to examine whether the effects of various different activities can accumulate to produce larger or more damaging ecological or environmental impacts.

Despite the difficulties, the importance of properly describing and addressing the issue of cumulative effects was acknowledged and incorporated into the legislation. This can be clearly seen in the wording of the EU Birds Directive (1979) and EU Habitats Directive (1982). These directives require that the ecological values, in terms of natural habitat types, species habitats and species, should not only be protected from the possible adverse effects of each separate human activity in and around protected areas on the ecological and environmental values in these areas, but also from the cumulative effects of all human activities. In the Netherlands the transposition into national law of these directives has created an explicit requirement under the Nature Conservation Act 1998 (*Natuurbeschermingswet* (*Nbw*)) not only to assess the effects on ecological values of individual initiatives with potentially significant adverse effects, but also their cumulative effects in combination with other plans and projects. The Flora and Fauna Act (Flora- en faunawet (*Ffw*)) also takes account of cumulative effects, but more implicitly by requiring an assessment of effects on favourable conservation status at various spatial scales.

In the period 2005–2009 the Dutch government received a large number of development consent applications for offshore wind farms and had to decide how to assess not only the effects on the marine ecosystem of the separate wind farms, but also the cumulative effects with other wind farms and in combination with other activities. In connection with a number of issues, including knowledge gaps about the cause–effect relationships, the presence of marine species and the resulting mandatory application of the precautionary principle, the assessment led to a number of mitigation measures.

In response to these knowledge gaps, research programmes were established (Shortlist Ecologische monitoring 2010–2011, *Vervolg Uitvoering Masterplan 2012–2015*[1]). Other countries have also recognised the problem of identifying and assessing the effects of offshore wind farms and have conducted considerable research in recent years.

The SER Energy Agreement for Sustainable Growth (*Energieakkoord voor Duurzame Groei or SER-akkoord*) published in 2013 heralded a new phase for offshore wind power. Given the size of the task and the costs involved, it was necessary to establish whether it would be possible, on the basis of the new insights obtained, to draw up a new framework for determining the effects of offshore wind farms, and especially for identifying and assessing their cumulative effects.

1.2 Purpose

The Framework for Assessing Ecological and Cumulative Effects (FAECE) describes a method for calculating cumulative effects. Given the reason for preparing the framework, it focuses mainly on offshore wind power. It has been used to assess the Roadmap for Offshore Wind Power, as included in the letter to the lower house of the Dutch Parliament of 26 September 2014, in order to ascertain the ecological parameters within which the Roadmap can be implemented in full. The framework will also have to be used when drawing up the environmental impact assessments (EIAs) and appropriate assessments (AAs) of the individual site decisions and all other decisions on the development of offshore wind farms.

Who are the intended users?

The FAECE has been prepared for use by the government authority responsible for decisions on the development of offshore wind power (such as strategic planning documents (structuurvisies) and wind farm site decisions (*kavelbesluiten*)).

[1] The *Vervolg Uitvoering Masterplan* (VUM) is a four-year follow-up research programme on Shortlist ecological monitoring studies into acoustics, fish larvae, birds, bats and mammals.

This also makes it relevant to consultancies preparing EIAs/AAs in support of these decisions and for stakeholders in offshore wind power to ensure transparent information on how the effects of these developments will be identified and assessed.

1.3 Remit and execution

The FAECE has been drawn up by Rijkswaterstaat (the part of the Ministry of Infrastructure and the Environment responsible for the design, construction and maintenance of the country's main infrastructure facilities) for the Ministry of Economic Affairs, with assistance from an interdepartmental steering group of representatives from the various departments of the Ministry of Economic Affairs and the Ministry of Infrastructure and the Environment. The following impact studies were carried out for Rijkswaterstaat for use in the preparation of this assessment framework:

- 'Cumulative effects of impulsive underwater sound on marine mammals' (*Cumulatieve effecten van impulsief onderwatergeluid op zeezoogdieren*), carried out by a consortium led by TNO;
- 'A first approach to deal with cumulative effects on birds and bats of offshore wind farms and other human activities in the Southern North Sea', carried out by a consortium led by IMARES.

During the preparation of this document various meetings were held with the wind energy sector and with nature conservation and environmental organisations.

1.4 Structure of the report

Part A of this report describes the methodology for describing and assessing the cumulative effects of the development of offshore wind farms.

These methods have been used to assess the effects of implementing the Roadmap, and this part of the report (Part B) contains a summary of this assessment. The accompanying research reports give a full account of the calculations and models used. The underlying research report by the Netherlands Organisation for Applied Scientific Research TNO on underwater sound is incorporated into this report as an Annex. In view of its size, the research report by IMARES on birds and bats is provided as a separate document. In Chapter 3 threshold values (limits of acceptable change) are derived for all the relevant groups of animals. Chapter 4 contains the results of the cumulative effect calculations for the three species groups considered here. The evaluation of the results for these species and species groups in relation to the threshold values is discussed in Chapter 5.

2 Scope

2.1 Boundaries of the assessment

When calculating the effects of the Roadmap for Offshore Wind Power, a decision was made to include only those impacts that could plausibly lead to significant adverse effects, either on their own or in combination with other activities. From current knowledge and previously prepared plan and project EIAs and AAs, it is clear that the biggest effects of the construction and operation of offshore wind farms can be expected to be on the following species groups: birds, bats and marine mammals. In addition, from a legal point of view these three species groups contain the greatest numbers of protected species under the EU Habitats and Birds Directives. For this reason the research into the effects was restricted to these three species groups. For marine mammals the study only examined the effects of underwater sound on the harbour porpoise and not on seals, based on the assumption that harbour porpoises are more sensitive to underwater sound. If the harbour porpoise is protected against underwater sound, it is assumed that this will also provide sufficient protection for seals. Fish were not included in the assessment because it is assumed that if harbour porpoises are sufficiently protected against the effects of underwater sound, fish will also be sufficiently protected.

The determination of the effects of implementing the Roadmap in this study covered the wind farm locations beyond the 12 NM territorial waters. Any effects in the yet to be designated zone between 10 and 12 NM from the coast have not yet been included in the calculations. As the proposed designation of two areas for the development of offshore wind farms within this zone was announced too late for them to be included in the studies, these effects will have to be identified using the method described here in support of the preparation of the strategic planning (scoping) document (*structuurvisie*) designating the 10–12 NM strips. It must also be stressed that the calculations of the seriousness of the effects on conservation status or populations should be made at the national scale. As the exact location of the wind farm sites is not yet known, the possibility that more detailed calculations in a project EIA will reveal significant adverse effects on specific protected populations cannot be entirely ruled out. For example, protected breeding colonies of lesser black-backed gull are found on the island of Texel (one of the West Frisian Islands) and near the Veerse Meer lake (in the delta area in the province of Zeeland). At this generic level of assessment it is not possible at this stage to determine whether these breeding colonies would experience significant adverse effects from the development of sites in the North Holland Coast and Borssele wind farm zones respectively. These types of effects will have to be calculated in more detail when carrying out an EIA/AA for the relevant site decisions.

2.2 Status and follow-up

In the national spatial strategy for offshore wind power (*Rijkstructuurvisie Windenergie op Zee, 26 September 2014*), the partial revision of the First National Water Plan (NWP1) and the draft NWP2 (2016–2021), it is stated that the Framework for Assessing Ecological and Cumulative Effects (FAECE) must be used to support decision-making on the delimitation and exploitation of future wind farms within the designated zones. When taking decisions on the development of offshore wind farms, such as designations of wind power zones and site decisions, the FAECE will be used to determine whether an offshore wind farm, on its own or in combination with other wind farms and activities, will lead to any significant ecological effects, or whether this possibility can be ruled out. The Dutch government is therefore committed to using the FAECE in decision-making procedures for the development of offshore wind farms.

The FAECE is a living document: it makes use of the knowledge and expertise available at the present moment and new developments may give cause to revise the document. These revisions may reflect advances in knowledge (e.g. population changes, understanding of cause–effect relationships, effects on species about which little was known), changes in the activities included in the assessment or the techniques used in the activities, changes in the legislation (including the relevant case law) or a broadening of the field of application of the framework (e.g. beyond offshore wind power). Deserving special mention in this regard is the Marine Strategy Framework Directive. Consideration must be given in future to incorporating some of the indicators stipulated by the directive into the FAECE.

Ongoing research into the effects of offshore wind farms, such as the research for the Vervolg uitvoering Masterplan [1] will be completed in mid-2015 and may generate new input to the FAECE. In addition, a list of knowledge gaps has been drawn up regarding the methodology (ecological and legal) and its application (ecological information). In the years to come attempts will be made to investigate and repair these knowledge gaps as far as possible.

[1] The Vervolg Uitvoering Masterplan (VUM) is a four-year follow-up research programme on Shortlist ecological monitoring studies into acoustics, fish larvae, birds, bats and mammals.

3 Limits of additional mortality due to human activities

3.1 General

The natural size of a healthy species population is limited mainly by the amount of food and other environmental factors, such as the area of reproduction and roosting habitats required and the presence of natural enemies. Unexpected temporary or permanent changes in environmental factors can cause additional deaths among animal populations (e.g. due to a virus infection). The likelihood of a population recovering from such a disturbance depends on the size of the change and the speed at which it occurs. A temporary increase in the mortality rate can be offset by increased survival rates of the remaining animals and the ability to raise more offspring (density dependent factors).

The mechanism described above gives the population a certain degree of 'resilience' against additional deaths resulting from individual or cumulative effects. But if the increase in mortality continues year on year, it means the carrying capacity of the environment has been reduced. If recovery is not possible, the species will eventually become extinct or disappear from part of its range, and if a population is already under pressure from human influences, such as pollution and disturbance, additional adverse effects will more readily lead to a significant cumulative effect. The 'resilience' argument is only valid for direct adverse effects on the size and/or quality of a species habitat if this loss is offset by positive effects, such as a richer environment in the remaining areas, natural migration or habituation.

From an ecological perspective, the thresholds for acceptable additional mortality must ensure that the conservation status of habitats is not adversely affected (reduction in size and/or quality) and populations do not decline as a result of the cumulative effects of the initiative in combination with all other influences of human activities. The carrying capacity of the ecosystem for the populations of the protected species must be maintained at the level of favourable conservation status. If the cumulative effects act to permanently reduce the size of a species population or pose a structural threat to the favourable conservation status of a habitat (expressed as area and/or quality), the activity in its proposed form is not acceptable.

In principle, the FAECE assesses effects on species against potential biological removal (PBR). The PBR is a measure of the maximum number of individuals of a species that may be removed from the population in addition to natural mortality and emigration caused by the cumulative effects, expressed as virtual annual additional mortality, without the population undergoing a structural decline. Population characteristics such as capacity for growth and recovery and the trend in population size are incorporated into this measure. As long as the PBR is not exceeded, there will be no significant – and therefore unacceptable – effects.

From a legal point of view it is important to assess the effects of activities on the favourable conservation status of species (under the Flora and Fauna Act) or the conservation objectives as set down in the designation orders for Natura 2000 sites (under the Nature Conservation Act). As the Flora and Fauna Act does not contain a definition of the term 'favourable conservation status' it is necessary to fall back on the definition given in Article 1 of the Habitats Directive: 'The conservation status of a natural habitat 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, and
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.'

The conservation objectives may be targets for the maintenance, expansion or improvement in the quality of habitat. The minimum requirement for all bird species is a maintenance target, but in some cases there may be an improvement task.

3.2 Thresholds for harbour porpoise

The prime source of guidance for defining the thresholds (limits of acceptable change) for effects on marine mammals is ASCOBANS (Agreement on the Conservation of Small Cetaceans in the Baltic, North-East Atlantic, Irish and North Seas). This is because the conservation objectives for Natura 2000 sites cover only parts of the North Sea, whereas the whole of the North Sea is the habitat of the harbour porpoise. This Agreement contains an indicative standard (a best efforts obligation).

The interim objective of ASCOBANS for harbour porpoise is to maintain the population level at a minimum of 80% of the carrying capacity. This is in keeping with the spirit of the PBR approach. It aims to maintain the population at a sustainable level, from which the population can grow to carrying capacity after mitigation of effects or cessation of human activities. What size of population this would be is not defined, so for the time being this is taken to be the current population size. For the North Sea as a whole there is not enough data available (two surveys carried out in 1995 and 2005), but much more information is available for the southern North Sea. The size of the population has been calculated by Dr Scheidat of IMARES. According to these calculations, in the period 2010–2014 the Dutch part of the population consisted on average of 51,000 individuals.

To prevent putting the objective of maintaining the population size at no less than 80% of the carrying capacity at risk, ASCOBANS contains a standard for the annual additional mortality (anthropogenic removal), which must be no more than 1.7% of the population size. This standard cannot be applied in a straightforward manner to the effects of underwater sound, which are expressed as a reduction in the population caused by both mortality and reduced reproduction. This population reduction can be related directly to the objective of restoring the population to or maintaining it at 80% or more of the carrying capacity. Assuming that the current population of harbour porpoises is at the carrying capacity of the Dutch Continental Shelf (DCS), a reduction of more than 20% (10,200 individuals) is not acceptable.

To establish with a high degree of certainty that the population will not be reduced to less than 80% of the carrying capacity as a result of human activity, it has been decided to set the limit at the 5th percentile of the model outcome. This means that there is a 95% probability that the reduction is less than 20%. In reality, the probability will be bigger because the assumptions are all based on the worst case scenario.

Given that the SER Energy Agreement for Sustainable Growth states that growth must also be possible beyond 2023, it is assumed that additional wind farms will be built even after the wind power capacity in the agreement has been built. The FAECE assumes further growth to at least 6000 MW (a capacity assumed in previous scenarios for 2030). This means that for the five years of construction to implement the Roadmap and a further three years for future capacity, the maximum acceptable reduction in the size of the population is 1/8 of 10,200 or 1275 individuals per year. For the five years of construction for the Roadmap capacity, this amounts to a reduction of 6375 individuals.

Cumulative effects with other activities

Besides the possible effects of offshore wind power, other activities also have an influence on the harbour porpoise population. Major influences are fishery by-catches and disturbance by underwater sound from seismic research for the exploration for oil and gas deposits.

However, too little is known to obtain a clear idea of the extent to which activities such as commercial fishing and oil and gas exploration already exert additional pressure on the population or whether they are already incorporated into the conservation status. In the absence of sufficient knowledge about the carrying capacity of the DCS without these human activities, it has been decided to use the current population size, which already (at least partly) reflects the results of these effects. Nevertheless, the ultimate goal of ASCOBANS is to minimise the influence of human activities on the population.

3.3 Thresholds for birds

Potential biological removals (PBRs) have been calculated for all the relevant species to assess the impacts of the estimated numbers of bird victims. Table 2 lists the PBRs for the species for which the research indicates that the mortality rate may be more than 10% of the PBR. The table also gives the minimum population for the southern North Sea (rounded down to the nearest hundred or thousand).

Species	PBR	Population[2] (minimum)
Northern gannet	5 245	240 000
Lesser black-backed gull	7 560	290 000
Herring gull	4 184	890 000
Greater black-backed gull	4 144	150 000
Kittiwake	16 473	700 000
Guillemot	26 641	1 300 000
Razorbill	7 129	280 000
Great skua	120	7 100
Bewick's swan	131	18 000
Red knot	6 099	400 000
Sanderling	1 770	28 000
Curlew	901	62 000
Black tern	43	5 300
Starling	139 577	8 600 000

Table 2. *Calculated threshold values for birds*

3.4 Thresholds for bats

The available information on bats is too limited to be able to make a sufficiently reliable calculation of the PBR. The most cautious estimates of the PBR of Nathusius's pipistrelle, based on population estimates of just part of the species' range, lie between 1000 and 5000. However, at the moment insufficient data are available to permit the calculation of a reliable PBR for the whole southern North Sea area.

[2] Population of the southern North Sea, rounded to two significant figures

4 Results of cumulative effects calculations

3.1 Algemeen

The methods used to calculate the cumulative effects are described in Part A of the FAECE and in the background reports in the Annexes.

4.1 Harbour porpoise

Effects of underwater sound from the construction of offshore wind farms

The effects of underwater sound on the harbour porpoise population have been calculated by TNO in cooperation with six other research consultancies.

The calculations were made in a number of steps:
1. sound diffusion per piling strike or seismic airgun pulse;
2. disturbance area;
3. number of disturbed animals;
4. animal disturbance days per offshore project and total;
5. population trend over the years, via Interim PCoD model.

The final outcome of the model is expressed as a reduction in the porpoise population after implementation of the whole SER Energy Agreement. The exact steps taken and assumptions made in this project are described in the research report on the cumulative effects of impulsive underwater sound on marine mammals (Cumulatieve effecten van impulsief onderwatergeluid op zeezoogdieren) by TNO (2015).

The calculations were based on 17 scenarios developed from different assumptions about the pile driving season, the period of time during which pile driving takes place, the duration of disturbance and the disturbance thresholds. The key results are shown in Table 3 as reductions in the harbour porpoise population resulting from the construction of the 10 wind farms planned in the Roadmap.

Scenarios: Number of wind farms (WF), pile driving season, with/without sound limit for pile driving	ADDITIONAL population reduction (individuals): 5th percentile (to 2 significant figures)
pile driving for 2 WF in spring	19 000
pile driving for 2 WF in spring + sound limit (German standard 160 dB)	2 600
pile driving for 2 WF in spring	16 000
pile driving for 2 WF in autumn	9 000
pile driving for 2 WF in spring + sound limit 165 dB	5 300
pile driving for 2 WF in spring + sound limit 168 dB	7 200

Table 3. *Effect on DCS harbour porpoise population of the construction of the wind farms planned in the Roadmap (the numbers in this table are rounded up)*

Cumulative effects with other activities

As stated in Chapter 3, besides the possible effects of offshore wind farms, other activities can also have an influence on the harbour porpoise population. Major influences are fishery by-catches and disturbance by underwater sound from seismic research for exploration of oil and gas deposits.

- Seismic research: research by the Netherlands Organisation for Applied Scientific Research TNO indicates that the effects of seismic research by all the relevant North Sea countries on the harbour porpoise population is of the same order of magnitude as the effect of the worst case scenario for piling for the construction of wind farms (all countries in the southern North Sea). The same applies to the DCS.
- Fisheries: of the harbour porpoises washed up on the Dutch coast it is estimated that about 150–250 died as a result of fishing activities. This is probably a low estimate because not all dead animals are washed up on the shore and not all the washed up animals are discovered and recorded. Neither is it possible to establish the cause of death of all the washed up animals because of their advanced state of decomposition (Conservation Plan for the Harbour Porpoise, Ministry of Economic Affairs). ASCOBANS sets a limit on by-catches of 1% of the population (472 individuals/year).
- It is important to realise that other activities may also affect the population (e.g. explosions from the disposal of unexploded ordnance found on the sea floor, shipping, sonar, etc.). For the time being, other activities have been left out of the equation because of a lack of quantitative data.

4.2 Birds

Population level effects

The calculation of cumulative effects on birds took account of habitat loss resulting from the presence of the wind farms in combination with bird collisions with wind turbines. Habitat loss also included the effect of disturbance by shipping on the presence of birds. More information on this can be found in the background report ('A first approach to deal with cumulative effects on birds and bats of offshore wind farms and other human activities in the Southern North Sea' by IMARES (2015)), which is attached as an Annex to this report.

The calculation of habitat loss is based on the assumption that 10% of the displaced birds die. The resulting number of deaths of guillemots, the most sensitive species for this type of effect, has been calculated to be about 3500. Kittiwake and razorbill are the next most affected, at approx. 700 and 550 victims respectively. Disturbance by shipping has been found to have just a fraction of the effects of wind farms.

Two models are used to calculate collision victims: the Band model, which has been used for some time, and the more recent Bradbury model. The Band model assumes 3 MW capacity wind turbines and relatively rapidly turning rotor blades. The other model (Bradbury, which contains less detailed wind turbine parameters) is based mainly on expert estimates of the behaviour of seabirds. The Bradbury model cannot be used for migrating landbirds.

Table 4 lists the most relevant results (rounded to 2 significant figures).

Species	Band	Bradbury	Habitat loss
Northern gannet	2 600	840	100
Lesser black-backed gull	14 000	2 300	160
Herring gull	5 800	1 200	57
Greater black-backed gull	4 700	800	78
Kittiwake	5 900	3 200	730
Guillemot	13	450	3 500
Razorbill	29	31	550
Great skua	12	14	3
Bewick's swan	58		
Red knot	650		
Sanderling	380		
Curlew	540		
Black tern	23		
Starling	17 000		

Table 4. *Calculated bird deaths (whole southern North Sea)*

The estimated total population of the lesser black-backed gull based on counts on the DCS is 1.6 to 3.5 times higher than the estimate based on the counts of the breeding birds on the Dutch and Belgian coast. This difference remains about the same order of magnitude even after correcting the DCS counts for concentrations of birds flying behind fishing vessels. This difference may partly account for why the estimate of collision victims among lesser black-backed gulls is so high. A follow-up study will examine how such an overestimate could have been made and whether this may also have led to systematic over- or underestimates for other bird species.

Both the Band and Bradbury models have their advantages and disadvantages and no clear-cut decision can be made for using one or other of the two models. The Bradbury model usually gives a lower number of collision victims than the Band model. Use should therefore be made primarily of the numbers obtained from the Band model, not only because in the absence of specific knowledge or data the Birds and Habitat Directives implicitly require the application of the precautionary principle, but also because the methodological update for appropriate assessments (Boon et al. 2012) uses the numbers obtained from the Band model.

Effects at the sub-population level

It must be stressed that the above calculations apply to the populations of the whole southern North Sea. However, Natura 2000 sites which have an additional or special function for some species and which are near to planned wind power initiatives should be given special attention in the assessment under the Nature Conservation Act. For birds, these are the Natura 2000 sites where seagoing birds such as lesser black-backed gull breed. During the breeding season these bird species regularly go on foraging flights within a certain distance of the nesting areas. Cumulative effects on the conservation objectives for these species in these areas are only expected from those initiatives located within this flight range.

The zones in which new wind farms are planned in the Roadmap are mostly beyond the foraging distances of the birds breeding in the Natura 2000 sites. Only lesser black-backed gulls are capable of reaching the wind farms in the Borssele and North Holland Coast zones in relevant numbers. Any significant effects on these species from the relevant Natura 2000 sites are quite separate from the cumulative effects on the populations in the North Sea presented in the FAECE. If new wind farms near these Natura 2000 sites are expected to cause any significant effects, additional mitigation measures will have to be taken.

The cumulative effects from development in the Borssele wind farm zone on the relevant colonies will be examined in the EIA/AA for the designated sites I and II. The cumulative effects of the development of wind farms in the North Holland Coast zone on the colony of lesser black-backed gulls in the Duinen van Texel Natura 2000 site will be examined in the EIA/AA for the strategic planning (scoping) document (structuurvisie) for the 12 mile zone.

4.3 Bats

Knowledge of the presence, behaviour and therefore the sensitivity of bats at sea to operational wind farms is still in its infancy. Nevertheless, there are indications that at least one and possibly three species of migratory bats may fly over the southern North Sea in larger numbers than previously thought. It is also very difficult to relate effects to population numbers, because so little is known about them. The most important species in this regard appear to be Nathusius's pipistrelle, but the parti-coloured bat and the common noctule may also be present. The sparse data that do exist suggest that bats are active over the North Sea almost exclusively at night during spring and autumn when wind speeds are low.

For the time being, the worst case scenario for determining effects is one dead bat per turbine per year. With 8000 turbines in the whole of the southern North Sea, this means an additional 8000 bat deaths per year, mostly of Nathusius's pipistrelle.

5 Assessment of results

In this chapter the calculated results are assessed by comparison with the previously described threshold values in order to draw a conclusion about the possible significance of the effects on the species concerned of the activities in question

5.1 Harbour porpoise

Table 5 lists the calculated effects for the harbour porpoise and the available threshold values from the ASCOBANS agreement.

	Effects	Thresholds
Scenarios	**Additional reduction in harbour porpoise population**	**ASCOBANS**
pile driving for 2 wind farms (WF) in spring	19 000	6375
pile driving for 2 WF in spring + sound limit (German standard 160 dB)	2 600	
pile driving for 1 WF in spring + 1 WF in autumn	16 000	
pile driving for 2 WF in autumn	9 000	
pile driving for 2 WF in spring + sound limit 165 dB	5 300	
pile driving for 2 WF in spring + sound limit 168 dB	7 200	

Table 5. *Effects on the harbour porpoise population of the DCS in relation to ASCOBANS standard*

It is clear that the construction of wind farms in the North Sea will impose a considerable pressure on the harbour porpoise population. Even if only the effects of the construction phase of the Dutch wind farms are taken into account, in only two scenarios do they remain within the ASCOBANS limits.

National/international ratio

If we look at the Dutch contribution to the effects on the harbour porpoise population in the North Sea, it is evident that a considerable proportion of the effects are caused by foreign wind farms, assuming the planned expansion of capacity to 2023 and without mitigation measures (with the exception of Germany, where the currently applicable sound standards have been taken into account).

	Population reduction due to wind farm piling	Population reduction due to Dutch wind farms	Population reduction due to foreign activities
Additional reduction in the population	100 000	19 000	92 500

Table 6. *Effects of unmitigated wind farm construction on the harbour porpoise population of the whole North Sea*

The numbers in table 6 are the results of a scenario in which the effects of the underwater sound from the construction of wind farms are not mitigated. This is because it is not yet known which mitigation measures will be compulsory for the international wind parks. The only exception to this is Germany, where a noise threshold for sound produced during construction is compulsory. This has been taken into account for the international scenario. Table 6 shows that the ASCOBANS limit is exceeded at both the national and international levels and that the Dutch share of the pressure on the total population of harbour porpoise in the North Sea is around 20%. The table clearly shows that mitigation measures are necessary. The contribution to these numbers by the German parks, where the noise threshold is in effect, is much smaller than that of other countries. These effects have been calculated from 500 runs of the model for each scenario. The effects presented here are the average of the results of all these runs, which is why the reduction obtained by adding

up the effects of the Dutch wind farms and those of other countries is not equal to the total reduction.

Conclusions

If we look at the effect of the construction of wind farms on the harbour porpoise population, the thresholds are in danger of being exceeded, both at the national and international levels. It must therefore be concluded that for harbour porpoise significant adverse effects can only be avoided by taking mitigation measures to reduce the sounds emitted during construction.

5.2 Birds

The most relevant research results on bird mortality in the southern North Sea are shown in Table 7. Where several model calculations are available the highest estimate of the potential number of victims has been used.

Species	PBR	Collision mortality	Mortality due to habitat loss
Northern gannet	5 245	2 600	100
Lesser black-backed gull	7 560	14 000	160
Herring gull	4 184	5 800	57
Greater black-backed gull	4 144	4 700	78
Kittiwake	16 473	5 900	730
Guillemot	26 641	450	3 500
Razorbill	7 129	31	550
Great skua	120	14	3
Bewick's swan	131	58	
Red knot	6 099	650	
Sanderling	1 770	380	
Curlew	901	540	
Black tern	43	23	
Starling	139 577	17 000	

Table 7. *Effects of wind farm construction on birds in relation to PBR (number/year)*

VNowhere does the potential loss of habitat lead to reductions in bird populations in the region of the PBR. The species most affected is the guillemot, with an estimated additional mortality of 13% of PBR as a result of habitat loss. It can be concluded that this is not a significant effect. However, population reductions due to collision mortality do exceed the PBR of the lesser and greater black-backed gull and the herring gull. Mitigation measures will therefore be necessary for these species. The measure currently preferred is the use of larger wind turbines with a greater capacity so that fewer will be needed. Possible options are described in Part A and Annex 6.

For the vast majority of bird species the cumulative effects do not appear to be ecologically significant. This means that these populations are not expected to decline as a result of the initiatives considered for the construction of wind farms as set out in the Roadmap. Of course, the effects of all the wind farms do contribute to the additional annual mortality resulting from human activities. If mitigation measures are taken for the three species mentioned above, other species can be expected to benefit as well so that the effects on those species will also be reduced.

For several species of migratory birds with relatively small populations (including curlew, red knot and Bewick's swan) the cumulative effects of collisions with wind turbines at sea have been calculated to be possibly as high as nearly 60% of the PBR. If weather conditions suddenly worsen during an otherwise good day for migration, it is conceivable that in some years the cumulative effects could be closer to or even exceed the PBR. Moreover, these species are already affected by other human activities (e.g. wind power on land, habitat loss, shooting, etc.). Under the Flora and Fauna Act due care should be given to limiting the number of deaths of migratory birds and maintaining the potential for population numbers to increase.

5.3 Bats

The available information on bats is too limited to be able to make a sufficiently reliable calculation of the cumulative effects. Based on the assumption of 8000 additional bat deaths per year described in Chapter 4 and a conservative estimate of the population sizes, the implementation of all the proposed wind farms in the southern North Sea could lead to the PBR for Nathusius's pipistrelle being exceeded.

In line with the precautionary principle implicit in the Birds and Habitats Directives, adequate mitigation measures must be taken for the bats (as long as the behaviour of the bats at sea cannot be determined with greater certainty). A research programme must be set up to obtain a greater degree of certainty about this behaviour in the longer term.

6 Follow-up actions

The assessment of the effects shows that the construction of wind farms as proposed in the Roadmap could lead to significant effects on various protected species. These species are the harbour porpoise, lesser black-backed gull, greater black-backed gull, herring gull, possibly Nathusius's pipistrelle and also conceivably two other species of bat. Under the Flora and Fauna Act due care should also be given to limiting the number of deaths of migratory birds. For the harbour porpoise, the construction of wind farms by other countries and other activities (at least seismic research and fisheries) can already lead to an excessively (and possibly unacceptably) high pressure on the population.

This means that additional measures will be needed to provide adequate protection for these species. Part A of this report mentions mitigation measures that can be used during the construction and operation of wind farms, such as the use of sound reduction measures (which may or may not be based on standards for pile driving) to protect the harbour porpoise, raising the minimum capacity of turbines to protect birds and, in specific circumstances, stopping or almost stopping the rotation of the turbine blades to protect migratory birds and bats.

No conclusions have been drawn regarding specific measures to be taken. Decisions on what measures should be taken and how, will be made when the site decisions and any other planning or environmental decisions are made about the development of offshore wind power. The FAECE provides sufficient information to inform these decisions so that the effects may be considered and appraised in a consistent manner and conclusions may be drawn concerning the necessary measures to be taken.

Measures relating to other activities influencing the species mentioned above fall outside the scope of the FAECE.

Colophon

The Framework for Assessing Ecological and Cumulative Effects of offshore wind farms was drawn up for the Ministry of Economic Affairs by Rijkswaterstaat, under the guidance of an interdepartmental steering group of representatives from the relevant directorates of the Ministry of Infrastructure and the Environment and the Ministry of Economic Affairs.

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