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GUIDANCE DOCUMENT ON ENVIRONMENTAL IMPACT ASSESSMENT

Danish Offshore Wind Farms

PROJECT

Guidance document on Environmental Impact Assessment
Danish Offshore Wind Farms

Danish Energy Agency

This guidance document has been produced by NIRAS for the Danish Energy Agency in close collaboration with the Danish Nature Agency, DONG Energy, Vattenfall and Energinet.dk. Inputs and comments have been received by DCE, Aarhus University, Jens Rydell and Orbicon.

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SUMMARY

Denmark has ambitious goals for the development of renewable energy. A major part of this progress is planned to be within offshore wind development.

This guidance document has been developed for the Danish Energy Agency (DEA). The document complements the current legislation in Denmark with further guidance on the requirements for the Environmental Impact Assessments (EIA) of offshore wind projects.

The aim of the guidance is to support authorities and developers in the impact assessment procedures and methodologies related to the marine natural environment of offshore wind farms (OWF) in Denmark. The documets is limited to marine biological effects and does not cover the elaboration of a full EIA. This guidance document focuses primarily on the EIA phase in its time span from the license for preliminary investigations to the time of being granted the license to establish the wind farm.

The guidance document is split into two parts. Part A (chapters 2-7) introduces the legal framework and the EIA overall process and procedures. Part B (chapters 8-13) presents details related to the marine environment focusing on benthic flora and fauna, fish, marine mammals, bats and birds. The second part of the guidance document is primarily based on experience from Danish and other European studies and includes acknowledged survey methods, requirements for documentation, testing methods and, wherever possible, guidance for analytical methods and extent.

Part A

The EIA process will be initiated when the licence for preliminary investigations has been issued by the DEA. In advance, the developer has normally made an application to the DEA for EIA and preliminary investigations including a description of the proposed project. The license will outline the main topics that should be described and evaluated within the EIA report.

The EIA is to include the activities related to construction, operation and decommissioning of the complete project, including e.g. foundations, turbines, substations and cables offshore as well as onshore cables and transformerstation.

The first step for the developer after receiving the license for preliminary investigations will be to identify potential site-specific surveys and agree the scope of work with the relevant authorities for survey requirements. It is recommended for the developer to consider scoping as part of the preparatory application process to facilitate the identification of the potential significant impact of the project at an

early stage. Attention must be given to relevant Natura 2000 issues to ensure that an Appropriate Assessment (AA) of the impacts on Natura 2000-protected sites, species and marine habitats can be performed, if required.

The content of the EIA shall fulfill the requirements in Annex 2 of the Danish regulation on EIA offshore wind (executive order no. 68, 26/01/2012), including a description of the project, alternative projects, the environment, impact assessment, assessment of cumulative effects, mitigation measures and a post-construction monitoring programme.

Impact assessment includes the prediction of the potential impact of the wind farm project on the physical/chemical, human and natural environment during the lifetime of the project: construction, operation and decommissioning. The impact assessment shall also include cumulative impacts which result from incremental changes caused by other past, present or planned projects or activities in combination with the applied project.

Where the environmental impacts of an OWF project are assessed to be significant or severe, it may be necessary to adopt mitigation measures, and in some cases the DEA requires a monitoring programme to obtain knowledge about specific issues during the operation phase. If servere impact cannot be mitigated the DEA can reject the approval of the project.

This guidance document describes the process, the legal framework, the responsibilities of regulators and developers and the methodologies to be applied in the EIA for an OWF in Denmark.

Part B

Part B of this guidance document describes the assessment methodologies for the marine biological environment related to offshore windfarms. The following biological groups of species have been selected: benthic flora, fauna and habitat types, fish, marine mammals, bats and birds.

The key impact issues are described for each group of species. The main aspects related to existing data, field surveys, data analysis and assessment are included or referenced to in this guidance document.

SAMMENFATNING

Danmark har ambitiøse mål for udviklingen af vedvarende energi, og det er planen, at en stor del af denne udvikling skal ske inden for udviklingen af havmøller.

Energistyrelsen har foranlediget udabejdelsen af denne vejledning om miljøvurdering af det marinbiologiske miljø. Vejledningen skal ses som et værktøj der kan hjælpe med at operationalisere de eksisterende love og bekendtgørelser om vurderinger af virkningerne på miljøet (VVM) i forbindelse med anlæg af nye havmølleprojekter.

Målet med vejledningen er at understøtte myndigheder og bygherrer i miljøvurderingsprocedurer og -metoder i forbindelse med VVM af havmølleparker i Danmark. Denne vejledning fokuserer primært på VVM-fasen og den påkrævede dokumentation, der skal til for at opnå etableringstilladelse. VVM'er igangsættes på basis af en forundersøgelsestilladelse, der udstedes af Energistyrelsen.

Vejledningen er opdelt i to. Del A (kapitel 2-7) præsenterer de lovgivningsmæssige rammer og den overordnede VVM-proces og -procedurer. Del B (kapitel 8-13) angiver nærmere detaljer for havmiljøet med fokus på bentisk flora og fauna, fisk, havpattedyr, flagermus og fugle. Vejledningens anden del er hovedsageligt baseret på erfaringer fra danske og andre europæiske undersøgelser og indeholder anerkendte undersøgelsesmetoder, dokumentationskrav, analytiske metoder og vurderingsmetoder.

Del A

VVM-processen indledes, når Energistyrelsen har udstedt en forundersøgelsestilladelse. Bygherren har forinden indsendt en ansøgning til Energistyrelsen, hvori der er en beskrivelse af det foreslåede projekt. Forundersøgelsestilladelsen skitserer de hovedemner, der skal medtages og vurderes i VVM-undersøgelsen.

VVM'en skal indeholde de aktiviteter, der er forbundet med opførelse, drift og nedtagning af det samlede projekt, herunder fundamenter, turbiner, transformerstationer og kabler, både marint og på land.

Første skridt for bygherren, efter modtagelse af forundersøgelsestilladelsen, vil være at igangsætte potentielle områdespecifikke undersøgelser. Arbejdsprogrammet kan aftales med relevante myndigheder. Man skal fra et tidligt tidspunkt være opmærksom på Natura 2000 beskyttede områder og - arter, der kan påvirkes af projektet, for at sikre afklaring af, om der vil være behov for konsekvensvurderinger i forhold til habitatdirektivet.

Indholdet i VVM'en skal opfylde kravene angivet i *Bekendtgørelse om vurdering af virkning på miljøet (VVM) ved projekter om etablering m.v. af el-*

produktionsanlæg på havet (BEK nr. 68 af 26. januar 2012), herunder en beskrivelse af projektet, alternative projekter, miljøet, som kan blive berørt af det forestående projekt, miljøpåvirkninger og eventuelle afværgeforanstaltninger.

VVM'en skal omfatte en vurdering af den potentielle påvirkning af havmølleprojektet på det fysiske/kemiske, menneskelige og naturlige miljø i projektets levetid: opførelse, drift og nedtagning. Miljøvurderingerne skal også omfatte vurdering af de kumulative påvirkninger, der skal inddrage nuværende eller planlagte projekter eller aktiviteter i kombination med det ansøgte projekt.

Såfremt det vurderes, at virkningerne på miljøet fra et havmølleprojekt vil være betydelige eller alvorlige, kan det være nødvendigt at indføre afværgeforanstaltninger, og i visse tilfælde kan Energistyrelsen påbyde et monitoreringsprogram for at opnå viden om specifikke miljømæssige forhold i driftsfasen. Såfremt foranstaltningerne ikke kan afværge betydelige miljøpåvirkninger kan Energistyrelsen se sig nødaget til at afvise projektet.

Denne vejledning beskriver processer, tilladelser, lovgivningsmæssige rammer og ansvarsfordeling mellem bygherre og myndigheder i forhold til VVM vurderinger af havvindprojekter i Danmark.

Del B

Denne vejlednings del B beskriver vurderingsmetoderne for det marinbiologiske miljø i forbindelse med anlæg og drift af havmølleparker. Følgende biologiske grupper er indeholdt i vejledningen: bundfauna og -flora, marine habitattyper, fisk, havpattedyr, flagermus og fugle.

De væsentligste påvirkningsforhold beskrives for hver enkelt gruppe. Vejledningen indeholder hovedaspekterne, der bør medtages i en VVM i forbindelse med indsamling af eksisterende data, feltundersøgelser, dataanalyse og vurdering.

1 INTRODUCTION

Considerable knowledge about the impact of wind farms on the environment exists, primarily accumulated through the environmental demonstration programmes and monitoring of e.g. cumulative effects, but also from monitoring programmes abroad. This knowledge can, in many cases, form a baseline of some elements of the EIA and impact assessment in a new project for the identification and assessment of environmental effects.

1.1 Objective and target group

The aim of this guidance document is to support authorities and developers in focusing and mainstreaming the impact assessment procedures and methodologies for offshore wind farms in Denmark.

This guidance document is targeted towards relevant environmental research, methodologies and analyses. It can provide support to the developers on the EIA process, and it can facilitate the authorities when setting up requirements in license conditions. The document is based on existing knowledge from Danish offshore wind farm projects and relevant experience from abroad.

This guidance document is restricted to covering only environmental impact assessment related to the marine natural environment of the offshore wind farms. It covers the construction, operation and decommissioning of the offshore wind farm, including foundations, turbines, offshore substation and offshore cables.

This document focuses on the EIA phase, which in its time span is from the license for preliminary investigations to the time of being granted the license to establishment of the wind farm.

1.2 Instruction to readers

This EIA guidance document is split in two individual parts. The first part (Part A) introduces the legal framework, the EIA overall process and procedures including detailed guidance on appropriate assessments (AAs), the consultation and public hearing procedures and finally the license conditions.

The second part (Part B) presents details related to the marine environment focusing on benthic flora and fauna, fish, birds, bats and marine mammals. Based on Danish and European studies, acknowledged survey methods are described and requirements for documentation and testing methods are listed for each species group. Wherever possible, guidance for analytical methods and extent are included. In conclusion, an extensive bibliography is included where further information can be sought if required.

1.3 Abbreviations

This section reviews the abbreviations used in the following sections of the guidance document.

Table 1-1 Commonly used abbreviations

Abbreviation	Description
AA	Appropriate Assessments
BACI	Before/After-Control/Impact
CIA	Cumulative Impact Assessment
CPUE	Catch Per Unit Effort
DCE	Danish Center for Environment and Energy
DEA	Danish Energy Agency
DNA	Danish Nature Agency
DOF	Dansk Ornitologisk Forening/Danish Ornithological Society
EIA	Environmental Impact Assessment
EMF	Electromagnetic Ffields
HRA	Habitat Regulation Assessment
ICES	The International Council for the Exploration of the Sea
IUCN	International Union for Conservation of Nature
LSE	Likely Significant Effect
NERI	National Environmental Research Institute
OWF	Offshore Wind Farm
POD	Acoustic porpoise Detectors
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SPA	Special Protection Areas
TADS	Thermal Animal Detection System

Part A

2 LEGAL FRAMEWORK

This chapter contains a list of European and national legislation relevant to the Environmental Impact Assessment (EIA) and Appropriate Assessments (AA) of offshore wind farm projects. The legislation having direct influence on the assessments of the marine environment is included. In addition, a number of other laws and regulations which may be relevant in relation to environmental assessment on land are listed.

2.1 European legislation and international conventions

- EIA Directive (2011/92/EU)
  http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:026:0001:0021:EN:PDF
- Habitat Directive (92/43/EEC)
  http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm
- Birds Directive (2009/147/EC)
  http://ec.europa.eu/environment/nature/legislation/birdsdirective/index_en.htm
- Water Framework Directive (2000/60/EC)
  http://ec.europa.eu/environment/water/water-framework/index_en.html
- Marine Strategy Framework Directive (2008/56/EC)
- Espoo Convention with first and second amendments. Environmental impact assessment in a transboundary context
  http://www.unece.org/env/eia/eia.html
- OSPAR Convention. The Oslo – Paris Convention for protection of the marine environment in the north east Atlantic Ocean
  http://www.ospar.org
- HELCOM. Helsinki Commission. Protection of the Baltic Sea
  http://www.helcom.fi
- The Aarhus Convention on access to information, public participation in decision-making and access to justice in environmental matters (25 June 1998)
  http://ec.europa.eu/environment/aarhus/

2.2 EU guidelines

- Guidance on EIA. Screening. June 2001
  http://www.naturstyrelsen.dk/Planlaegning/Miljoevurdering_og_VVM/Lovgivning_for_miloevurdering/Vejledninger_VVM/
- Guidance on EIA. EIS Review. 2001
  http://www.naturstyrelsen.dk/Planlaegning/Miljoevurdering_og_VVM/Lovgivning_for_miloevurdering/Vejledninger_VVM/
- Guidance on the Assessment of indirect and Cumulative Impacts as well as Impact Interactions. 1999

http://www.naturstyrelsen.dk/Planlaegning/Miljoevurdering_og_VVM/Lovgivning_for_miloevurdering/Vejledninger_VVM/

- Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC http://ec.europa.eu/environment/nature/natura2000/management/guidance_en.htm
- Guidance on the Practical Application of the Espoo Convention http://www.unece.org/env/eia/guidance/welcome.html
- EU Guidance document on wind energy development in accordance with EU nature legislation. 2010 http://ec.europa.eu/environment/nature/natura2000/management/docs/Wind_farms.pdf

2.3 National legislation

- Wind Energy act: VE-loven. Bekendtgørelse af lov om fremme af vedvarende energi (LBK nr. 1074 af 08/11/2011) https://www.retsinformation.dk/forms/r0710.aspx?id=139075
- Offshore Wind EIA act: Bekendtgørelse om vurdering af virkning på miljøet (VVM) ved projekter om etablering m.v. af elproduktionsanlæg på havet (BEK nr. 68 af 26. januar 2012) https://www.retsinformation.dk/Forms/R0710.aspx?id=140308
- Appropriate Assessment act: Bekendtgørelse om konsekvensvurdering. Bekendtgørelse om konsekvensvurdering vedrørende internationale naturbeskyttelsesområder samt beskyttelse af visse arter ved projekter om etablering m.v. af elproduktionsanlæg og elforsyningsnet på havet (BEK nr. 1476 af 13/12/2010) https://www.retsinformation.dk/Forms/R0710.aspx?id=134988
- EIA act: VVM-Bekendtgørelsen. Bekendtgørelse om vurdering af visse offentlige og private anlægs virkning på miljøet (VVM) i medfør af lov om planlægning1) (Bek. nr. 1510 af 15/12/2010) https://www.retsinformation.dk/Forms/R0710.aspx?id=134469
- Habitat Directive act: Habitatbekendtgørelsen. Bekendtgørelse om udpegning og administration af internationale naturbeskyttelsesområder samt beskyttelse af visse arter (Bek. nr. 408 af 1. maj 2007 med ændringer) https://www.retsinformation.dk/Forms/r0710.aspx?id=13043

In addition, all projects should consider the following listed legislation:

- Marine Strategy act: Lov om havstrategi (LOV nr. 522 af 26/05/2010) https://www.retsinformation.dk/Forms/R0710.aspx?id=131991
- Environmental act: Miljømålsloven. Bekendtgørelse af lov om miljømål m.v. for vandforekomster og internationale naturbeskyttelsesområder (Miljømålsloven) (LBK nr. 932 af 24/09/2009) https://www.retsinformation.dk/Forms/R0710.aspx?id=127102

- Nature Protection act: Naturbeskyttelsesloven. Bekendtgørelse af lov om naturbeskyttelse (LBK nr. 933 af 24/09/2009) https://www.retsinformation.dk/Forms/R0710.aspx?id=127104
- Energinet.dk act: Bekendtgørelse af lov om Energinet.dk (LBK nr. 1097af 08/11/2011) http://retsinformation.w0.dk/Forms/R0710.aspx?id=124121
- Wildlife Management act: Bekendtgørelse af lov om jagt og vildtforvaltning (LBK nr. 930 af 24/09/2009) https://www.retsinformation.dk/Forms/R0710.aspx?id=127099

2.4 National guidelines

- Habitat Directive guidelines: Vejledning til Habitatbekendtgørelsen (VEJ nr. 408 af 01/05/2007) http://www.naturstyrelsen.dk/Nyheder/Vejledning_til_Habitatbekendtgoerelsen.htm
- EIA guidelines: Vejledning om VVM i Planloven (VEJ nr. 9339 af 12/03/2009) http://www.naturstyrelsen.dk/Planlaegning/Miljoevurdering_og_VVM/Lovgivning_for_miloevurdering/Vejledninger_VVM/
- Noise guidelines: Støj fra vindmøller. Vejledning fra Miljøstyrelsen nr. 1. 2012 http://www2.mst.dk/Udgiv/publikationer/2012/05/978-87-92903-08-2.pdf

3 LICENSE FOR PRELIMINARY INVESTIGATIONS

A license for Environmental Impact Assessments (EIA) and preliminary investigations will be granted by the Danish Energy Agency (DEA) before environmental surveys for the proposed wind farm can be initiated. The license will outline the main topics that should be described and evaluated within the EIA report. The license is valid for a limited period (typically one year) after which an EIA report must be submitted to the DEA.

3.1 Application

The application for EIA and preliminary investigations from the developer shall be submitted to the DEA and must as a minimum include:

- A description of the project
- Proposed size and number of turbines
- Location of the project and boundaries of the project area
- The expected magnitude of environmental and seabed surveys

In order to make an application that is sufficiently detailed it will often be necessary to complete the scoping process in advance; see section 4.2.

3.2 Hearing of relevant Danish and foreign authorities

Upon receiving the application, the DEA will consult with relevant Danish authorities to clarify whether there would be concerns about the development or if any authorities require site-specific surveys completed as part of the EIA.

If the project can potentially have transboundary environmental impacts in other EU member states, the DEA will request the Danish Nature Agency (DNA) to conduct a hearing of the relevant authorities, including provide information to the particular country on the project and the potential transboundary impacts. Likewise, information regarding the project will be provided by DNA to other countries which may not be EU member states but which have agreed to the Convention on Environmental Impact Assessment in a Transboundary Context of 25 February 1991 (Espoo Convention). Further information on the Espoo Convention is given in section 6.4.

3.3 License

Based on the hearing of authorities, the DEA decides if a license for preliminary investigations shall be granted to the proposed project. If so, the license will be issued allowing the developer to carry out environmental and seabed surveys. The license will also contain details on the minimum requirements of the preliminary investigations by the authorities which must form part of the EIA process and report.

4 EIA

Projects likely to significantly affect the environment are obliged to go through an Environmental Impact assessment (EIA). The Danish regulation on EIA offshore wind found in executive order no. 68, 26/01/2012 specifies the procedure for the EIA regarding electricity-producing installations. This regulation also includes the implementation of the conditions related to the EU EIA Directive (2011/92/EU).

The EIA is required to cover the complete project including offshore and onshore installations and related industries. The EIA shall include the activities related to construction, operation and decommission of the complete project, including e.g. foundations, turbines, substations and offshore inter-array and export cables as well as the onshore part of the project consisting of cables and potential substations.

The onshore part of the project shall cover the area of the planned cable corridor and the transformer station. The onshore procedure is briefly described in the following paragraph, though it should be specified that this document only provides guidance for the offshore marine environment.

For the onshore part of the project, the first step will be to make a screening of the landuse of the planned area, including urban development, agriculture, protected nature, cultural heritages etc. Data is gathered from www.miljoeportalen.dk and from municipality administrations. Scoping is carried out as a part of a preliminary public hearing that the Danish Nature Agency (DNA) is responsible for. Usually a pamphlet informing of the project and the likely environmental impact is produced and submitted to the public, as the part of the hearing process. The DNA will collect the comments and guide on the type of potential investigations to be included in the EIA. The investigations often involve flora / fauna surveys including species on the Annex IV of the Habitat Directive and visualization of the planned transformer station. The EIA will go through a second public hearing, before it may be approved.

The remaining of this guidance document will focus only on the offshore environment.

4.1 EIA process

The Danish Energy Agency (DEA) is the responsible authority for the EIAs for offshore wind farm developments. The DEA will be coordinating the inputs from relevant authorities and hearing processes during the EIA.

Upon request from the DEA, the Danish Nature Agency (DNA) will be responsible for managing a potential hearing of neighbouring countries. If the impacts are likely to have transboundary effects, the DNA will notify the affected countries in compliance with the Espoo Convention. The process of the EIA is shown in **Fejl! Henvisningskilde ikke fundet.**.

On the basis of the developer's application and preliminary Appropriate Assessment (AA) the DEA will evaluate whether the project might have an impact on Natura 2000 sites or species. If a species or a site might be affected by the project, the developer must perform an AA of the particular site or species as part of the EIA. In this case, the AA shall be highlighted in the EIA report or in a separate report.

The EIA process is initiated when the developer has received the licence for preliminary investigations. The scoping process related to the application is also described in brief in these guidelines. The scoping is closely linked to the following EIA as described below.

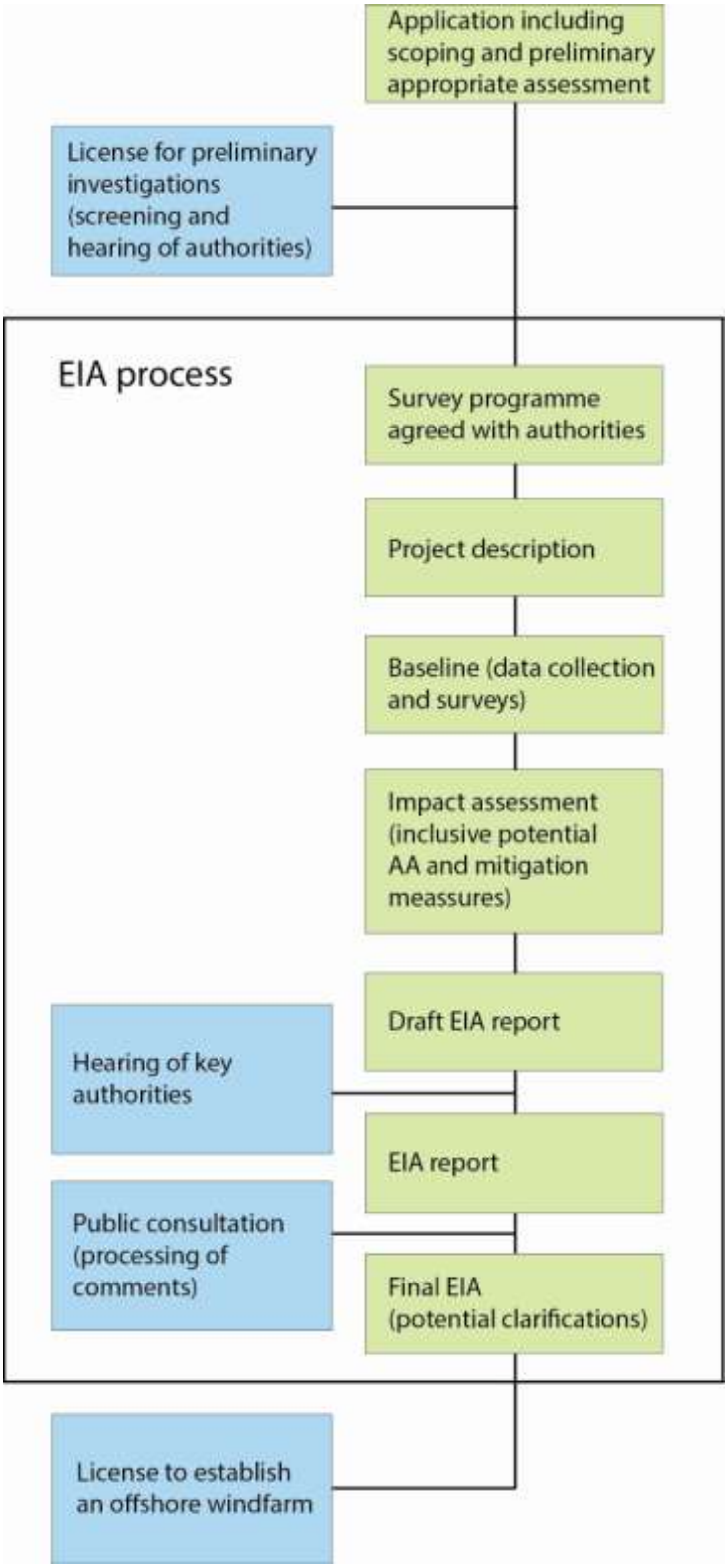


Figure 4-1 EIA Process with boxes in blue indicating authority responsibilities, and boxes in yellow indicating the developers' responsibilities.

4.2 Application to the DEA including scoping of the project

The developers first step in the formal procedures to erect a wind farm is the submission of the application for preliminary investigations. It should be clear whether the project is a new offshore wind farm (OWF), an alteration or extension of an existing OWF or a pilot project. The reason for this is that alterations and extensions do not always require an EIA. Only an overall description of the wind farm components will be required at this stage. The detailed design will not have to be completed before approval of the EIA.

It is recommended for the developer to consider scoping as part of the preparatory application process to facilitate the identification of the potential significant impact of the project at an early stage.

Scoping is the process of early identificatin of the overall framework, content and extension of the EIA. Scoping primarily identifies the most important issues to be addressed during the EIA and will identify potential site-specific surveys required during the EIA. Scoping is based on existing knowledge of environmental aspects in the project area and will facilitate the subsequent work with EIA investigations and reporting.

Scoping is *not a formal requirement* within Danish legislation or by the regulators, but it may support the developer in a *strategic decision* to proceed with a project. The scoping should identify potential major environmental impacts that may arise from the project, or potential extensive survey requirements, and therefore facilitate an early clarification with the regulators, if needed.

During scoping special attention must be given to Natura 2000 sites and species designations in the vicinity of the development (offshore as well as onshore). Potential significant impacts on Natura 2000 designations can pose a high risk for a project not being granted a license at a later stage. An early identification of potential impacts on Natura 2000, can therefore facilitate an early identification of potential mitigation measures that may be required, e.g. surveys required or adjustment of the wind farm layout.

In Chapter 5 further details on the assessment according to the habitat regulations, including an assessment of Likely Significant Effects (LSE) and AA, are presented.

4.2.1 Scoping form

It is recommended to use a scoping form or a matrix to present the overview of the preliminary assessment.

In Table 4-1 an example of a table structure is presented.

Table 4-1 Example of scoping form

Issue	Natura 2000 relevant	Key impact (noise, disturbance, displacement, habitat degradation etc.)	EIA approach (surveys, modelling or impact assessment)	Recommendation (methods, frequencies etc.)
Harbour seal (*Phoca vitulina*)	Not relevant No high densities of Harbour Seal are expected in the area (based on existing survey data from nearby areas)	Injuries and displacement because of construction noise	There are no breeding areas nearby and the area does not have special importance to the species. It is sufficient to make impact assessment based on existing knowledge	No surveys expected
Land-bird migration	Not relevant There are no Natura 2000 Special Protection Areas for birds nearby. Though there may be effects on long distance migratory birds	Risk of collision during migration and barrier effect	Little is known about the extent of long-distance migration in the area. In order to evaluate effects surveys can be required	Migration survey may be required. Only visual observations are expected, no radar surveillance expected
Sediment dispersion	Yes relevant Sedimentation might impact reefs in nearby Natura 2000 site	Potential change of habitat for fish and benthos, and degradation of certain nature types such as reefs. Coast morphology impact	Project can involve sediment dispersion close to protected reefs. In order to evaluate effects on sedimentation a model may be required	No surveys expected. It may require modelling of scenarios of the extent of sediment plumes during construction
Etc.				

Based on the scoping of the projects' EIA, potential major environmental risks will be identified at an early stage. The results of the scoping should be submitted to the DEA together with the application for the project.

4.3 License for preliminary investigations

When the developer submits an application for the project, the DEA will assess if the project is subject to EIA according to the criteria in Annex 2 of the Danish regulations on EIA offshore wind. It has always been the case that new OWFs must carry out an EIA. The DEA will be hearing relevant authorities for potential concerns related to the proposed development ("one stop shop"). The authorities will identify key concerns and list survey requirements (if required) in the license for preliminary investigations.

4.4 Data collection and survey requirements

The first step for the developer after receiving the License for preliminary investigations will be to identify potential site-specific surveys and agree the scope of work with the relevant authorities for survey requirements. If a scoping process has been completed, the baseline for this work can be reused again at this stage.

If the scoping process has not been completed at an earlier stage of the project it can also be included at this stage. A minimum requirement will be to complete a detailed desk-based data collection. Based on the existing data and experience from other wind farms the scope of work for potential surveys can be defined and agreed with the DEA.

If there is not sufficient knowledge on the relevant environmental aspects identified as a concern by the authorities, environmental investigations (modelling or surveys) must be performed.

When planning the environmental investigations attention must be given to relevant Natura 2000 issues. This must be done to ensure that an AA of the impacts on Natura 2000-protected sites, species and marine habitats can be performed if required. When environmental investigations have been performed, the EIA report can be completed.

4.5 EIA report

The individual steps in the EIA is described in the following.

The contents of the EIA shall fulfil the requirements listed in Annex 2 of the Danish regulation on EIA offshore wind (see text box below). The individual sections of an EIA report are explained below the text box.

Minimum requirements for the contents of the EIAs

1. **Description of the project**, including:
   - The physical characteristics of the whole project and the land-use requirements during the construction and the operational phases
   - The main characteristics of the production processes, such as nature and quantities of the materials used
   - An estimate, by type and quantity, of expected residues and emissions (water, air and soil pollution, noise, vibration, light, heat, radiation, etc.) resulting from the operation of the proposed project
2. **Outline of the main alternatives** studied by the developer and an indication of the main reasons for the choices made taking into account the environmental effects.
3. **Description of the aspects** of the environment likely to be significantly affected by the proposed project, including in particular population, fauna, flora, soil, water, air, climatic factors, material assets, including the architectural and archaeological heritage, landscape, and the inter-relationship between the above factors, and socio economic effects*.
4. **Description of the most likely significant effects** of the proposed project on the environment resulting from:
   - The existence of the project
   - The use of natural resources
   - The emission of pollutants, the creation of nuisances, the elimination of waste and the description by the developer of the forecasting methods used to assess the effects on the environment
5. **Description of the measures** envisaged to prevent, reduce, and where possible offset any significant adverse effects on the environment.
6. **Non-technical summary** of the information provided under the above headings.
7. **Indication of any difficulties** (technical deficiencies or lack of knowhow) encountered by the developer in compiling the required information.

*The socio-economic description will cover the direct effects and any indirect, secondary, cumulative, short, medium- and long-term, permanent and temporary, positive and negative effects of the project.

4.5.1 *Non-technical summary*

The EIA report must contain a short non-technical summary of the information in the EIA report. This summary shall be easy to understand and enable non-experts as well as experts to get a brief overview of the specific project and its environmental impacts.

4.5.2 *Description of project*

The EIA report must cover a full description of the project offshore as well as onshore, including:

- A description of the area required for the OWF as well as the area where environmental effects may occur
- A description of the main technical characteristics of the project, for instance the number, size and placing of turbines, type of foundation, internal and external cable connections, the nature and quantity of all materials used, activities related to the project such as vessel traffic, etc. A detailed design is not required at this stage. Instead ranges of e.g. sizes of wind turbines, types of foundations can be described
- An estimate of all influences of the project on the environment (water, air and soil pollution, noise, vibration, light, heat, radiation, etc.). Ideally, the description should estimate the influences for the individual three phases, construction, operation and decommissioning, separately.
- The expected time schedule for the project, especially the construction phase

4.5.3 *Alternatives to the project*

The EIA report must outline the main alternative approaches to the project. The alternatives that have been considered could include:

- Alternative geographical sites
- Alternative design of the OWF (e.g. placing of turbines or no. of turbines)
- Alternative technical characteristics of the project (e.g. turbine size or foundation type)
- Alternative phasing of construction

Describing and selecting alternatives is a way of optimising the project. Furthermore, description of alternatives provides information about the considerations that the developer and authorities have made about the possibility of other approaches.

The choice of the preferred alternative should involve an overall comparison of the environmental effects of the alternatives considered. Where no alternatives are considered (e.g. if there are no other potential sites), the reason why alternatives are not feasible should be explained.

Furthermore, an alternative has to be described including the consequences if the project is not carried out (the 0-alternative).

4.5.4 *Description of the environment*

In order to assess the environmental impacts and effects of the OWF the developer must first fully understand the marine environment of the site and the surrounding area.

The developer must provide appropriate environmental data in order to make it possible to predict and evaluate environmental impacts. This data can come from a number of sources, e.g. desk-based studies, surveys and modelling.

For issues where there is a lack of available data the earlier phases of the EIA should have initiated modelling or survey efforts in order to obtain sufficient additional data for the impact assessment.

The main emphasis should be on issues where the project is likely to give rise to significant effects. In some cases, only a few of the issues will need to be assessed in the EIA in great depth. Where issues have minor or no significant impact, the description may be less detailed though indicating that the issues have been considered and assessed.

4.5.5 *Impact assessment*

Impact assessment includes the prediction of the potential impact of a wind farm project on the physical/chemical, human and natural environment.

Assessing impact is a difficult task which can be compromised by an incomplete understanding of significance, poor data or poor assessment, and complex process interactions. The assessment of environmental impacts therefore often requires highly specialised expertise and may involve a number of analytical techniques. Therefore, the developer often needs to consult qualified environmental specialists to predict and evaluate environmental impacts and to advise on their potential mitigation measures.

The methods used to predict the environmental impacts of the project must be described and a justification of the methods should be included. This is to allow the reader to assess whether the selected analyses are appropriate.

The scale of impacts has to be classified, and the assessment of whether an impact is significant or not should be clearly defined in the EIA report. Ecological thresholds and criteria must be defined and described.

To ensure that the environmental assessment methods are consistent, and robust it is recommended to choose a pre-defined and commonly used methodology for the impact assessment. This will ensure that the EIA is transparent and the report coherent and easy to read. An example of how this can be done is attached to this guidance document (Annex 1).

The assessment should estimate the impacts for the three phases of the projects, construction, operation and decommissioning, respectively.

Cumulative impact assessment

Cumulative impacts are impacts that result from incremental changes caused by other past, present or planned projects or activities in combination with the applied project. Such projects or activities are not only other OWFs; it could also be e.g. oil and gas activities, dredging and other offshore activities.

Many environmental effects can be minor and only become apparent in a cumulative assessment. These effects may be individually acceptable, but might cumulatively result in a severe significant impact. These circumstances shall be assessed and presented in the EIA report.

To correctly assess cumulative impacts it is necessary to identify all past, existing and future actions relevant to the area of the planned OWF. The maximum geographic range of impacts from the OWF can be used to determine the area for which assessment of cumulative impacts shall be covered. If for instance drilling operations in connection with exploration and production of hydrocarbons are carried out in an area close to the planned construction area of OWFs, cumulative impacts of noise on e.g. mammals have to be considered in the EIA.

A number of factors may influence the approach adopted for the assessment of cumulative and in-combination impacts for a given project. The method applied should be suitable for the project, given the data, time and information available. The geographic range of a cumulative impact assessment (CIA) also vary considerably depending on the subject to be assessed (see box below). A summary of different methods is given in the EU Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions (Walker & Johnston, 1999).

Boundaries of a cumulative impact assessment (CIA)

The boundaries in the CIA will vary considerably depending on the issue for the CIA. If you e.g. assess marine archaeology in your CIA the delineation will be rather limited in geographic range since effects are only considered locally, whereas if you assess migrating birds in your CIA the delineation may cover various countries along the migrating bird route.

4.5.6 *Mitigation measures*

Where the environmental impacts of an OWF project are assessed to be significant and severe, it may be necessary to adopt mitigation measures.

Potential mitigation measures will be described in the license to establish the offshore wind farm granted by the DEA. Therefore, it is recommended that mitigation measures are agreed with the DEA as early as possible during the EIA process.

Ideally, mitigation measures are an integral part of the initial planning phases of the OWF project. This can provide opportunities to 'design out' or reduce effects by, e.g. optimisation of the construction procedures or adjustments of the construction timetable. The incorporation of mitigation measures at a later stage may not be possible and, if it is, considerable delay in the process may result.

If the mitigation (and monitoring) measures described in the EIA report are adequate for dealing with the impacts of the OWF project, the level of significance will decrease. This can enable the DEA to grant a license for the project.

4.5.7 *Monitoring programme*

Danish regulation on EIA offshore wind does not require a description of a monitoring programme as part of the EIA. However, in some cases the DEA can require a monitoring programme to obtain knowledge of a specific issue e.g. to assess if a mitigation measure has the effect predicted in the EIA.

Monitoring can provide valid information about the real impact from construction or operation of the wind farm. Data can be compared using the BACI principle (Before-After-Control-Impact) where environmental survey data is compared from a baseline situation before construction and then compared to the observed situation post construction.

5 APPROPRIATE ASSESSMENT (AA)

This chapter describes the process, methods and terminology used for impact assessment on offshore wind farms (OWF) located within or close to one or more Natura 2000 sites or affecting Annex IV species (species which are strictly protected under Annex IV of the EU Habitats Directive). The overall process is called Habitat Regulation Assessment (HRA), with Appropriate Assessment (AA) being a part of this process.

5.1 Background

Whenever there is a risk of a project significantly affecting an International Nature Conservation designation, an AA must be carried out according to executive order no. 1476 13/12/2010 (Bekendtgørelse om konsekvensvurdering vedrørende internationale naturbeskyttelsesområder samt beskyttelse af visse arter ved projekter om etablering m.v. af elproduktionsanlæg og elforsyningsnet).

The process of a Habitat Regulation Assessment (HRA) is a stepwise approach, where the first stage is a screening process to assess if a project is likely to have a significant effect on a Natura 2000 site or an annex IV species. If so, the second stage is required which includes the AA. The process of the AA is described in detail in the EU guide: Assessment of plans and projects significantly affecting Natura 2000 sites, and in the EU Wind Energy Developments and Natura 2000 guidance document from 2010 (Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC, November 2001).

The EU nature conservation designations include Special Areas of conservation (SAC), Special Protection Areas (SPAs) and Ramsar sites. The SAC and SPA are the areas included under the EU Natura 2000 network (Figure 5-1). It is an EU-wide network of geographic areas and species protection established under the 1992 Habitats Directive. The aim of the network is to assure the long-term survival of Europe's most valuable and threatened species and habitats. It is comprised of SAC designated by Member States under the Habitats Directive, and also the SPA which they designate under the 1979 EC Birds Directive.

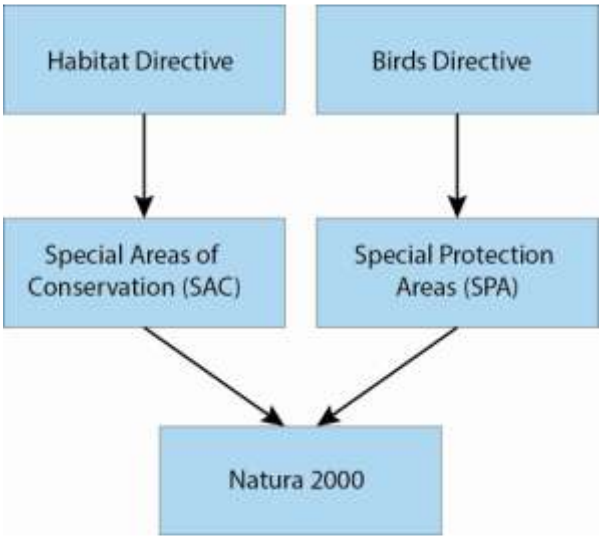


Figure 5-1 The EU Natura 2000 network.

5.2 Habitats Directive

The principal aim of the Habitats Directive is to sustain biodiversity through the conservation of natural habitats and wild fauna and flora in the European Member States.

The Habitats Directive also provides strict protection of certain species outside Natura 2000 sites. These are named Annex IV species and apply to marine species as well as terrestrial species (e.g. harbour porpoise and bats). An OWF project must not deteriorate or destroy the breeding sites, resting places or foraging sites of these species.

An authority is not allowed to give a permission to a plan or a project before a screening has proven, on the basis of the best available scientific knowledge, that the plan or project has no significant effect on the Natura 2000 site or affecting Annex IV species. The Directive requires that any activities, plans, or projects whether inside or outside a Natura 2000 site, that are likely to have a significant effect (LSE) on the conservation status of the protected habitats and/or species, shall be subject to an AA.

Therefore, where an OWF is located within, or would be likely to significantly affect a designated or proposed Natura 2000 site, it is required according to legislation to carry out an AA.

It is recommended to clarify with the Danish Energy Agency (DEA) as early as possible whether it is necessary to carry out an AA or not. An AA can potentially require targeted surveys and mitigation measures to the project.

5.3 Birds Directive

The principal aim of the Birds Directive is to protect birds, their eggs, nests and habitats in the European Member States. This is achieved in the same way as for the Habitats Directive through the establishment of Natura 2000 sites and identification of sensitive species.

Apart from the fact that the sites designated with reference to the Birds Directive, are only established to protect birds, there are no fundamental differences in the way that a LSE and an AA is carried out between sites designated with reference to the Birds Directive and the Habitats Directive.

5.4 Stage 1: Screening

Every project that could potentially affect (a) Natura 2000 site(s) and/or Annex IV-protected species, should initially be considered as a candidate for AA. But an AA will only be required for those with an LSE on the designation. A flowchart describing the overall provisions of Article 6(3) and (4) of the Habitat Directive is presented in Figure 5-2.

The first step of the Habitat Regulation Assessment include a screening process to determine whether or not an AA is actually needed. If it can be determined with certainty that the project is not likely to have a significant effect, either individually or in combination with other plans or projects, then the project can be approved without further AA.

If there is any doubt, then an AA will need to be undertaken so that these potential effects are studied in full before a decision is taken on whether to approve the project. It is ultimately for the DEA to decide, in the light of screening, whether or not an AA is required.

Screening is required for projects affecting sites classified under the Birds Directive and sites designated or proposed to be designated under the Habitats Directive. Projects located inside a Natura 2000 site shall be included, but locations outside Natura 2000 can also be required for screening if they are likely to have a significant effect on a Natura 2000 site or if an annex IV species is significantly affected.

The ‘likelihood’ of potential significant effects should be considered in the light of the conservation objectives, the characteristics and the specific environmental conditions of the site. Projects likely to undermine the site’s conservation objectives must be considered to have a significant effect on that site.

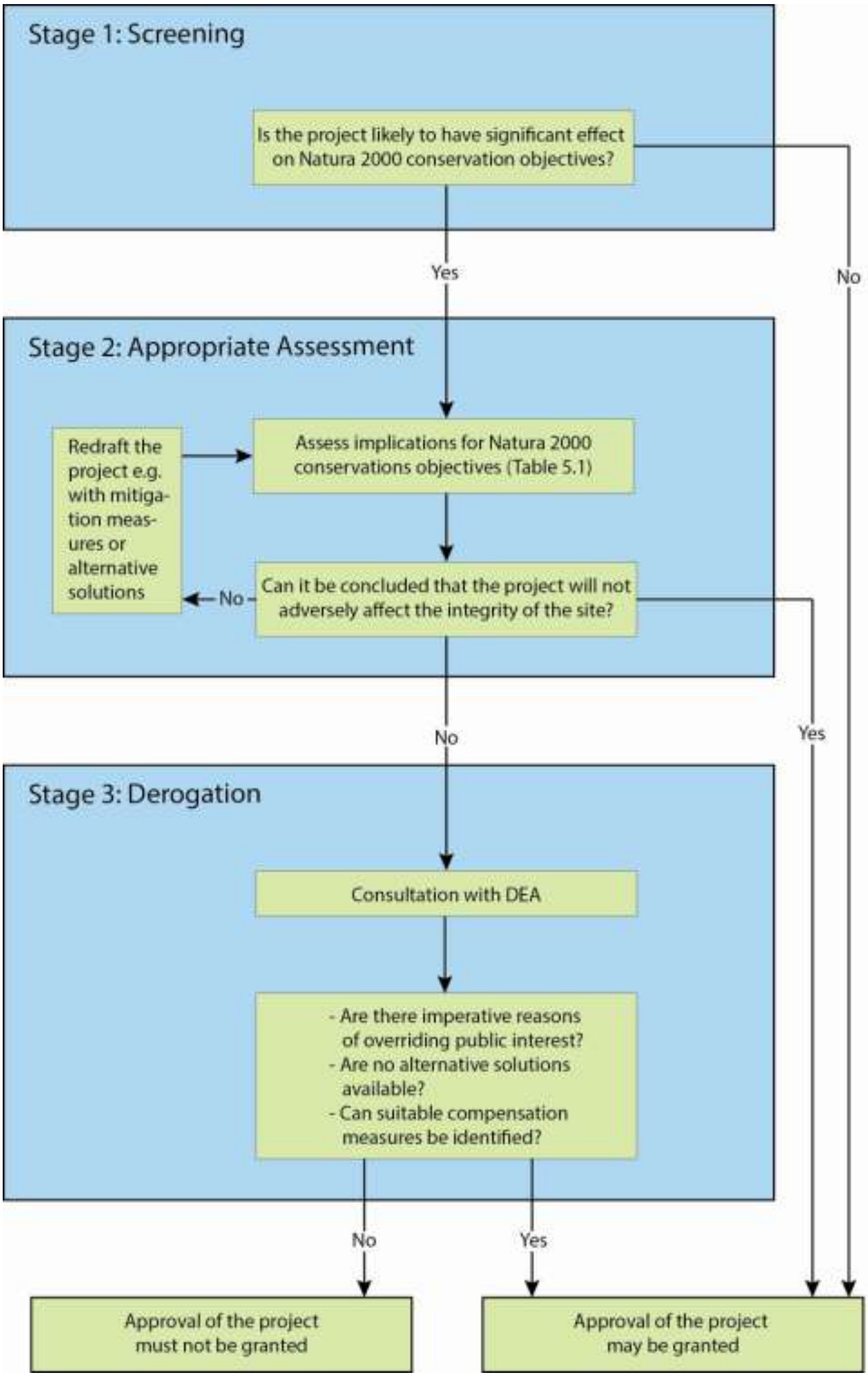


Figure 5-2. Flow chart of the Habitat regulation assessment.

Key questions to be considered in the screening phase:

- Identify the geographic scope of the project
- Identify all Natura 2000 sites or Annex IV-protected species, that might be affected by the project
- Identify the qualifying interests of the Natura 2000 sites concerned (i.e. the habitats and species for which the sites are designated) and the site's conservation objectives
- Determine which of those species and habitats could be significantly affected by the planned activities
- Analyse other plans or projects which could, in combination with the planned activities, give rise to a likely significant effect on a Natura 2000 site
- Analyse the possible interactions between the project, either individually or in combination with other plans or projects, and the qualifying interests, the ecological functions and processes that support them

If, during the screening, it cannot be excluded that the OWF will have a likely significant effect, then an AA must be initiated. The AA procedure is in many ways similar to the environmental impact assessment (EIA) procedure as described in Chapter 4.

If, on the other hand, the screening concludes that there will be no likely significant effects, no AA will be required. The screening analysis will need to be included in the EIA report in a separate chapter or as a seperate report.

5.5 Stage 2: Appropriate Assessment (AA)

The purpose of the AA is to assess the implications of the project in respect of Natura 2000 site(s) conservation objectives, individually or in combination with other plans or projects. The conclusions should enable the DEA to ascertain whether or not a project would adversely affect the intregity of the Natura 2000 site or the annex IV species concerned.

In summary, the term "appropriate" means that the assessment needs to be appropriate to its purpose under the Habitats and Birds Directives – i.e. that of conserving rare and endangered species and habitat types of European interest. In this respect, it is important to recall that, the outcome of the AA is legally binding for the authorities. The lack of information or data cannot e.g. be used as a reason for approving a project.

The AA must objectively demonstrate, with supporting evidence, that there will be no adverse effects on the integrity of the Natura 2000 site or Annex IV species.

If the AA cannot demonstrate sufficient evidence of adverse effects on a Natura 2000 designation, the developer is advised to immediately take contact with the Danish Energy Agency and the Danish Nature Agency in order to agree on potential mitigation measures.

If the conclusion of the AA is that the OWF will not adversely affect the integrity of a Natura 2000 designation, the project may precede.

There are several basic steps to follow when carrying out an AA (see box below). Focus of the AA should be specifically on the species and/or habitat types for which the Natura 2000 site is designated, and on the possible effects of the project on them. This should also include indirect effects on these species and/or habitat types, for instance on their supporting ecosystems and natural processes.

Steps to be undertaken as part of the Appropriate Assessment

1. Define the study area including the offshore-wind-farm project area and the Natura 2000 site(s)
2. Identify the conservation objectives of the Natura 2000 site(s). This can be provided with input from the Danish Nature Agency
3. Identify the habitats and species to be considered in the assessment. This includes an analysis of the sensitivity of species and habitats towards the offshore wind farm project
4. Collect information on the particular species or habitat type from existing information and/or from site-specific surveys
5. Collect information from other relevant plans or projects that may have an effect on the integrity of the species and/or habitat
6. Assess the effect on the Natura 2000 site and/or species, including ecological structure and functions
7. In case of significant impact, design preventive and mitigation measures. This could also include designing a monitoring programme
8. Determine the effects on the integrity of the Natura 2000 site and/or species

The AA can be attached as an annex to the EIA including a summary in the EIA, or be included with full text in a separate chapter of the EIA report. Annex 1 to executive order 1476 contains a list of the details and the impact assessment that are required in the AA analysis.

The reporting of the results from the AA must include:

- A description of the Natura 2000 site and conservation status
- A description of the project and identification of the data required to assess the impact of the project on the Natura 2000 designation
- Identification of all those elements of the project alone or in combination with other projects, that are likely to give rise to significant effects on the Natura 2000 designation
- Assessment of the impact, including cumulative and in-combination impacts, alternative solutions and potential compensatory measures
- Describe potential mitigation measures, including a timescale of how these will be implemented and monitored

The process of the AA is described in more detail in the EU guide: Assessment of plans and projects significantly affecting Natura 2000 sites, and in the EU Wind Energy Developments and Natura 2000 guidance document from 2010, supplemented with the methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC (November 2001), and in the guidance document from the Danish Nature Agency (Naturstyrelsen, 2011).

5.6 Stage 3: Derogation procedure of the Habitat Directive

It is important to note that although an AA and EIA are similar in structure they are still two different procedures with different objectives.

The AA does not deal with all the elements within a full EIA. The AA focuses only on elements related to the integrity of Natura 2000 designations and protection of annex IV species. However, an AA requires a very thorough assessment and needs to take into account the precautionary principle (assuming worst-case scenarios).

If, on the basis of the AA, it cannot be ascertained that a project will not adversely affect the integrity of a Natura 2000 site or species, the project should either be refused as it stands, or the provisions of Article 6(4) of the Habitats Directive should be applied. Article 6(4) is only applicable under strict conditions and will only be passed in exceptional circumstances. In that case, the following conditions for the project must be proven to exist (see also Figure 5-2):

- Appropriate grounds of imperative overriding public interest
- No alternative solution is available
- Suitable compensating measures can be identified

However, it should be stressed that these exceptions have not been used and can only rarely be justified regarding offshore wind farm developments.

6 CONSULTATION AND PUBLIC HEARING

6.1 Background

Consultation and public hearing are key components of an Environmental Impact Assessment (EIA) which usually involves citizens, organisations, companies and all relevant authorities in the environmental decision-making process. It may be an advantage to involve key stakeholders as soon as possible in the EIA process.

The main objective of consultation and hearing is for the public and the relevant authorities to contribute to the final decision. For instance, the public may bring forward new information or concerns not being assessed in the EIA report, thereby influencing e.g. the layout or size of an offshore wind farm (OWF).

6.2 Internal hearing of key authorities

Before the Danish Energy Agency (DEA) can issue a license for preliminary investigations a hearing of relevant authorities must be conducted.

The relevant authorities will usually be the municipalities with coastline along the area in which the OWF project is located and such government authorities as the Heritage Agency of Denmark, the Danish Transport Authority, the Danish Maritime Authority, the Danish Nature Agency, the Ministry of Food, Agriculture, and Fisheries etc.

6.3 Public hearing of the EIA report

When the DEA receives the EIA report, a public hearing lasting eight weeks will be initiated. The hearing will be announced nationwide and locally by the DEA. This enables authorities, interest groups and the general public to comment on the application and the EIA report.

6.4 Espoo hearing

If the project is likely to have significant transboundary effect the respective neighbouring countries will have to be notified and consulted according to the Espoo Convention – through an Espoo hearing. The basis on which the hearing is performed is the Espoo Convention of 25 February 1991 on the assessment of environmental impacts across national borders. It is a UN convention, ratified by Denmark and several other states.

The objective of the convention is to counter the possible transboundary effects of a project on the environment. The hearing can usually be carried out at the same time as the hearing of the EIA report, but the competent authority has to notify the affected countries as early as possible. That can be done in a letter during the end of scoping process where sufficient information on the project can be provided.

The Espoo hearing gives the public in all areas likely to be affected by a proposed project the possibility to express comments and opinions on the proposed activity before the final decision-making process.

The DEA is responsible for assessing whether a project must be subjected to an Espoo hearing or not, and responsible for carrying out the Espoo hearing. Most OWF projects in Danish waters will not have transboundary effects and will therefore not be subject to an Espoo hearing.

7 LICENSE TO ESTABLISH AN OFFSHORE WIND FARM

If the consultation and public hearing process does not result in compelling objections to the project, the Danish Energy Agency (DEA) will give permission to construction – license to establish an offshore wind farm (OWF) (in Danish: "Tilladelse til etablering af elproduktionsanlæg"). The permit will be given in accordance with Danish legislation (VE-loven) and will include a number of terms and conditions which are to be met by the developer.

The permit may include measures to mitigate environmental impacts during the construction and possibly also operation phase. The permit may also include requirements for further monitoring. This monitoring programme will normally focus on environmental issues where further knowledge will strengthen the conclusions, verify the environmental impact assessment (EIA) results and also benefit future offshore wind farm developments by providing valid information on potential post construction impact.

There is a right to appeal the result of the initial screening of the DEA to the Energy Board of Appeal, according to executive order no. 68 of 26/01/2012 (in Danish: Bekendtgørelse om vurdering af virkning på miljøet (VVM) ved projekter om etablering m.v. af elproduktionsanlæg på havet). After the DEA's adoption of the EIA anyone with a particular interest in the project, including non-governmental organisations, can appeal the permit to the Energy Board of Appeal within four weeks. Construction of the OWF must not start until the appeal period has expired. The right to appeal is laid down in the VE-loven.

Following the completion of the wind farm construction, the DEA shall grant a license for the utilisation of wind energy, provided that new concerns arise during construction.

Part B

8 BENTHIC FLORA AND FAUNA

8.1 Introduction

This chapter provides information on the benthic flora and fauna that should be considered in Environmental Impact Assessments (EIA) and Appropriate Assessment (AA) in relation to offshore wind farms (OWFs) in Denmark. It describes the commonly used methods which have been applied in Danish EIA surveys in terms of both small- and large-scale OWFs.

The benthic flora and fauna (also known as “benthos”) is the community of organisms which live on, in, or near the seabed. It includes many types of animals, algae (and macro algae), plants, etc. This chapter considers the effects on organisms, whereas special attention is given in chapter 9 to the habitats in which the organisms live.

Photo: Rune Frederiksen, Ruf Dykkerservice

8.2 Key impact issues

The key impact issues regarding the benthic community during construction and operation of an OWF are presented in Table 8-1 below. The impact is divided into three overall categories; disturbance, pollution and habitat change.

Table 8-1 Most significant impacts and effects on the benthic community in relation to offshore wind farms

Impact	Source of impact	Effect
Disturbance	*During construction* Sediment dispersion and sedimentation during dredging and burial of cables and establishment of foundations	Smothering of the seabed may influence respiration, inhibit feeding or bury benthic organisms Increased turbidity leads to shading effects on vegetation and influences feeding and respiration of filter feeders
	During operation Reduced fishing activity	Exclusion of trawling potentially leads to less physical disturbance of benthic communities and more favourable environments for long-lived species
Pollution	*During construction* Dispersal of pollutants in the sediment during dredging and e.g. drilling of foundations	Remobilisation of pollutants can cause acute toxic effects or bioaccumulation in the benthos
Habitat change	*During construction* Burial of export and inter-array cables	Dredging or jetting of cable trenches will change the habitat and the benthic community for a short or long period of time. Changes may be long-term where e.g. large stones are placed along the cable trench as protection for the cable
	During operation Scour protection and foundations, resulting in establishment of artificial reef	Introduction of hard-bottom structures increases habitat heterogeneity and changes the benthic communities.

Construction of OWFs will disturb and re-suspend fine-grained sediment from the seabed. Concentration of suspended particles and the area of impact depend on a variety of factors (see fact box below). Smothering of the seabed may influence respiration, inhibit feeding or bury benthic organisms (Wilhelmsson *et al*, 2010).

Dredging or jetting of cable trenches will change the habitat and the benthic community for a short or long period of time depending on the geological characteristics of the seabed (e.g. chalk, clay, sand, gravel or reefs). In most cases the period before the benthic community has re-established can be shortened by backfilling the trenches.

Trawling, which is one of the most severe threats to the benthic community (Wilhelmsson *et al*, 2010), is prohibited or limited inside Danish OWFs. This regulation will often cause less physical disturbance of benthic communities and more favourable environments for long-lived species at the OWF site.

OWFs introduce long-term effects on the local environment, especially on soft bottoms where foundations and scour protection will introduce hard-bottom substrate thereby creating an artificial reef. These hard-bottom structures increase habitat heterogeneity and change the benthic communities from communities with most benthic organisms living in the seabed to hard-bottom communities with other species of animals, macro algae and plants (Hiscock *et al*, 2002; Danish Energy Agency, 2006). This artificial-reef effect will be locally important, but as the foundations only cover a very small part of the total seabed area, the overall effect is likely to be small.

In some areas there is a potential for pollutant remobilisation due to suspended sediment related to foundations and cable installation activities. The further away from the coast, the less likely it is that high levels of pollutants will be encountered. However, consideration must be given to the issue. Remobilisation of pollutants can cause acute toxic effects or bioaccumulation in the benthos.

In addition to the impacts presented in Table 8-1, other potential impacts, such as electromagnetic fields and heating caused by cables, and pollutants from the cable coating have often been considered when evaluating effects on the benthic community. These impacts are often considered of minor importance; however there is a lack of substantial data on the effects on marine species. Among other things, potential impact depends on the strength of the electromagnetic fields produced and type of cables (e.g. HVDC or ACDC cables).

The magnitude of the potential impacts presented in Table 8-1 is affected by the sediment dispersion and changes in water quality caused by the OWF. Therefore, assessment of sediment dispersion and water quality must be included in the assessment of the potential impacts on benthic communities.

The impacts of sediment dispersion and water quality on benthic communities depend on the local conditions, e.g. seabed substrate and the currents in the area. The most important issues related to sediment dispersion and water quality are presented in the fact box below.

Sediment dispersion and water quality

Description of seabed structure and estimates of suspended sediments require knowledge about:

- Grain-size distribution
- Content of organic matter
- Content of pollutants

This knowledge can be obtained by using different methods, including grab sampling and sonar surveys such as side-scan sonar and multibeam sonar.

A description of the current regime, tide and wave conditions at the OWF site is essential as these processes affect the suspension of and deposition of sediment.

The assessment of the impact of sediment suspension and deposition may be based on dispersion and deposition calculations. In some cases more detailed hydrodynamic models such as a MIKE model can be used (e.g. Energinet.dk, 2009c).

Hydrodynamic models can also provide information on effects of the OWF during operation such as effects on coastal morphology and scour around foundations.

Hermit crab *(Pagurus bernhardus)* (Photo: Orbicon)

8.3 Key species

In most cases no specific benthic species are subject to a higher level of concern. Instead, the impact of OWF projects is often assessed at community level, and focus is on the changes in community structure, i.e. changes on the characteristic elements of the benthic communities like the “macoma community” or the “venus community”.

Species characteristic of the *macoma* community

The corcle (*Cerastoderma glaucum),* the sand gaper *(Mya arenaria)*, the ragwork *(Nereis (Hediste) diversicolor),* the bristle work *(Pygospio elegans),* the mud snail *(Hydrobia sp.).* (Danish Energy Agency, 2006)

8.4 Existing data

Before planning possible field investigations, existing information on distribution and abundance should be considered in order to assess whether this data is adequate for providing information to the EIA.

The overall composition of the benthic communities in Danish waters has been outlined by Thorson (1979). This only deals with the soft-bottom communities and it is a very general description of the communities.

It is also possible to find data on benthic fauna and macro vegetation (mainly eelgrass) in a national database (MADS) (DMU, 2011).

More specific data from the OWF area or nearby areas can sometimes be available from investigations performed as part of other offshore projects.

8.5 Field surveys and data analyses

If the existing data is not sufficient for evaluating the impact of the project on the benthos, surveys of the abundance and distribution of benthic communities in the area might be required. In relation to OWFs in Denmark a limited number of methods have been used.

An overview of the commonly used methods is given in Table 8-2.

Table 8-2 Overview of frequently used survey methods

Benthos type	Method	Platform	Information
Macro algae and plants	Line transect surveys and/or point observations (e.g. DONG Energy, 2007 and Sund & Bælt, 2008)	Boat based. Observations performed by diver and sometimes by ROV (Remotely Operated Vehicle) controlled from the surface	• The qualitative composition of the flora community • Spatial coverage • Biomass • Shoot density, percentage coverage, etc. • The method can also be used to examine the distribution of mussel beds See technical instruction for the

Benthos type	Method	Platform	Information
			national monitoring programme for further information on how surveys are conducted (DMU, 2004a)
Infauna on soft bottom	Core and grab sampling (e.g. Energi E2, 2006a; Vattenfall, 2006 and Energi-net.dk, 2009a)	Boat based. In Denmark HAPS core sampler is typically used for intensive investigations and a Van Veen grab sampler for extensive investigations. A number of other samplers are also available	• The quantitative composition of the fauna community • Number of individuals of different species • Size distribution of individuals • Biomass etc. See technical instruction for the national monitoring programme for further information on how surveys are conducted (DMU, 2004b)
	Line transect surveys (e.g. Danish Energy Agency, 2006)	Same platform as for macro algae and plants	• On infauna the method can be used to verify the existing information on the qualitative composition of the community
Epifauna on hard bottom	Line-transect surveys and/or point observations (e.g. Energinet.dk, 2009b)	Same platform as for macro algae and plants	• The qualitative composition of the fauna community • Per cent coverage of different species • Frequency of different species See technical instruction for the national monitoring programme for further information on how surveys are conducted (DMU, 2004c) Methods also applicable for post-construction surveys of fouling of hard-substrate structures of the OWF
Mobile epifauna	Trawl/drege surveys (These methods have not been included in Danish EIAs; for methodology see e.g. BSH, 2007)	Vessel	Information on mobile epifauna provides input for assessment of the impact on commercial fisheries

There are a number of other methods than the ones described in Table 8-2 which can also provide useful qualitative and quantitative information on the benthic communities. Use of other methods will often be acceptable as long as the results fulfil the requirements for an EIA. It is important to describe the reason(s) for the choice of method and to document that the method suits the purpose.

Until now, surveys on mobile epifauna have not been included in the existing EIA for Danish OWFs but often data is insufficient in order to assess the impact on commercial fisheries for e.g. brown shrimp and edible crab (North Sea). Such methodologies have been applied for other European OWFs; see e.g. German Guidelines, StUK 3 (BSH, 2007).

8.5.1 Planning of field investigations

The survey setup always has to be planned in accordance with the specific conditions of the OWF site.

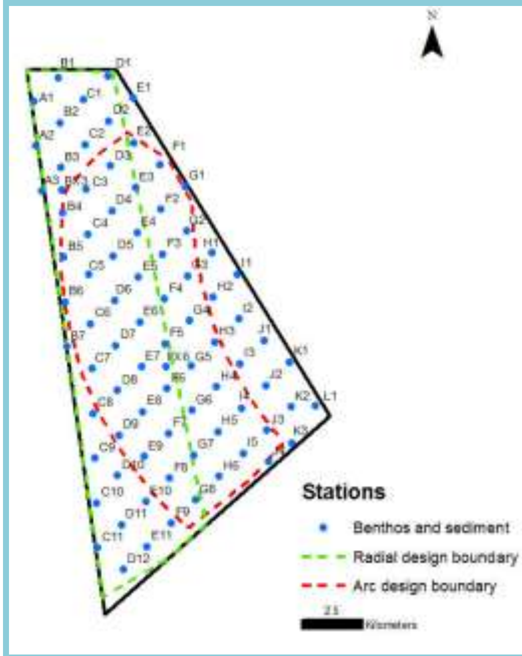
If the potentially impacted area is a relatively uniform soft-bottom area, the need for conducting qualitative sampling must be assessed. If results from other projects suggest that the effects of the project on infauna communities are likely to be negligible, existing knowledge or qualitative investigations might be sufficient.

Hard bottom is rare in Danish waters; however, in some cases OWF projects are placed in areas with relatively coarse sediment with gravel and stones mixed with sand, which provides ample opportunities for macro vegetation. There can also be eelgrass meadows and mussel beds in the project area. In these cases the need for mapping of the epifauna and macro vegetation in the area must be assessed.

Planning and design of surveys also has to be considered according to different spill scenarios that affect areas of importance and must be made according to results gained by the side-scan sonar survey (or similar information). The design of the preliminary survey programme should be made in a way which will ensure that a subsequent baseline for monitoring purposes can be designed according to the BACI approach.

Field investigations at Anholt OWF

During the EIA process at Anholt OWF it was necessary to conduct a rather thorough classification of the benthic fauna in the area. Samples were taken at 80 stations in the area using a Van Veen grab.



Stations where samples of benthos were taken (Energinet.dk 2009a)

In addition to data on sediment characteristics, the samples were used to generate quantitative data on species composition, dry weight of species and length of the shelves of bivalves.

To complete the investigations on benthos a mapping of substrates (related to habitat types, see Chapter 9) was conducted using side-scan sonar and ROV (Energinet.dk 2009b). (Radial and Arc design refer to the wind turbine layout).

During the EIA process the need for post-construction monitoring is not known. However, if there are indications during the EIA process that effects on the benthos will be an important issue, the gathering of quantitative data should be considered.

Specific attention must also be given to the shallow water communities, eelgrass meadows, and important feeding areas for waders.

8.6 Impact assessment

The impact assessments must be based on the collected data on the benthos community, information on the construction work (dredging etc.), sediment dispersion (modelled or assessment based on existing knowledge; see fact box below), the extent of the introduction of hard substrate in the area etc., and expert knowledge on the effects of offshore construction work on the benthos.

The general methodology to assess the environmental impact from the OWF project is specified in Chapter 4.

If possible, key species for the benthic communities should be identified and used in the assessment of possible impacts on benthic communities. Here, habitat suitability mapping might be a useful tool for the assessment of the possible occurrence and distribution of key species. Key species could also be important prey species, indicators of sediment disturbance, key elements in nursery or feeding grounds, e.g. eelgrass beds, etc.

Particular attention should be given to the impact from invasive/alien species and the impact of entry points on the biogeographic distribution of species.

8.7 Appropriate Assessment (AA)

In Denmark, no benthic species are protected by Natura 2000 designation. However, in all marine Special Areas of Conservation (SAC) (except SAC no. 260 Femern Bælt) one or more habitat types comprising benthic species are protected. More information on the protection of these habitat types is presented in Chapter 9. Furthermore, the benthic communities are often important food items to Natura 2000-protected species of birds and marine mammals. Therefore, it is sometimes relevant to consider impacts on benthic communities and specific key elements/species when assessing impacts on Natura 2000-protected sites and species.

In case of the identification of a potential significant impact on Natura 2000-designated habitat types, an AA will be required due to the construction of an OWF.

For further information on AA, see Chapter 5.

Hiscock *et al* 2002. High Level Environmental Screening Study for Offshore Wind Frarm Developments Marine Habitats and Species Project. JMBA report to the Department of Trade and Industry New & Renewable Energy Programme

9 MARINE HABITAT TYPES

9.1 Introduction

This Chapter provides information on marine habitats which are protected under Natura 2000. These habitats comprise a number of structural elements and benthic species, including both flora and fauna. Therefore, the important impact issues and survey methods used in order to describe the marine habitats are closely connected to the issues described in Chapter 8.

9.2 Key impact issues

The key impact issues regarding protected marine habitats are similar to the key impact issues regarding the benthic community. A review of these issues can be found in Chapter 8.

Razor shell *(Ensis sp.)* (Photo: Orbicon).

9.3 Key species

In Denmark no benthic species are protected by Natura 2000. However, a number of marine habitat types are protected. All protected marine habitat types in Danish waters are shown in Table 9-1 (based on the European Commission, 2012).

Table 9-1 Marine habitat types protected by Natura 2000 designation in Danish waters

Habitat type	Description
1110 Sandbanks which are slightly covered by sea water all the time	Sandbanks are elevated, elongated, rounded or irregular topographic features, permanently submerged and predominantly surrounded by deeper water. They consist mainly of sandy sediments, but large grain sizes, including boulders and cobbles, or small grain sizes, including mud may also be present on a sandbank. Banks where sandy sediments occur in a layer over hard substrata are classed as sandbanks if the associated biota are dependent on the sand rather than on the underlying hard substrata. "Slightly covered by sea water all the time" means that above a sandbank the water depth is seldom more than 20 metres above low tide level. Some sandbanks are covered in eelgrass while others have no vegetation. The habitat is often important as nursery areas for fish, and feeding grounds for birds.
1130 Estuaries	Estuaries are the downstream part of a river valley, subject to the tide and extending from the limit of brackish waters. There is a gradient of salinity from freshwater in the river to increasingly marine conditions towards the open sea. The mixing of freshwater and sea water and the reduced current flows in the shelter of the estuary lead to deposition of fine sediments, often forming extensive intertidal sand and mud flats. Where the tidal currents are faster than flood tides, most sediments deposit to form a delta at the mouth of the estuary. The vegetation often consists of eelgrass and attached macro algae. The habitat is often important as feeding grounds to many birds.
1140 Mudflats and sand flats not covered by seawater at low tide	These flats are sands and muds that are not covered by sea water at low tide, and that are mostly devoid of plants and usually coated by blue algae and diatoms. The physical structure of the flats ranges from mobile, coarse-sand beaches on wave-exposed coasts to stable, fine-sediment mudflats in estuaries and other marine inlets. They are of particular importance as feeding grounds for wildfowl and waders.
1150 Coastal lagoons	These lagoons are areas of shallow coastal water of varying salinity and water volume, wholly or partially separated from the sea by sand banks, shingle or, less frequently, rocks. Salinity may vary from brackish water to hypersaline (more salty than seawater) depending on rainfall, evaporation and through the addition of fresh seawater from storms, temporary flooding of the sea in winter or tidal exchange. The flora and fauna communities of lagoons vary according to the physical characteristics and salinity regime of the lagoon. However, compared to other marine habitats, there is usually only a limited range of species present. The species that live in the lagoons are often adapted to the varying salinity.
1160 Large shallow inlets and bays	This habitat consists of large indentations of the coast where, in contrast to habitat type 1130 Estuaries, the influence of freshwater is generally limited. These shallow indentations (with water depth generally less than 30 m), are more sheltered from wave action than the open coast and contain a great diversity of sediments and substrates with a well-developed zonation of benthic communities. These communities generally have a high biodiversity.

Habitat type	Description
1170 Reefs	Reefs can be either biogenic concretions or of geogenic origin consisting of rocks, boulders and cobbles (> 64 mm) or other hard substrate on solid and soft bottoms, which arise from the seabed They are generally covered in water all the time but may extend into the tidal zone where they are exposed to the air at low tide. Examples in Danish waters are mussel beds, sabellaria reefs and oyster beds. Reefs often support a zonation of benthic communities of algae and animal species from the seabed and up. Reefs are very variable in the communities that they support. In Denmark this is, among other factors, caused by the decrease in salinity in the Danish waters from Kattegat to the waters around Bornholm.
1180 Submarine structures made by leaking gases	These structures consist of sandstone slabs, pavements and pillars formed by aggregation of carbonate cement resulting from microbial oxidation of gas emissions, mainly methane. The formations are interspersed with gas vents that intermittently release gas. The methane most likely originates from the microbial decomposition of fossil plant materials. The type of structure which is found in Danish waters is known as "bubbling reefs". These formations support a zonation of diverse benthic communities consisting of algae and/or invertebrate specialists of hard marine substrates different to that of the surrounding habitat. Animals seeking shelter in the numerous caves further enhance the biodiversity. These bubbling reefs shelter a highly diversified ecosystem with often brightly coloured species.

The habitat types are subject to a special conservation interest in Natura 2000 sites where they are part of the designation. However, the impact of an OWF project on these habitat types outside Natura 2000 areas should also be considered as part of an environmental impact assessment (EIA).

All habitat types can be affected by the different aspects of an offshore wind farm (OWF) project; cf. the section on key impact issues in Chapter 8

The hard substrate habitat types, reefs and bubbling reefs are often subject to special attention. These habitats are often considered highly sensitive because of their scarcity in Danish waters, and because self-restoring processes are not as likely and rapid as for the soft-bottom habitats when disturbed and damaged.

9.4 Existing data

Before planning possible field investigations, existing information on the distribution of marine habitat types in the area should be considered in order to assess whether this data is adequate for proper assessment in the EIA. On some aspects the data gathered will relate to data gathered on the distribution of benthic communities (see Chapter 8).

The most important source of existing knowledge on marine habitats is the Natura 2000 plans. Using the online maps that are part of these plans makes it possible to attain information of the distribution of marine habitat types inside the Danish Natura 2000 sites (Naturstyrelsen, 2011).

Large aggregations of stones often impact fishing activities. Therefore, local fishermen may be another source of information on a possible occurrence of sensitive habitat types such as reefs in the wind farm area.

9.5 Field surveys and data analyses

In many cases the existing knowledge will be sufficient to achieve a relatively clear picture of the general distribution of marine habitat types in the wind farm area and potentially impacted areas in the close vicinity of the proposed wind farm. However, occurrences of smaller areas of sensitive habitats such as reefs and bubbling reefs may not be known.

It is important that the possible affected area shall be assessed using different spill scenarios and scenarios for impact on current regimes.

Methods to achieve a more detailed picture on the distribution of habitat types are described in the sections below.

9.5.1 Survey methods

The survey methods developed to describe the densities and distribution of benthic communities will in general provide valuable information on the habitat types in the project area. See chapter 8 for further information on the different methods.

In addition to the traditional survey methods on benthic communities described in chapter 8, geophysical surveys of the seabed using different types of sonar such as side-scan sonar and multibeam sonar also provide information about the occurrence of different habitat types within the project area.

Scans of bottom substrate

In relation to OWF projects, geophysical surveys are often undertaken pre construction. These surveys provide information about the geological conditions as part of the design of the wind farm and the technical solutions which will be used for the construction activities.

Furthermore, the results of the geophysical surveys can often verify the distribution of habitat types and reveal even small occurrences of hard-bottom substrate in a soft bottom environment like small reefs and bubbling reefs which need special attention during in the EIA.

Using bottom scans to identify habitat types

In relation to the EIA of Frederikshavn Offshore Wind Farm, bubbling reefs were identified by the use of side-scan sonar (DONG Energy, 2008a and 2008b). Another example can be found at Energinet.dk (2009b).

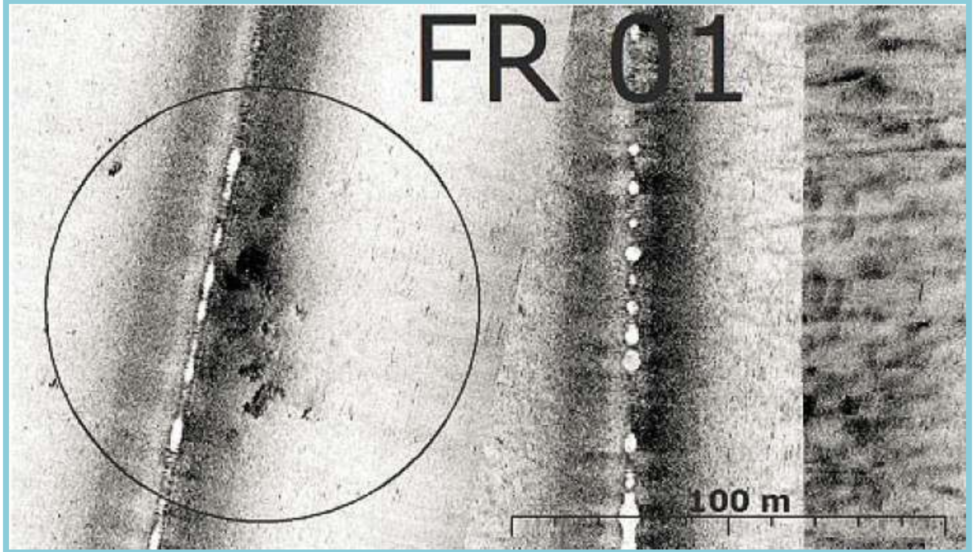


Image of bubbling reef from side scan sonar (DONG Energy, 2008b)

9.6 Impact Assessment

The assessments of the effects on marine habitat types are closely related to the assessments of the effects on the benthos community; cf. Chapter 8 for further information. For information on the general methodology, see Chapter 4.

9.7 Appropriate Assessment (AA)

In all marine Special Areas of Conservation (SAC) one or more habitat types are part of the designation (except SAC no. 260 Femern Bælt).

In case of identification of a potential significant impact on Natura 2000-designated habitat types or species due to the construction of an OWF, an AA will be required.

See Chapter 5 for further information on appropriate assessment (AA).

10 FISH

10.1 Introduction

This chapter provides guidance on the assessment of fish in the Environmental Impact Assessments (EIA) for offshore wind farms (OWFs). It describes background information and the most commonly used survey methods which have been applied in EIA surveys of fish in relation to both small- and large-scale OWFs in Denmark and other European countries.

Please note that this section does not cover fisheries but only issues related to biological conditions.

10.2 Key impact issues

This section outlines a number of key impact issues in relation to fish which can be considered and assessed for all wind farms as part of the EIA.

10.2.1 Main impacts on fish

Offshore wind farms may affect fish in several ways. Subject to most concern are *disturbance* due to underwater noise and vibration during construction and operation, *habitat changes* caused by sediment spillage during construction and the introduction of new habitat due to scour protection and foundations. The loss of habitat may impact feeding, spawning, nursing and resting grounds of both stationary and migratory species. Finally, "*secondary" effects* on fish as a result of impacts on food items or predators from other trophic levels are often considered of potential importance to fish.

Electromagnetic fields (EMF) emitted around the cables during operation have also been considered potential impacting on fish, e.g. by acting as a barrier to migrating fish when passing the export cables to shore.

Thus the main impacts on fish from OWFs can be divided into the following main categories:

- Disturbance
- Habitat change
- Secondary effects

Table 10-1 presents an overview of the impact issues related to fish. In the table there is a brief description of the main impacts to be considered in the EIAs.

Table 10-1 Potential impacts and effects on fish in relation to offshore wind farms

Impact	Source of impact	Effect
Disturbance	*During pre-construction surveys* Noise from sub-bottom profiling (geophysical surveys) *During construction* Underwater noise from construction activities (including pile driving noise and vessels) Sediment spillage	Avoidance of the use of favourable habitats Impacts on the survival of juvenile fish and fish larvae Sediment spillage (suspension and re-deposition) may affect foraging efficiency and/or prey availability and potentially result in lethal, physiological and behavioural effects Disturbance of migration patterns
Habitat change	*During operation* Change of physical environment due to scour protection and foundations, resulting in establishment of artificial reef communities Changes in substrate structure and texture, emergence of shadows and changed hydrographical conditions due to potential changes in local current patterns. Exclusion of fishery	Loss of habitat and introduction of new habitat Change in feeding opportunities and attraction of new species due to hard structures (artificial reefs) The attraction of fish to hard structures makes them easier for predators to catch Changed seabed structure may lead to changes in bottom-living fish communities The area may act as refuge due to fishing restrictions and alter species composition and distribution
Secondary effects	*During operation* Changes in benthic communities or at higher trophic levels Electromagnetic fields (EMF) from submarine cables	Reduced/enhanced food availability and predation may alter fish communities

10.2.2 *Disturbance*

Impacts during pre-construction
In the pre-construction phase seismic surveys of the seabed may give rise to transient emissions of noise and vibrations from seismic survey equipment and vessel activities in the wind farm area. Although unavoidable and associated with high but transient levels of noise, these impacts are considered insignificant to fish. They may flee from the impacted areas or avoid these during the surveys, but no lasting effects are to be expected (e.g. Danish Energy Agency., 2006).

There is a lack of existing knowledge on the possible effects of seismic surveys on fish eggs and larvae but reviews of the current scientific literature indicate that damage on eggs and larvae is limited within a radius of a few metres of the seismic array (e.g. Gausland, 2003; Tenera Environmental, 2011; Sydney Basin SEA, 2007; Dalen & Mæstad, 2008; Wilhelmsson *et al*., 2010).

Impacts during construction
The construction phase is considered the most important phase to fish in terms of impacts. The main potential impacts on the ecology of fish species derived from the construction phase are expected to be related to construction noise and seabed disturbance.

The most significant source of noise during construction will result from piling activities for the installation of foundations. The impact from noise emissions, particularly in terms of behavioural responses due to interference of fish hearing and communication affinities, may have different implications depending on the use of the species in the area (spawning, nursery, feeding grounds, etc.). Impact levels also depend on whether or not alternative suitable areas for fish populations are present in the vicinity, provided avoidance reactions are triggered.

In addition to noise, construction-related activities like dredging during seabed preparation for installation of foundations and sea cables could result in an increase in suspended sediment concentrations and subsequent re-deposition of suspended sediment.

Increased sediment suspension can result in species-specific physiological and behavioural effects on fish, and especially on the survival of eggs and larvae (Engell-Sørensen & Holm Skyt, 1980 and references herein). Sediment re-deposition could result in smothering, particularly impacting species and/or life stages with limited mobility (e.g. eggs and larvae). In addition, re-deposition of sediment may potentially result in a temporary change in the characteristics of the seabed. This may have effects on some species, particularly those with specific substrate requirements, such as flatfish (e.g. plaice and sole) and benthic spawners such as sandeels, spawning their eggs on substrates.

10.2.3 *Habitat change*

Impacts during operation

The introduction of the turbines, foundations, cables and other wind farm-related infrastructure (e.g. offshore substation) may result in a loss of habitat area; however, the structures will only cover a relatively small proportion of the wind farm area. The coverage depends on the type of foundations and scour protection structures, but it is typically in the range of 0.2-0.3 % of the total wind farm area (e.g. Danish Energy Agency, 2006; E.ON, 2007).

The introduction of foundations and scour protection results in an introduction of a new habitat which may potentially influence fish communities. Turbines and scour protection will be readily colonised by a number of organisms and provide habitats for species other than those normally associated with the seabed within the wind farm area. Fish may therefore find increased feeding opportunities, shelter, etc., within the structures (Leonhard & Petersen, 2006). Studies seven years after the construction of Horns Rev 1 Offshore Wind Farm show that fish abundances and species richness seem to increase with increasing depth, increasing the significance of deployed turbine structures at greater depths as refuge areas for fish (Leonhard *et al*., 2011).

During operation, EMFs associated with inter-array and export cables may potentially have an effect on electro- and magneto-sensitive species which may use the area, including migratory species such as salmon, sea trout, European eel and river and sea lamprey as well as demersal sharks. According to Wilhelmsson *et al.* (2010) no significant effects of EMF have been identified.

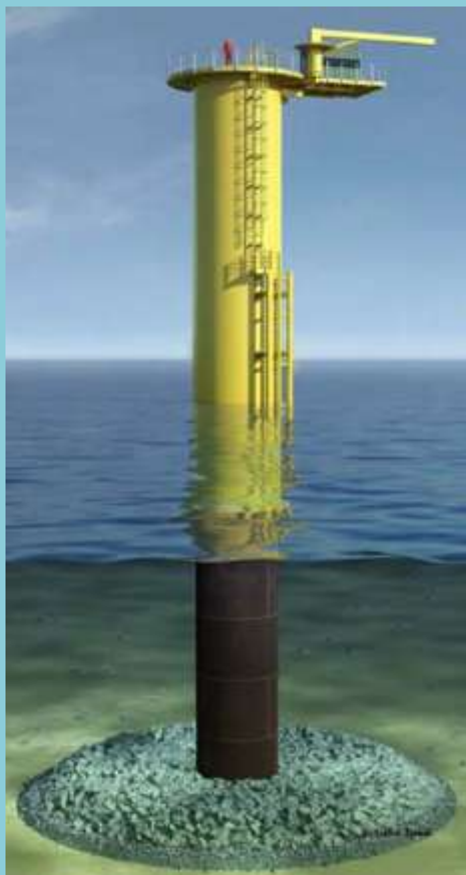
Similarly, underwater noise and vibration generated from the operating wind farm may potentially have an impact on the fish resulting in behavioural impacts and masking of communicative signals in some species.

Exclusion of fisheries, especially trawling, at wind farm sites may affect fish communities in the area. Around sub-sea power cables the “Danish Executive Order on cabling” provide a 200 m protective zone against bottom-trawl fishing and raw-material extraction, which in general excludes these activities within a wind farm area. Wind farm areas might therefore function, temporarily or permanently, as a refuge for different fish species altering the species composition and abundance relatively to the area outside the wind farm.

The deployment of wind farms may cause changes in substrate structure and texture, emergence of shadows and changed hydrographical conditions due to potential changes in local current patterns. These changes may affect the seabed structure and bottom-living fish communities.

Artificial reefs

The monopile is the most used foundation in offshore wind farms. The scour protection around the monopile is typically made of boulders and gravel. These reef-like structures constitute habitats for fish, crabs, lobsters, fouling animals and plants. They may generate specific communities, and increasing habitat heterogeneity within the area of the wind farm potentially improves biodiversity and abundance.



Monopile and scour protection at Horns Rev 1 Offshore Wind Farm
(Photo: from Leonhard *et al.,* 2011)

10.3 Key species

Key species in relation to the wind farm shall be identified as part of the EIA.

Key species are sensitive fish species that may be impacted by the development of wind farms. Key species can be numerous with high densities, e.g. commercially important species, at the development sites. Key species can also represent smaller populations of highly sensitive species which may be nationally or internationally protected and designated based on e.g. important spawning or nursery grounds in the vicinity of the wind farm.

In terms of the EIA it is important to focus on how the fish use the wind farm area. Some species are stationary fish and spend the majority of their lifetime in the area and areas in the vicinity of the wind farm. Other species are migratory species passing and foraging in the area during shorter periods. In addition the importance of the area as spawning or nursery ground for fish species should also be considered. Furthermore, it is important to distinguish between demersal species which are closely connected to the seafloor and pelagic species living in the water.

The sensitivity of fish species depends on the local conditions, and it is not possible to draw general conclusions regarding specific key fish species in Denmark. Thus, different Danish EIAs have considered different key species. Sandeel (*Ammodytidae* spp.) and other benthic species with a high affinity for a sandy bottom were the most abundant groups of fish at Horns Rev 1 OWF whereas pelagic species such as herring (*Clupea harengus*) and Atlantic cod (*Gadus morhuai)* were among the most abundant species caught at Nysted OWF during the EIA investigations (Danish Energy Agency, 2006). At Anholt OWF the EIA investigations, however, focused on bottom-living (benthic) flatfish species as the area is an important foraging and spawning area for these species (Krog & Carl, 2009).

European flounder (*Platichthys flesus*) in its natural surroundings
(Photo: Maks Klaustrup, BioApp)

10.3.1 *Designated sites and species protection*

A limited number of fish species are protected under the Natura 2000 designations in Denmark. However, updated information on designated species that may be impacted by the wind farm must be identified and described as part of the EIA. The marine Natura 2000 areas in Denmark are shown in Chapter 4.

For further information about Natura 2000, see:
www.naturstyrelsen.dk
http://ec.europa.eu/environment/nature/natura2000/index_en.htm

10.4 Existing data

Before planning possible field investigations existing information on fish distribution and abundance in the study area shall be reviewed. Based on assumptions on site-specific key species, there shall be a preliminary assessment of the existing data in order to determine if the data is adequate for the EIA or if it is to be supplemented through site-specific field surveys. Such information includes both published and unpublished materials.

Data can be gathered from other offshore projects, from the national environmental monitoring programme or other monitoring programmes. However, it is important to note that the data must be up to date as population and distribution of fish species may change over time. Useful information could also be obtained from consultation with local fishermen, fisheries biologists and fisheries organisations.

Fisheries statistics based on information on landings by ICES (the International Council for the Exploration of the Sea) rectangles provide a good indication of the commercial species present in the area and their relative abundance and distribution. Data can be gathered from the Ministry of Food, Agriculture and Fisheries: http://naturerhverv.fvm.dk/fiskeristatistik.

Data on fish in Danish coastal waters is available at the Danish Natural Environment Portal; however fish abundance and distribution is not currently monitored regularly as part of the Danish monitoring programme NOVANA.
http://www.miljoeportal.dk/Overfladevand/Nyheder/Opdatering_FiskBase.htm

10.5 Field surveys and data analyses

Before planning an EIA investigation it is important to review existing data on fish abundance and distribution in the area and identify data gaps in order to optimise the field studies.

Identification of data gaps must be based on the existing knowledge about site-specific fish issues and the design and location of the wind farm, and it should be determined if there is any need for field surveys.

The primary aim of the field surveys is to fill the data gap and to gather adequate information for subsequent impact prediction and evaluation and formulation of proposed mitigation measures.

The below sections create an overview of field survey methodologies which have been used in EIA investigations in selected OWFs in Denmark and other European countries.

Photo: Maks Klaustrup, BioApp

10.5.1 *Survey methods*

For EIA investigations adult and juvenile fish characterisation surveys can be conducted. It is important that the survey design is suitable for the specific investigation needed to describe fish abundance and distribution and subsequently assess the potential impacts on fish from the wind farm deployment. In order to cover the large diversity and wide distribution of the target species a variety of fishing gear and methods shall be considered to ensure efficient survey harvest and gathering of sufficient relevant data.

The large diversity of target species in capture fisheries and their wide distribution require a variety of fishing gear and methods for efficient harvest as all methods of physical capture are inherently selective. Small fish may pass through large-meshed nets; large fish may out-swim trawls; gill nets will catch fish mainly of a certain size range. Fish may react differently to fishing gear with respect to species, size, biological state, environmental conditions including ambient light and the acoustic noise field, among many other factors. Therefore, the sampling approach and sample size that are appropriate for one group are often inappropriate for another. The choice of a suitable sampler is a compromise between a variety of factors. For further information, see: http://www.coastalwiki.org/coastalwiki/Sampling_tools_for_the_marine_environment

An overview of some of the methods which have been used in EIA investigations in Denmark is given in Table 10-2 and explained in more detail in the sections below. It should be noted that the survey methodologies are continuously developed. If new methods are used, it is important to argue for this and to document that the chosen method is suitable compared to the more well-known and commonly accepted methods.

Table 10-2 Overview of survey methods commonly used in EIA investigations

Fish	Method	Platform	Information
Pelagic and demersal species	Traditional fishing methods (e.g. gill nets, fykes, trawls) (Danish Energy Agency, 2006; Krog and Carl, 2009; Rasmussen *et al.*, 2000 and others)	Vessel	Species and size composition
Benthic species (sand eel)	Dredging and grab sampling (sand eel) (Danish Energy Agency, 2006; Leonhard *et al*, 2011.)	Vessel	Fish (and benthos) distribution and abundance
Eggs and larvae	No available results from Danish EIAs. For description of fishing methodologies, see: http://www.fao.org/docrep/003/AA044E/AA044E03.htm, http://www.coastalwiki.org/coastalwiki/Sampling_tools_for_the_marine_environment	Vessel	The importance of the wind farm area as spawning and nursery ground.

Fishing gear

The most commonly used methods in relation to fish characterisation surveys are traditional fishing methods with fishing gear such as gill nets, fykes and trawl. The traditional methods provide information on the species composition and spatial and temporal distribution of fish. These methods can be supplemented with e.g. acoustic methods or underwater video or diving to estimate the biomasses of demersal and pelagic fish abundance and biomass.

Specially-designed survey gill nets with different mesh sizes can be used to target specific species of importance for the wind farm area.

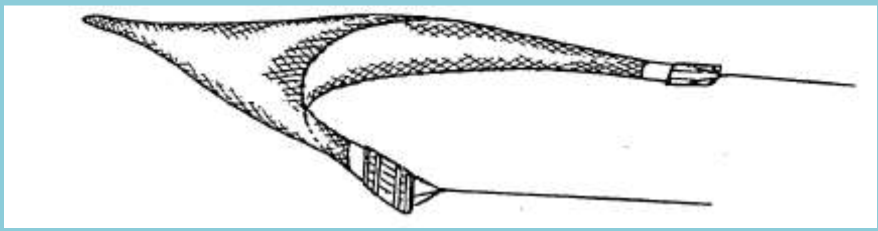
The catch depends on the kind of fishing gear used during the surveys. 'Passive' (stationary) gear such as gill nets and fykes relies on the level of activity and migration. The more activity the higher the catch.

Trawling is used for catching fish which live near or on the bottom. In addition, trawling is used to catch pelagic species such as herring and sprat. The species composition and size distribution of the catch will reflect the fishing gear which has been used, i.e. the mesh size. Also, the timing and weather conditions will influence the results of the fishing.

Therefore, the investigations shall be optimised in terms of fishing gear, methods and timing so that the required information about the key species is gathered during the surveys. This will ensure that applicable and reproducible data will be produced. The use of different types of fishing gear is often required in order to fulfil the EIA requirement.

The choice of the most appropriate method for sampling eggs and larvae is aided by knowing the spawning habits of the target fish species and also a knowledge of the habitat in which the eggs and larvae occur. Floating or suspended fish eggs and newly hatched larvae are often caught with Bongo nets consisting of a pair of nets mounted horizontally and towed behind a survey vessel. Eggs laid on the sea bottom are difficult to catch, and supplemental video inspections may be necessary.

Fyke (Photo: Maks Klaustrup, BioApp)



Otter trawl (http://www.fao.org/fishery/geartype/search/en)

Survey design and data requirements

The data requirements and the specific design of the baseline investigations should be assessed and established together. In some cases, if monitoring post construction will be required, sufficient data should be gathered for doing BACI (Before/After-Control/Impact) analyses. The design is based on the comparison of the changes before and after construction compared to the (natural) changes during the same period in non-affected control areas.

10.5.2 *Data analyses*

The following data will normally form part of the requirement for EIA investigations:

- Species identification and numbers
- Middle length and weight of the individual species
- Catch Per Unit Effort (CPUE) (an indirect measure of the abundance of the target species)

It is important to note that size selectivity differs between different fishing gear and that this has to be taken into account during the analyses.

Anholt OWF

The assessment of the impact on fish from the wind farm at Anholt was based on a combination of existing knowledge from literature, information on commercial fisheries from local fishermen and additional field surveys.

The survey methodologies were according to the Danish national guidelines ("Tekniske anvisninger" (Strand, 2006)). Different types of stationary fishing gear (gill nets and fykes) were used at 20 stations within the wind farm area in order to obtain sufficient data to describe the fish community in the area (Krog & Carl, 2009).

The survey area and the 20 surveyed locations at Anholt OWF (Krog & Carl, 2009)

10.6 Impact assessment

Assessment of impacts on fish should be based on both qualitative and quantitative estimates of the direct or indirect impacts on population level in terms of the number of individuals of a species (or fraction of population) which are subject to different levels of impact.

The following main aspects must be taken into account in terms of the assessment:

- The importance of the area as foraging area
- The importance of the area as spawning ground for important fish species
- The importance of the area as nursery ground for important fish species
- Migration routes
- Fisheries
- Conservation interests

10.7 Appropriate Assessment (AA)

If the construction of an OWF potentially affects fish species that are part of the conservation objectives in Natura 2000 sites, the risk of affecting Natura 2000-protected fish should be addressed, i.e. if the wind farm is located on the migration route of a protected migrating fish species, or if the wind farm area falls within spawning or nursery grounds of the protected species. If this is the case the EIA shall include an AA in a separate section in accordance with the Danish and EU guidelines. For further information on AA, see Chapter 5 in this guidance document.

11 MARINE MAMMALS

11.1 Introduction

This chapter provides information about the key species which must be considered as well as the commonly used methods that have been applied in Danish Environmental Impact Assessment (EIA) studies of marine mammals in relation to both small- and large-scale offshore wind farms (OWF). Reference is made to NIRAS (2011) and Seacon (2011b) for further details on survey and assessment methodologies.

11.2 Key impact issues

A number of key impact issues in relation to marine mammals must be considered and assessed for all OWFs as part of the EIA. This section outlines these issues.

11.2.1 Main impacts on marine mammals

OWF's may affect marine mammals in several ways. However, the subject of most concern is underwater noise during construction. Main noise sources are pile driving, vessel traffic, dredging, foundation construction and tower mounting.

The main impacts on marine mammals from OWFs are related to:

- Disturbance from noise and activities – causing changes in behaviour
- Habitat change – resulting in less use of the area

An overview of the main impact issues regarding marine mammals due to OWFs is presented in Table 11-1. The issues listed in the table must be considered in an EIA.

Table 11-1 Main impacts and potential effects on marine mammal species

Impact	Source of impact	Potential effects	Marine mammal
Disturbance	*Pre-construction phase* Noise from sub-bottom profiling (geophysical surveys)	Alterations in the use of potentially important foraging, resting and breeding habitats, including haul-out sites. Possibility of physical harm (e.g. damage to sensory system) Change in prey distribution and availability	Harbour porpoise Harbour seal Grey seal
	Construction phase Noise from pile driving and vessel traffic. Includes both underwater and air-borne noise	Alterations in the use of potentially important foraging, resting and breeding habitats, including haul-out sites Possibility of physical harm (e.g. damage to sensory system) Change in prey distribution and availability	
Habitat change	*Operation phase* Change of physical environment Turbine foundations and scour protection provide substrate for establishment of novel plant and animal communities	Change in foraging efficiency Change in prey distribution and availability	Harbour porpoise Harbour seal Grey seal
	Indirect impacts caused by restriction of fishery activities within the OWF	Change in prey distribution and availability	

Disturbance

Noise from pre-construction geophysical surveys may have an impact on marine mammals. The impact will be short term, and the noise levels must be considered since different survey methods (e.g. side scan and seismic surveys) will result in different noise levels (Gausland, 2000; MPA News, 2009). The noise and vessel activities may cause marine mammals to abandon potentially important foraging, resting and breeding sites. Furthermore, high-intensity sound from geophysical surveys can inflict damage on the sensory system if animals are close to the source of the noise (Gordon *et al.*, 2004).

Underwater noise during the construction phase is widely regarded as the most important issue in relation to marine mammals and OWFs. Construction activities are generally noisy, and especially pile driving generates very high sound pressures. These sound pressures may disturb harbour porpoises and seals and lead to avoidance or alterations in behaviour of potentially important foraging, resting and breeding habitats, including haul-out sites. The sound pressures may also cause physical damage to the hearing of the animals.

Seal haul-out sites can be affected by direct disturbances during construction from air-borne noise and vessel traffic. In addition, underwater noise may reduce access to haul-out sites, as seals can be reluctant to pass through a noisy construction site.

Responses of marine mammals to three OWFs

At Horns Rev 1 OWFs, harbour porpoises inside the wind farm and up to 15 km away reacted to pile driving operations. The pile-driving activities at Horns Rev 1 OWF resulted in a decrease in harbour porpoise abundance, but no effect was registered once the OWF was in operation (Tougaard *et al*, 2006a).

At the Nysted OWF, the construction resulted in a decrease in harbour porpoise abundance (Carstensen *et al.* 2006). Teilmann *et al*. (2012) found a significant increase from construction to operation of Nysted OWF, though their study indicate that the activity within the windfarm has not fully recovered yet.

At Rødsand 2 OWF there was no overall change in ecolocation from harbour porpoises, from the baseline before construction to operation theoughout the study area (Teilmann *et al*., 2012).

At the Dutch Egmond aan Zee OWF harbour porpoise abundance is higher inside the OWF than outside (Scheidat *et al.* 2011).

No general change in the behaviour of seals at sea or on land could be linked to the construction or operation of the Nysted and Horns Rev 1 OWFs, although both areas constitute important foraging, resting and breeding habitats (Tougaard *et al*., 2006c; Edrén *et al.* 2010).

Habitat change

The construction of an OWF creates permanent alterations to the local environment, especially on soft bottoms where foundations and scour protections will be colonised by macro algae and animals that may be new to the area, thus creating an artificial reef. This will lead to changes in the fish fauna. Such changes to the fish fauna and productivity are likely to be neutral or even positive to opportunistic feeders such as seal and porpoise (Danish Energy Agency*,* 2006).

Responses of harbour porpoise to noise at Horns Rev 2 OWF

Pile driving of steel monopiles represents a significant source of high-intensity underwater noise. Behavioural responses of harbour porpoises to construction noise were investigated using acoustic monitoring devices (T-PODS) during the construction of Horns Rev 2 OWF. A negative effect at Horns Rev 2 on porpoise acoustic activity was detectable at a mean distance of 17.8 km, and porpoise activity was reduced throughout the entire construction period (five months) (Brandt *et al*., 2011).

Harbour porpoise (Photo: Erik Christensen)

Mitigation

Mitigation methods can be used in OFWs to minimise the risk of potential impacts on marine mammals. Below are some examples:

- A soft-start procedure where the strength of the blows of the pile-driving hammer gradually increases, which gives mammals a chance to leave the area before critical noise levels are reached;
- To avoid injuries from acute sound pulses, 'pingers' can be used to ensure that porpoises leave the area before construction activities start;
- Introduction of transport corridors to and from harbours during construction and operation, to avoid intensive ship traffic near sensitive marine mammal sites, e.g. haul-out sites for seals;
- In cases of risk of servere impact on marine mammals during construction, the timing of piling activities can be optimised to minimise impact during a sensitive season for the marine mammals in the area.
- The use of foundations other than monopiles, e.g. gravity foundations, can be considered in areas of high importance to marine mammals

11.3 Key species

EIAs must include an identification of key marine mammal species within the OWF area as well as a species-specific assessment of potential effects caused by the OWF. This section provides a brief description of the key marine mammal species in Danish territorial waters, including considerations related to the EU and national protection of the species.

Of the marine mammals occurring in Denmark, the harbour porpoise, harbour seal and grey seal are the most common species and should always be considered in EIAs. Other marine mammal species, such as minke whales and white-beaked dolphins, should only be considered in relation to projects within the North Sea and the Northern Skagerrak, as these species rarely occur in inner Danish waters, but are resident in the North Sea.

Key marine mammal species in Denmark

- Harbour seal (*Phoca vitulina*)
- Grey seal (*Halichoerus grypus*)
- Harbour porpoise (*Phocoena phocoena*)
- Minke whale (*Balaenoptera acutorostrata*)*
- Killer whale (*Orcinus orca*)*
- White-beaked dolphin (*Lagenorhynchus albirostris*)*
- Bottlenose dolphin (*Tursiops truncatus*)*

Grey seal (Photo: Mateusz Włodarczyk)

*Only within the North Sea and Northern Skagerrak

11.3.1 *Designated sites and species protection*

All species of marine mammals are highly protected through EU legislation, international agreements and Danish legislation. Marine mammals are equally protected irrespective of whether they are found inside or outside of Natura 2000 sites

An overview of Natura 2000 sites in Denmark, where harbour porpoise, harbour seal, and grey seal are part of the conservation objective, is shown in Figure 11-1.

If Natura 2000-designation objectives may be affected by the construction of an OWF (Likely Significant Effect), the EIA must include an Appropriate Assessment (AA) in accordance with Danish and EU guidelines (for further information, see Chapter 5). Whether or not an OWF project results in likely significant impacts on marine mammals must be assessed during the initial screening. Attention should also be payed if the planned OWF is within the normal foraging range of a seal haul-out site designated under Nature 2000, these cases may also require an appropriate assessment.

Finally, harbour porpoise and other cetacean species are strictly protected under Annex IV of the EU Habitats Directive. This implies that an assessment of the impacts on these species must always be conducted regardless of the presence or absence of specific Natura 2000 sites within the vicinity of the planned.

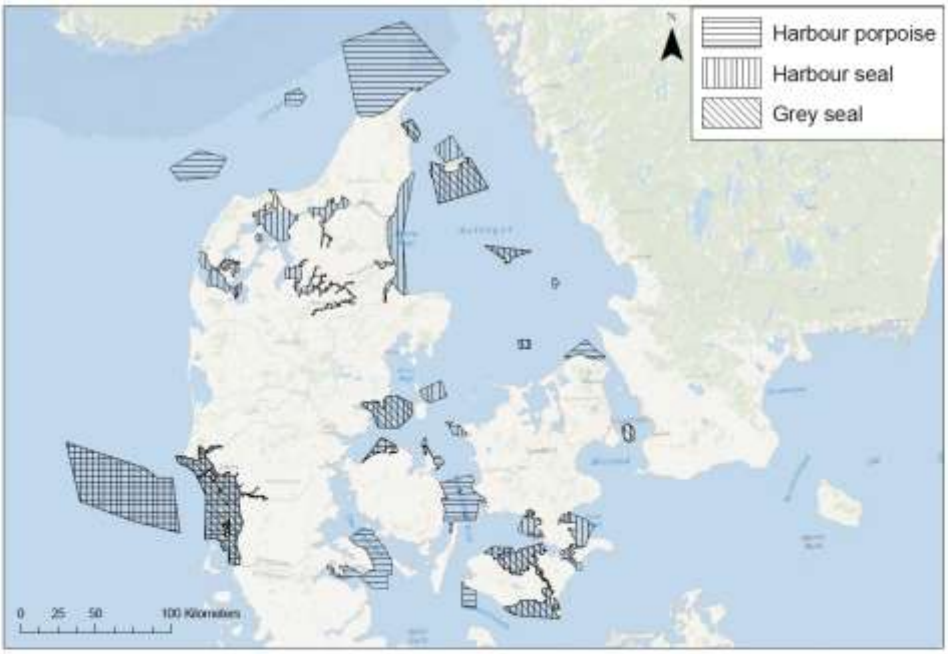


Figure 11-1Natura 2000 sites where harbour porpoise, harbour seal or grey seal is part of the conservation objective (map from 2012)

11.4 Methods and data analysis

The distribution and abundance of marine mammals can be assessed in several different ways. The sections below provide an overview of the methods that have been applied in previous EIAs in OWFs in Denmark and other European countries (Table 11-2).

11.4.1 Existing data

Existing data on site-specific marine mammal distribution and abundance in the planned OWF should form the basis of an early-stage assessment of whether this data is adequate for the EIA or whether additional site-specific investigations are required.
Existing data can be gathered from other related and recent projects, from the NOVANA national monitoring programme or other monitoring programmes. It is important to note that the data must be relatively up-to-date as the abundance and distribution of marine mammals in Denmark may change over time.

For cetaceans, a number of databases and studies on abundance and distribution are available (University of St. Andrews, 2006; James *et al*., 2003; Teilmann *et al*., 2008; Wollny-Goerke and Eskildsen, 2008). Specifically for harbour porpoise, the results of the SAMBAH programme, which are expected to be published in 2014 or 2015, will significantly increase the knowledge of harbour porpoise in the Baltic Sea east of Gedser (Sambah, 2011).

The abundance of harbour seals on haul-out sites in Danish waters has been assessed annually or biannually in August (during the moulting period) by the National Environmental Research Institute (NERI) (now the Danish Centre for Environment and Energy (DCE)) since 1979 (Olsen *et al.,* 2010). Thus, updated knowledge on all major haul-out sites and summer abundance of harbour seals on land is available from DCE (www.dce.au.dk).

11.4.2 Field investigations

Field investigations must be planned in accordance with the specific conditions of the OWF site and the importance of the potential impacted area for the different marine mammal species. An overview of the commonly used methods is given in Table 11-2 and explained in more detail in the sections below.

Table 11-2 Overview of methods for assessing distribution and abundance

Issue	Method	Platform	Information

Issue	Method	Platform	Information
Harbour porpoise Abundance and distribution	Systematic or random visual or acoustic line-transect counts	Aerial or boat-based surveys	Relative or absolute density/ abundance (no. of animals per unit area)
	Acoustic Porpoise Detectors (PODs)	Fixed to mooring system	Continuous registration of porpoise echolocation activity Information on temporal variation on local scale
	Telemetry (ARGOS or GPS)	Individual tagging	Movements and time budget on a larger spatial scale including diving behaviour and indications of habitat use (feeding behaviour)
Harbour seal and grey seal Abundance and distribution	Visual observations of seals on land by aerial photography or remote video recording	Aerial surveys or camera surveillance on land	Number of seals on haul-out sites Breeding behaviour
	Telemetry ARGOS and GPS-based	Individual tagging	Movements and time budget including diving behaviour and habitat use (feeding behaviour).

11.4.3 *Harbour porpoise*

As regards the harbour porpoise, line transects and PODs (Table 11-2) have been applied in EIA investigations in Denmark.

Line transect counts

More or less standardised visual counting of harbour porpoise along line transects has been undertaken in a number of Danish OWF projects since the Nysted and Horns Reef 1 OWF EIA investigations in 1999.

Line transect counts are applicable for rather large survey areas. Both vessel- and aerial-based surveys often combine bird and marine mammal observations.

The two most common methodologies used are visual observations by trained observers (from aircrafts and vessels) and high-resolution images captured from aircrafts.

When conducting visual observations from an aircraft, observers cover each side of the aircraft during the survey. The flight level must be relatively low. High-resolution images can be captured from a higher flight level. This will increase the area that can be covered and reduce the potential impact of noise from the aircraft on the animals.

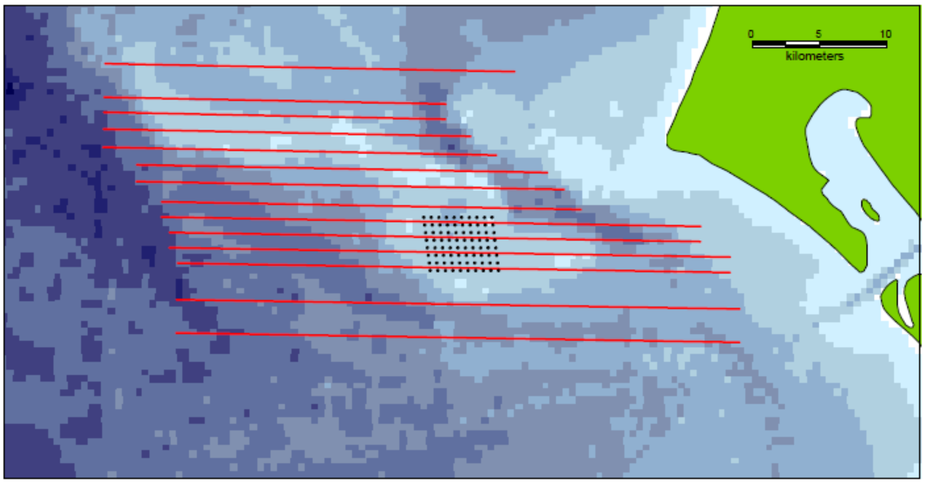
An important advantage of vessel-based surveys is the potential for gathering detailed information on marine mammal behaviour, whereas an advantage of the aerial surveys is the possibility to cover larger areas in a shorter time, thereby reducing the risk of weather down time and potential bias introduced by day-to-day movements of animals.

As an example, the Horns Rev 1 OWF EIA investigations included both vessel- and aerial-based surveys of harbour porpoise (see text box below) (Petersen *et al.,* 2006; Tougaard *et al*., 2006b). It should be noted that the Danish Transport Authority may restrict future aerial surveys flying at rotor heght witin OWF. This may therefore complicate a potential BACI survey methodology, since it will not be possible to fly at rotor height post construction of the wind farm.

Line transects

Transect layout during the boat-based baseline studies at Horns Rev 1 OWF consisted of lines oriented east-west. It covered an area of approximately 500 km of transect lines and could be completed in two days in the summer.

Observations were made from the roof of the bridge. Three observers were continuously searching for porpoises and seals.



Transect lines at Horns Rev 1 OWF during baseline investigations (Tougaard *et al*., 2006a)

Acoustic Porpoise Detectors (PODs)

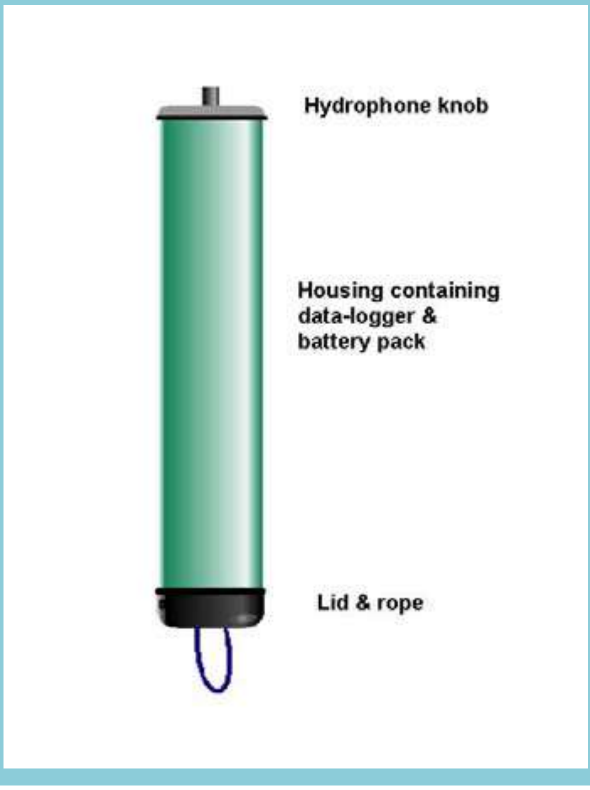
The harbour porpoise emits click-like sounds for echolocation more or less continuously as part of its internal communication and foraging activities. Therefore, the distribution and abundance of the species can be investigated by using passive acoustic monitoring devices (PODs or similar devices) deployed in the water, cf. text box below.

PODs register porpoise activity continuously and thus provide direct information on the presence of harbour porpoise. PODs also provide information about spatial variation on a local scale (up to 300-400m), which can result in indirect evidence of habitat use.

Examples of EIA investigations that have included the deployment of PODs are the OWFs at Nysted (Petersen *et al.,* 2006;Tougaard *et al*., 2006c), Horns Rev 1 (Petersen *et al.,* 2006;Tougaard *et al*., 2006c), Rødsand 2 (E.ON 2009.), and Anholt (Energinet.dk, 2009d).

The T-POD

The T-POD is a self-contained and fully-automated system for the detection of echolocation clicks from harbour porpoises and other cetaceans. It is programmable via specialised software. The T-POD consists of a hydrophone, an analogue click detector, a digital timer and a duration logger (Energi E2, 2006b).



Telemetry on harbour porpoise

The term telemetry covers any kind of remote tracking of individual animals tagged with radio transmitters, ARGOS satellite transmitters and/or GPS receivers. Presently, the only available telemetry technique for harbour porpoise is ARGOS satellite telemetry.

ARGOS provides information on the relative distribution and movements of the species on a large geographic scale. The transmitters can also be configured with different kinds of data loggers to provide information on diving behaviour, which can result in indirect information of habitat use.

Due to the practical constraints in catching the animals and limitations in EIA time schedules, telemetry studies on harbour porpoises have not yet been performed as part of an EIA investigation for Danish OWFs.

11.4.4 *Seals*

The methods applied for the two seal species inhabiting Danish waters, the harbour seal and the grey seal, are very much alike.

As a first step, existing information on seal occurrence must be compiled and analysed before the planning of possible field investigations. Existing data has been adequate for most of the Danish EIAs. However, it must be ensured that the most recent data and knowledge are applied. Field investigations must be undertaken if the potentially impacted area is of high importance to seals.

Two different aspects of seal occurrence should be considered: the abundance at the haul-out sites and the abundance and distribution at sea.

Haul-outs

Haul-outs is a term used to describe the sites on land that seals use. It is important to ensure that seals are not disturbed on haul-out sites, especially when newborn pups are present at the sites.

Harbour seal at haul out site (Photo: Andreas Trepte).

Counting of seals on haul-out sites

The abundance of seals on haul-out sites is typically estimated by aerial surveys using high-resolution imaging. In addition, remote-controlled video cameras on a land-based platform have been applied in some areas (e.g. Nysted and Anholt).

Counting of seals in the water

No techniques exist to provide absolute density estimates of seals in the water. Telemetry is an approved method to obtain information on the distribution and movements of seals. Previously, seal telemetry relied primarily on the ARGOS satellite system. However, more advanced GPS-based transmitters are now available, which provide more accurate information about movements and habitat use.

Telemetry studies of seals have not normally been considered as part of an EIA investigation for a Danish OWF. However, the demonstration project at Horns Rev 1 OWF included a telemetric study of harbour seal (Tougaard *et al*., 2006c), and a another telemetric study was undertaken at the Rødsand seal sanctuary prior to the construction of Nysted OWF (Dietz *et al*., 2003).

Examples of EIA projects which have included counting of seals are the OWF at Nysted (aerial surveys and remote-controlled video camera mounted on fixed platform) (Petersen *et* al., 2006; Teilmann *et al*., 2006) and Horns Rev 1 (vessel-based line transect surveys and individual tagging by ARGOS telemetry) (Petersen *et* al., 2006; Tougaard *et al*., 2006a).

11.4.5 Data analyses

Different kinds of spatial and distribution modelling based on field observations have been used to estimate the distribution of marine mammals in EIAs on Danish OWFs.

Modelling is not a prerequisite for the EIA but in some cases modelling of suitable habitats may replace site-specific mammal surveys (e.g. Energinet.dk, 2010). In general, modelling must be based on robust qualitative data from the local area and it is important to be aware of the pros and cons of the modelling approach which has been chosen.

Spatial modelling

Spatial modelling can provide overall estimates of the mean densities and distribution within the investigated area.

The spatial modelling can be used to interpolate observations based on the properties of the observed data. For instance, the method can be used to estimate densities of marine mammals in the entire investigation area based on densities from line transect data.

Multivariate spatial models and habitat suitability models

Another type of modelling is multivariate statistical models which are mainly used to identify possible correlations between observed distribution data and environmental variables such as water depth, currents, bottom characteristics and food resources.

Examples of EIA projects which have included data modelling:

- Nysted OWF (spatial modelling, harbour porpoise and seal). (Petersen *et al*., 2006; Tougaard *et al*., 2006c)
- Horns Rev 1 OWF (spatial modelling, harbour porpoise) (Petersen *et al*., 2006; Tougaard *et al*., 2006b)
- Anholt OWF (spatial modelling, harbour porpoise) (Energinet.dk, 2009d)

Porpoise-POP model

The potential effects of wind farms on harbour porpoise behaviour and population dynamics have been assessed by the use of an individual-based model, the Porpoise-POP model (Nabe-Nielsen *et al.*, 2011). The method makes it possible to study potential effects on the population level by altered movement patterns.

Recently, this model was used to assess the degree of disturbance of the harbour porpoise population in Kattegat caused by wind farms and ship traffic.

The results did not suggest that the existing wind farms affect the size of the porpoise population and its long-term survival (Nabe-Nielsen *et al.*, 2011).

11.5 Impact assessment

Assessment of impacts on marine mammals should be based on quantitative estimates of the direct or indirect impacts on population level in relation to the number of individuals (or fraction of population) which are subject to different levels of impact.

It is rarely possible to address impact at the population level directly. Instead, it is useful to address the issue through an overview of the significant factors affecting seals and porpoises and then relate the extent of the potential effects to the ultimate impact on the population. Types of potential effects are much the same for seals and porpoise around OWFs, whereas an additional set of factors are present for the potential impact on seals on haul-out sites within the vicinity of the planned OWF.

The general methodology for assessing the environmental impact from the OWF project during construction, operation and decommissioning is specified in chapter 4.

11.6 Appropriate Assessment (AA)

In case of the identification of a likely significant impact on a Natura 2000-designated objective or an Annex IV-species there will be a requirement to conduct an AA which shall comply with Danish and EU guidelines and be based on the initial screening. For further information on AA, see chapter 5.

12 BIRDS

12.1 Introduction

This chapter provides guidance on the assessment of birds to be considered in the Environmental Impact Assessments (EIA) for Offshore Wind Farms (OWFs). It describes background information and the most commonly used survey methods which have been applied in EIA surveys of birds in relation to both small- and large-scale OWFs in Denmark and other European countries. Reference is made to NIRAS (2011) and Seacon (2011a) for further details in survey and assessment methodologies.

12.2 Key impact issues

This section outlines key impact issues in relation to birds which shall be considered and assessed for wind farms as part of the EIA.

12.2.1 Main impact on birds

Key impacts from OWFs on birds can be divided into two main categories; habitat utilisation and collision risk, respectively .

Key impacts on birds from offshore wind farms

- *Habitat utilisation* includes the risk of displacement, avoidance or attraction behaviour as well as a potential barrier effect during construction and operation of the OWF
- *Collision risk* is the risk of birds colliding with the wind turbines during operation of the OWF

Table 12-1 presents an overview of the main categories of impact on birds. Below the table there is a brief description of the main issues to be considered in the EIAs.

Table 12-1 Major impacts and effects on birds in relation to offshore wind farms

Impact	Source of impact	Effect
Habitat utilisation	*During construction*	
	Disturbance from piling and construction noise, vessel trafic and sediment spillage	Displacement where birds are avoid-ing the use of otherwise favourable habitats due to disturbance and habitat change
	During operation	
	Physical barrier of the turbines and visual impact	Barrier effect leading to changes in bird movements
	Turbine noise, rotor veloci-ties, maintenance vessel and helicopter activities	Displacement where birds are avoid-ing the use of otherwise favourable habitats due to disturbance and physical presence of turbines
	Scour protection and foundations, resulting in establishment of artificial reef community	Physical change of habitat leading to displacement or attraction of birds. For some species the changes may result in increasing numbers at the site
	Turbine structures (above water) offering resting place for some species	
Collision risk	*During construction*	
	Nocturnal light sources	Attraction and collision of birds with construction vessels and turbine structures, platforms, and substa-tions.
	During operation	
	Presence of turbines (i.e. rotating rotor blades)	Collision of migrating birds with tur-bines and rotating rotor blades; ei-ther from long-distance migration or from local movements e.g. between feeding or roosting places
	Nocturnal light sources and wires	

Habitat utilisation

Disturbance due to human activities from e.g. intensive boat traffic during construction, construction noise, presence of the turbines during operation and maintenance activities may potentially displace birds from the site. This may lead to habitat loss and reduced habitat utilisation for bird species at the site.

Bird sensitivity to disturbance varies considerably between the species, where some species may be attracted by human activities, for instance gull species, and other species such as divers (*Gavia* spp.) and common scoter (*Melanitta nigra*) may be displaced from wind farm sites (Danish Energy Agency, 2006). Therefore, even if the habitat and food resource remain intact, some local resting and feeding birds may be displaced from otherwise favourable habitats and may risk poorer foraging opportunities and greater competition in their new foraging areas where bird densities are consequently increased.

Habitat utilisation

At Nysted OWF the abundance of long-tailed duck decreased immediately after the installation of the turbines (Kahlert, *et al.*, 2004; Desholm & Kahlert, 2005). The construction of Rødsand 2 OWF has increased the displacement effect on long-tailed duck (Petersen et al. 2011; E.ON, in press)

In some cases OWFs can present a barrier to long-distance and local migration of birds ('barrier effect'). Some species may avoid unfamiliar objects and the construction of OWFs leading to changes in birds movements and migration routes. For long distance migrations, the barrier effects causing birds to avoid a single OWF by extending the route around the windfarm are likely to cause only a minor increase in energetic loss for the bird. However, there may be potential cumulative effects if birds need to avoid several OWFs along a migration route (Petterson, 2005; Masden, *et al.*, 2009; Masden, 2010). With respect to local migration, the main concern is windfarms that may be placed between breeding sites and a foraging site, since this will lead to frequent passage that can potentially lead to increased collision risk or increased flight distances.

The construction activities in particular in relation to foundation and cable installation often lead to some sediment spillage and increased sediment dispersion in the water. This temporary effect may impact the prey availiabilty of birds and the ability of birds to forage in the water and on the seabed. The marine environment will re-establish shortly after construction activities, and the effect on birds will therefore only be short term.

The establishment of OWFs will lead to physical changes in the marine environment with its foundations and anti scour protection. These structures will also lead to changes in the physical habitats changing the available food resources for birds in the area. However, these structures will only cover a small part of the wind farm area. Depending on the type of foundation the area covered by foundations and scour protection is typically 0.2-0.3 % of the total wind farm area (e.g. Danish Energy Agency, 2006; E.On, 2007).

The introduced hard structures such as foundations in an area of sandy substrates could on the other hand create novel feeding opportunities through establishment of artificial benthos reef communities. Thus habitat changes due to impacts from the OWF on the available food supply can potentially lead to habitat loss for seabirds. It can also lead to an introduction or favouring of other bird species feeding e.g. on benthos living on hard structures in the wind farm.

The turbine structures above the water, e.g. landing platforms or substation structures will offer resting places for some bird species. Often gulls and cormorant are seen associated with these structures. The abundance of these species may therefore increase in an area with offshore wind turbines and offshore transformer platforms.

Common scoter returned to Horns Rev Offshore Wind Farm

Results from post-construction monitoring concluded that the distribution of divers and common scoter were adversely affected by the presence of the wind turbines at Horns Rev.

In 2006 and 2007 maintenance crews and helicopter pilots reported increasing numbers of common scoters present within the wind farm site. Subsequent surveys showed that common scoter may indeed occur in high densities between wind turbines.

There was no sign that divers, previously concluded to avoid the wind farm area and its surroundings, had changed the distribution after construction of the wind farm (Petersen & Fox, 2007).

Collision risk

Collision with wind turbines and in particular rotor blades is often considered to be the most severe impact on bird populations in relation to OWFs. If bird flight heights are within the rotor-swept area and if they do not show avoidance behaviour there is a risk of collisions with the rotor blades or turbine structures. Numerous investigations during operation of OWFs do, however, show a high degree of avoidance behaviour in ranges between 90% and 99% by birds when approaching the wind farm farm (e.g. Danish Energy Agency, 2006; Desholm, 2009).

The avoidance behaviour depends on the ability of the birds to see the structures when approaching, i.e. the degree of avoidance is affected by weather conditions and by whether movements are during day or night time.

Collisions increase mortality rates in bird populations. At the flyway population level, the sensitivity to additional mortality depends on the population dynamics of the species. Long-lived species with a low reproduction rate such as many water birds and birds of prey are likely to be more sensitive to small changes in adult mortality compared to short-lived birds with a higher reproduction rate (e.g. passerines). In the EIAs both long-distance migration and short-distance movements of birds shall be considered and assessed.

Collision modelling at Rødsand 2 OWF

Post-construction monitoring at Rødsand 2 OWF has indicated that a number of species of birds of prey use the wind farm as a 'stepping stone' during the autumn migration from the Danish to the German coast. This attraction to the wind farm can increase the risk of collision. However, the collision modelling indicates that collisions will not affect the population level of sensitive, long-lived birds of prey (E.ON, 2012).

12.3 Key species

Key species in relation to the wind farm shall be identified as part of the EIA.

Key species are sensitive bird species that may be affected by the development of the wind farm. Key species can be numerous with high densities at the development sites but can also represent smaller populations of highly sensitive species. Highly sensitive species may be nationally or internationally protected and designated based for instance on the presence of important breeding, feeding or moulting sites in the vicinity of the wind farm.

The sensitivity of bird species depends on the local conditions, distance to shore, the degree at which the species utilise the area, migration routes, etc. Thus, it is not possible to draw general conclusions regarding specific key bird species in Denmark, since this will be site-specific.

The Danish OWF EIAs have identified different key species for the individual wind farms. At Horns Rev and Nysted for instance the physical characteristics and thereby the bird species varied considerably between the sites (Danish Energy Agency, 2006). At Horns Rev, the following numerically important bird species were identified as key species: divers (mostly red-throated diver (*Gavia stellata*)), gannet (*Morus bassanus*), common scoter (*Melanitta nigra*), herring gull (*Larus agentatus*), little gull (*L. minutus*, kittiwake (*Rissa tridactyla*), arctic/common tern (*Sterna paradisaea/hirundo*), auks (guillemot (*Uria aalge*) and/or razorbill (*Alca torda*). At Nysted OWF, key species included migrating waterbirds (e.g. eiders and geese), comorant (*Phalacrocorax carbo*) and mute swan (*Cygnus olor*) as well as wintering long-tailed duck (*Clangula hyemalis*), since they occurred in internationally important numbers (regularly >1% of the flyway population).

Impacts on birds are normally assessed at species level. However, closely related birds such as auks, divers and certain sea ducks that may be difficult to determine to species level in the field can be grouped, provided that they can be assumed to be impacted in the same way by the project. If no species-specific information is available it will be necessary to apply precautious assumptions when assessing the impact.

Different methods have been applied in identifying key species for sites. Seacon (2011) proposes a classification of bird species according to importance at the following three levels (major, medium and minor) below:

Level 1. Major importance

For migrating birds the potential impacted area is of major importance if:

- At least 1 % of the biogeographic population regularly migrate through the area; or
- At least 0.5 % of the biogeographic population of a species of very high conservation status (Annex I of the Bird Directive) or a species of global or European concern (SPEC1 or SPEC2 – see below) migrate through the area

For staging birds, the potential impacted area is of major importance, if:

- It includes parts of Natura 2000 sites having birds as part of the conservation objectives;
- The area regularly hosts more than 1 % of the biogeographic population, or the density of birds within the area is regularly higher than the 1 % area criteria proposed by Birdlife International (2004), i.e. 1 % of the biogeographic population within 3,000 km^2; or
- The area regularly hosts more than 0.5 % of the biogeographic population – or a density higher than 0.5 % of the biogeographic population within 3,000 km^2 – of a species of very high conservation status (Annex I of the Bird Directive) or a species of global or European concern (SPEC1 or SPEC2 – see below)

Level 2. Medium importance

For migrating birds the area is of medium importance if:

- Between 0.5 and 1 % of the biogeographic population regularly migrate through the area; or
- Between 0.1 and 0.5 % of the biogeographic population of a species of very high conservation status (Annex I of the Bird Directive) or a species of global, European concern (SPEC1, SPEC2, SPEC3 or NON-SPEC^E – see below) regularly migrate through the area

For staging birds the area is of medium importance if:

- The area regularly hosts between 0.5 and 1 % of the biogeographic population;
- The density of birds within the area is regularly between the denisty corresponding to 0.5 and 1 %, respectively, of the biogeographic population within 3,000 km^2; or
- The area regularly hosts between 0.1 and 0.5 % of the biogeographic population – or a density corresponding to between 0.1 and 0.5 % of the biogeographic population within 3,000 km^2 – of a species of very high conservation status (Annex I of the Bird Directive) or a species of global,

European concern (SPEC 1, SPEC2, SPEC3 or NON-SPEC^{E} – see below)

Level 3. Minor importance
For migrating and staging birds the potential impacted area is of minor importance if the abundance and usage is less than stated above.

The conservation concern status mentioned above is defined by Birdlife International (2004) as follows:

SPEC1: European species of global conservation concern, i. e. classified as Critically Endangered, Endangered, Vulnerable, Near Threatened or Data Deficient under the International Union for Conservation of Nature (IUCN) Red List Criteria (2004) at a global level

SPEC2: Species whose global populations are concentrated in Europe, and which have an Unfavorable conservation status in Europe

SPEC3: Species whose global populations are not concentrated in Europe, but which have an Unfavorable conservation status in Europe

Non-SPEC^{E}: Species whose global populations are concentrated in Europe, but which have a Favorable conservation status in Europe

Non-SPEC: Species whose global populations are not concentrated in Europe, and which have a Favorable conservation status in Europe

Impacts on the bird species of major importance are likely to be critical for the project, i.e. the approval process may be significantly prolonged or an application may be rejected. Impacts on the bird species of medium importance are not likely to be critical, but they have to be assessed in more detail, e.g. requiring an Appropriate Assessment (AA) of the species. Impacts on species of minor importance are not considered critical to the OWF project.

12.3.1 Designated sites and species protection

Updated information on designated sites or species that may be impacted by the wind farm shall be identified and described as part of the EIA. Designated sites and breeding colonies can be located far from the wind farm sites, but still be essential to include if designated bird species will be impacted by the wind farm, e.g. through migration or movements between feeding and breeding sites.

There are a number of marine sites around Denmark which are bird protection areas designated in accordance with the Birds Directive and/or the Ramsar Convention.

An overview of Natura 2000 sites in Denmark where migrating and/or staging water birds are part of the conservation objective is shown in Figure 12-1.

If the OWF is located on the flyway of migrating birds, being part of the conservation objectives of the Natura 2000 sites in question, the risk of affecting the Natura 2000-protected bird species should also be addressed.

If Natura 2000-site objectives and the birds for which they have been designated may be affected by the construction of an OWF, the EIA shall include an AA in a separate section in accordance with the Danish and EU guidelines.

For further information about Natura 2000, see:
www.naturstyrelsen.dk

http://ec.europa.eu/environment/nature/natura2000/index_en.htm

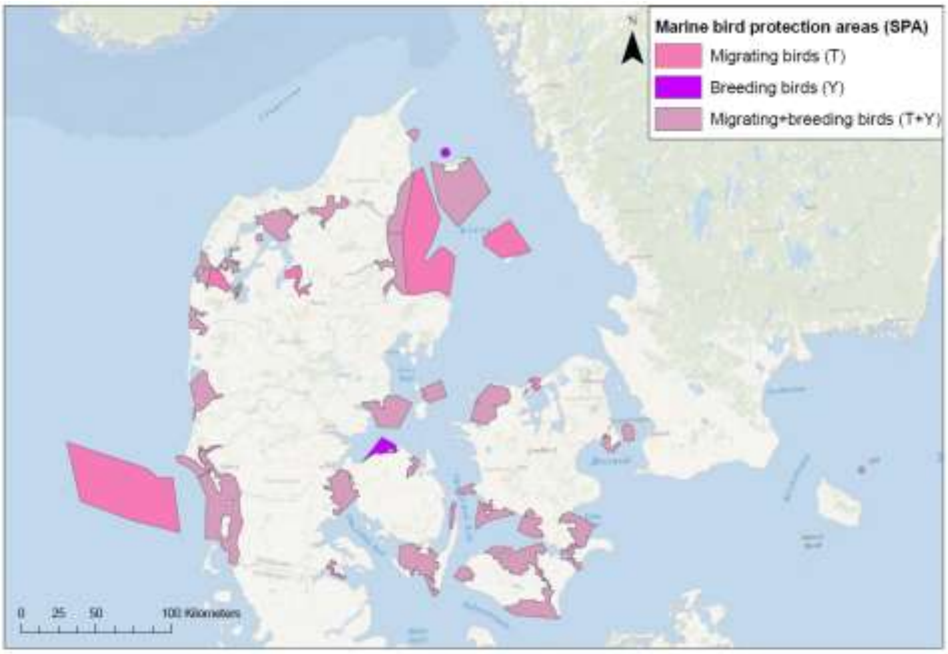


Figure 12-1 Natura 2000 sites where staging and/or migrating water birds are part of the conservation objective (map from 2012)

12.4 Existing data

Before planning possible field investigations, existing information on bird abundance and distribution in the area shall be gathered. Based on assumptions on site-specific key species, there must be a preliminary assessment of the existing data in order to determine if the data is adequate for the EIA or if it is to be supplemented through site-specific field surveys. Data can be gathered from other offshore projects, from the national environmental monitoring programme or other monitoring programmes.

In Denmark, surveys for staging birds are carried out regularly as part of a national programme. Distributional data is available in the Danmarks Miljøportal (http://www.miljoeportal.dk) database. The data is used to report the status of the Danish Natura 2000 sites and can also be obtained from the Danish Centre for Environment and Energy (DCE) (www.dce.au.dk), Department of Bioscience. (www.bios.au.dk).

No systematic monitoring of migrating birds is taking place, but the Danish Ornithological Society (DOF) is compiling data on bird migration. Some data can be found in the database DOFbase (www.DOFbasen.dk).

Existing data

Extensive water bird studies has been carried out to provide sufficient data to guide and communicate future plans for OWF development in Denmark. Abundance and distribution of red-throated / black-throated divers, common eider, long-tailed duck, common scoter red-breasted merganser and razorbill/guillemot were estimated, and the distribution of the selected water bird species in Danish waters was modelled based on aerial survey data.

These species are all relatively abundant and use the near-shore or offshore areas, where potential conflicts between birds and OWFs could be foreseen (Petersen & Nielsen, 2011).

Red-throated diver (*Gavia stallata*) (Photo: Ómar Runólfsson)

12.5 Field surveys and data analyses

Existing knowledge about site-specific bird abundance, habitat utilisation and migration, as well as the design and location of the wind farm, should be as-sessed in the early stage of the EIA in order to establish whether site-specific surveys will be required. If required, site-specific field surveys must be targeted at gathering relevant data on key bird species. Furthermore, results of benthic surveys can be included in the analyses in order to assess the food resources of bottom-feeding bird species. The sections below present a brief overview of field-survey methodologies which have been used in EIA investigations in selected

OWFs in Denmark and other European countries. Further details can be found in Seacon 2011a), NIRAS (2011) and BTO (2009).

12.5.1 *Survey methods*

To some extent field-survey methods have been standardised in Denmark and other EU countries (NIRAS, 2011).

The most commonly used methods in EIA assessments are presented in Table 12-2 and explained in more detail in the sections below. It should be noted that the survey methods are continuously developed. If new methods are used it is important to describe and argue for this and to document that the chosen method suits the purpose.

Table 12-2 Overview of frequently used survey methods (see details in the text below the table)

Issue	Method	Platform	Information
Bird distribution, abundance and behaviour	Visual surveys Digital surveys	Boat-based surveys Aerial surveys (standard visual) Aerial surveys (Stills or video)	Species identification Locations Numbers Sex (boat) Age (boat) Flight height (boat) Behaviour (boat)
Bird migration	Visual surveys	Coastal observations Boat-based surveys Fixed platforms	Species identification Locations Numbers Sex Age Day migration pattern
	Radar surveys	Boat-based surveys Fixed platform on land or at sea	Migration routes Migration intensity Flight direction Flight speed Flight altitudes Day and night migration pattern

Line transect surveys

The occurrence of resting, feeding and staging birds has often been investigated by visual counts along line transects from airplane or by boat-based line-transect counts – or a combination of both (Seacon, 2011a; Camphuysen, 2004). This method is suitable, in particular if very large offshore areas are to be surveyed.

Boat-based surveys

Boat surveys provide information about all bird species encountered on the sea, including details of species, numbers, sex, distance from the boat and behaviour of birds resting on the water. Birds sitting on the sea surface and birds in flight will be recorded in transects over predefined distance bands, including details of bird species, numbers, flight height (in predefined height bands) and flight direction.

Aerial surveys

Aerial surveys provide information about the species or groups of species, location and numbers. Standard visual aerial surveys are conducted along predefined parallel transect lines from an aircraft at low altitudes. Two observers conduct the observations along each side of the aircraft (Petersen & Nielsen, 2011).

Digital imaging (camera stills or video), in place of human observers, in aerial surveys has been applied for bird surveys over the past few years and may become more standard in future aerial surveys for Danish EIA investigations (Thaxter *et al*., 2009; Hexter, 2009; Mellor *et al*., 2008).

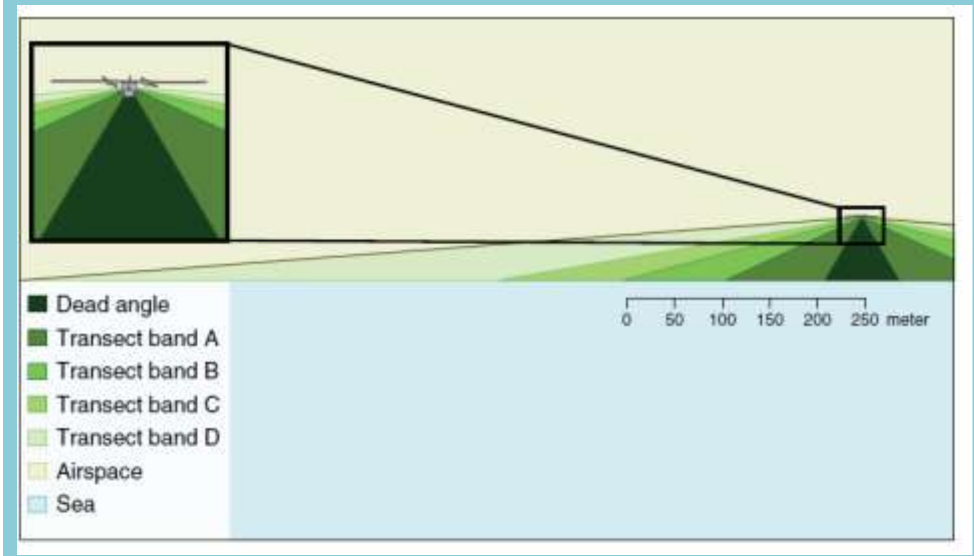
Apart from a more efficient identification and registration of staging and flying birds, the stills/video surveys are performed from a higher altitude, minimising the disturbance of the plane on the birds (Thaxter, 2009) as well as eliminating the need for flying low at turbine rotor height inside an OWF during operation. When surveying larger areas, standard visual aerial surveys can be more cost-effective than ship-based surveys. Larger areas are surveyed within a shorter time frame, and consequently this approach can take advantage of short favourable weather windows. The survey approach with vessels are more time-consuming offshore, but it provides more detailed information about the birds' behaviour (e.g. flight height and direction) and species-specific information (sex, age) than aerial surveys.

Therefore, the survey methodology shall be adapted to the key species and to the prioritised information needed to be gathered. Boat-based survey results and aerial counts are not directly comparable and must be treated separately.

Aerial-line transect surveys

Standard visual aerial surveys are conducted along pre-defined parallel transect lines (transect bands) from an aircraft at low altitudes. Two observers conduct the observations along each side of the aircraft.

A line spacing of 2 km is normally applied in Danish OWF EIA investigations, but a larger line spacing of up to 5 km has also been applied.



(Petersen & Nielsen, 2011)

Examples of EIA projects which have included boat- and aerial-based surveys

Boat-based surveys:

- Frederikshavn OWF (DONG Energy, 2008)
- Anholt OWF (Energinet.dk, 2009e)
- Westermost Rough OWF (UK) (DONG Energy, 2009)

Aerial surveys (visual observations):

- Nysted and Horns Rev OWFs (Petersen *et al.,* 2006)
- Yttgrunden and Yttre Stengrund Offshore Wind Farms in Kalmar Sound (Sweden) (Petterson, 2005)
- Horns Rev 2 OWF (NERI, 2006)
- Anholt OWF (Energinet.dk, 2009e)
- Westermost Rough OWF. (DONG Energy, 2009)

Aerial surveys (digital imaging):

- Walney Offshore Windfarms (surveys ongoing in 2012)
- Burbo Bank Extension OWF (surveys ongoing in 2012)

Radar surveys

Radar investigations provide information on migration routes, intensities of migrating birds as well as flight heights, speed and direction. Radar survey is mainly applied in cases where it is apparent that the OWF is situated on an important migration route which increases risk of collision or risk of the OWF constituting a migration barrier. Radar surveys are performed either from fixed platforms (e.g. on shore or at the OWF substation platform) or from vessels.

One common setup is the use of both horizontal and vertical radar. The use of two radars makes it possible to measure not only the flight speed and directions but also the height distribution of migrants at the actual site. If the wind farm area is mainly important for migrating land birds passing the sea between two coastal stretches, measurements could also be performed at the coast of departure and arrival of the birds.

There are three categories of radar systems which have been used for investigations on bird migration: marine surveillance radar, tracking radar and Pulse-Doppler radar. Presently, the marine surveillance radar has been applied in Danish EIA investigations, but both tracking radar and Pulse-Doppler radar should be considered for future OWFs.

Visual observations

To supplement the radar tracking, visual observations are required to validate the interpretation of radar track data. Visual observations provide information on species identification and actual numbers of migrating birds.

In addition, audio recording of flying birds can supplement species identification, especially during night where visual observations are not possible.

Though it should be noted that some birds migrate mute and quietly, whereas others make sounds while flying and make species identification easy.

Examples of EIA projects which have included radar surveys:

- Nysted and Horns Rev OWFs (Petersen *et al.,* 2006)
- Yttgrunden and Yttre Stengrund Offshore Wind Farms at Kalmar Sound (Sweden) (Petterson, 2005)
- Anholt OWF (Energinet.dk, 2009e)

- Rødsand 2 OWF (Grontmij | Carl Bro/NERI, 2011; Kahlert *et al*., 2007))

Telemetry

The telemetry term covers any kind of remote tracking of individual animals tagged with transmitters. Birds have been tagged with GPS or satellite tracking equipment to monitor detailed flight patterns. The method can be applied for monitoring of long-distance migration as well as local migration to monitor birds commuting, e.g. between breeding colonies and foraging sites.

Telemetric methods are at present considered to be of relatively limited value in relation to EIA investigations of bird migration for a specific OWF project. This is due to the fact that the telemetric methods provide information on single individuals or very few birds which can be difficult to apply to a site-specific OWF. Relevant information may be available from research programmes that can provide valid information to the ornithological impact assessment.

12.5.2 Data analyses

In the OWF EIAs different kinds of modelling based on field observations can be used to describe spatial distribution and estimate the collision risk of bird species. Modelling is not a prerequisite for the EIA; however, modelling can strengthen the data analysis and thereby the impact assessment and in some cases also replace site-specific ornithological surveys.

Modelling shall be based on robust qualitative data from the local area, and it is important to be aware of the advantages and limitations of the modelling approach which has been chosen.

Basic statistical considerations

The purpose of impact assessments is to evaluate if a stress factor has a significant effect on the environment and to estimate the magnitude of this potential effect. Sufficient data should be gathered from existing data and potential field investigations to perform a solid analysis. Statistical parameters that describe the variation of the calculated results (in terms of e.g. density, time or frequency) must always be presented including variance and confidence limits etc.

Data analysis to prepare for a BACI analysis (Before-After-Control-Impact) can be considered. The BACI design compares the changes from before till after the project activities in the impacted area with the (natural) changes during the same period in non-affected control areas. The evaluation is often difficult, because several factors may influence the environment additionally to the impact.

Habitat utilization

Spatial modelling can provide overall estimates of the mean densities and distribution of bird species within the investigated area.

Spatial modelling can be used to interpolate observations based on the properties of the observed data. The method can for example be used to estimate densities of birds in the entire investigation area based on densities from line transect data.

Based on site-specific data such as bathymetry, wave, tidal and current conditions, a model for suitable habitats can be established. This methodology can be applicable for some bird species with known habitat preferences (e.g. species feeding on benthos or pelagic fish), and where detailed information on the local conditions at the wind farm site is known.

It may be possible to identify through multivariate statistical models possible correlations between observed distribution data and environmental variables such as water depth, currents, bottom characteristics and food resources.

Agent-based modelling has been developed in an attempt to assess the cumulative impacts from offshore wind farms on birds. Model development has been carried out using a Pattern-Oriented Modelling procedure where model performance is compared with real data. The extent to which the model predicts impacts of wind farms correctly is related to the quality of real-world test data (Topping & Petersen, 2011).

Collision risk modelling

Different predictive collision models have been developed to predict the number of migrating birds that might collide with the turbines within the proposed OWF each year, e.g. Band *et al.* (2007). Collission risk modelling is based on the correlation of bird species and densities flying within the site in the rotor-swept area together with an estimate of species-specific avoidance rates.

A collision risk assessment may involve using the Potential Biological Removal (PBR) concept. The estimated numbers of collisions is compared with thresholds for sustainable removal from the relevant bio-geographic raptor population concerned (DONG Energy, 2012). The main advantage of this approach is that these assessments are conservative, and rely on those demographic parameters which are easy to obtain for the species.

The activity of flying birds close to wind turbines may be followed up by monitored post construction by the Thermal Animal Detection System (TADS) which uses a combination of infrared (thermal imaging) video cameras mounted on the base of the turbine tower and software (Desholm, 2003; Collier *et al*., 2011).

Examples of EIA projects which have included data modelling:

Habitat utilization modelling:

- Horns Rev 2 OWF (NERI, 2006)
- Rødsand 2 OWF (NERI, 2007; Grontmij | Carl Bro/NERI, 2011; E.ON, 2012)
- Anholt OWF (Energinet.dk, 2009)

Collision risk modelling:

- Nysted OWF (Petersen *et al.,* 2006)
- Rødsand 2 OWF (NERI, 2007; Grontmij | Carl Bro/NERI, 2011; E.ON, 2012)
- Westermost Rough OWF (DONG Energy, 2009)
- Horns Rev 2 OWF (DONG Energy, 2012)

12.6 Impact assessment

Assessment of impacts on birds should be based on quantitative estimates of the direct or indirect impacts on a species. The assessment must also take population levels or relevant (local) fractions of a population into account when potential impact is identified.

It is not realistic to address all impacts with respect to bird species occurring in the vicinity of the wind farms. It is required to focus on key bird species which are subject to special protection measures, species for which the wind farm area has significant importance at some stage in the annual life cycle, and species which are susceptible to habitat loss or even small increases in adult mortality (especially for long-lived birds with low annual reproductive output).

Displacement impacts can be assessed either conservatively by assuming displacement of all birds within an avoidance area ('buffer zone') around the OWF or based on detailed knowledge of avoidance for specific species from other studies, including knowledge of the adaptation of birds to their new surroundings (see box below).

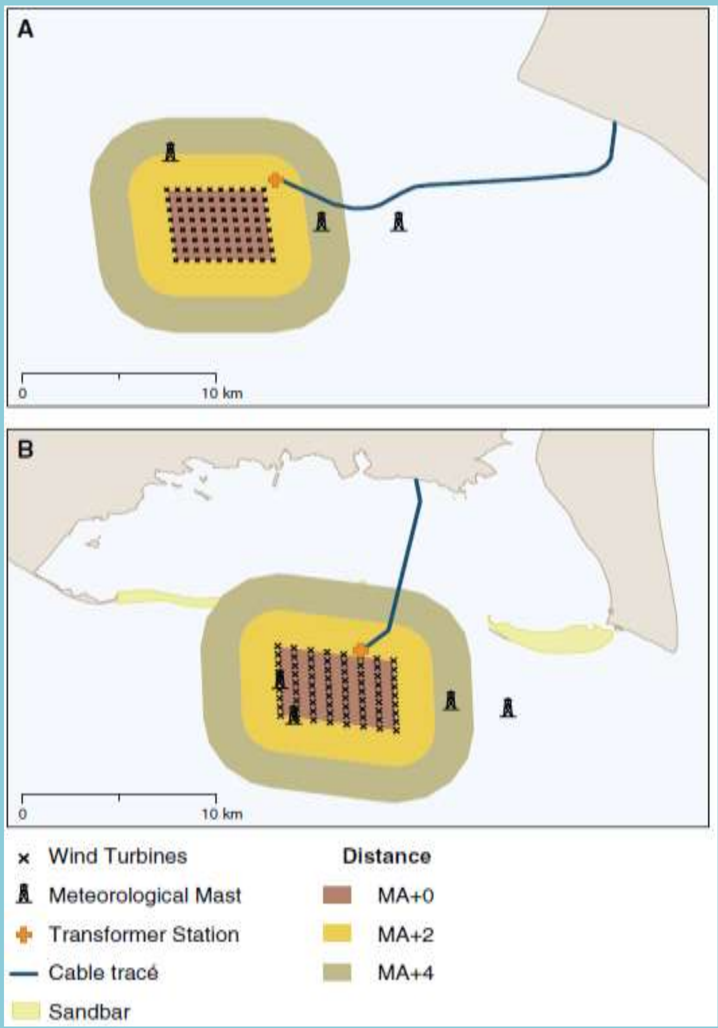
For migrating birds, barrier effect and collision risk should be assessed based on the expected intensity of migration in the OWF combined with experience from other offshore projects.

Cumulative assessment in relation to impact on birds from OWF development is being increasingly important as more wind farms are constructed (King et al., 2009). The EIAs of all new Danish offshore wind farms shall consider carefully the potential cumulative impacts that may arise from the development.

The general methodology to assess the environmental impact from the wind farm project during construction, operation and decommissioning is specified in Chapter 4.

Impact zones of bird displacement

The figure below presents an example of displacement impact zones used in the EIA for Horns Rev and Nysted OWFs. Both windfarms are assessed according to impact within the wind farm areas as well as buffer zones of 2 km and 4 km around the wind farm. (A) is Horns Rev OWF and (B) is Nysted OWF (Petersen *et al*. 2006. Report commissioned by Vattenfall A/S and DONG Energy).



12.7 Appropriate Assessment (AA)

In case of the identification of potential impact on a Natura 2000-designated objective or an Annex 1 Habitat species, there will be a requirement to do an AA. The AA shall comply with Danish and EU guidelines and be based on the initial screening. For further information on AA, see Chapter 5.

13 BATS

13.1 Introduction

This chapter provides guidance on the assessment of bats as part of the Environmental Impact Assessments (EIA) for offshore wind farms (OWFs). It describes background information and selected survey methods.

It should be noted that the knowledge base concerning bats at sea is still very limited, but in rapid development. In elaborating an impact assessment the lates knowledge must be utilised.

13.2 Key impact issues

This section outlines a number of key impact issues in relation to bats which shall be considered and assessed for all wind farms as part of the EIA.

Bat populations may be sensitive to increased mortality because bats generally have a long lifespan and slow reproduction. Therefore, the introduction of new mortality factors such as wind turbines on a large scale could potentially alter the conservation status of bat populations from favourable to unfavourable (Baagøe, 2010).

The fact that some bats migrate over long distances has been known for a long time (Griffin, 1970). For Scandinavian bats, in particular, this means that they regularly have to cross large expanses of open sea to and from the European continent. However, bat species differ considerably in their tendency to migrate long distances. Generally, only the species belonging to the *Nyctalus* genera (notably the common noctule *N. noctula*), *Pipistrellus* (the pygmy pipistrelle *P. pygmaeus* and the Nathusius pipistrelle *P. nathusii*) and possibly also *Vespertilio* (the parti-colored bat *V. murinus*) should be considered long-distance migrants in the true sense (Hutterer et al., 2005). The other North European species (belonging to the genera *Myotis* (mouse-eared bats), *Plecotus* (long-eared bats) *Eptesicus* (serotine and northern bat) and *Barbastella* (barbastelle) are believed to be more or less stationary, although they still may undertake considerable movement flights between summer and winter areas. Examples of such bats are *Myotis dasycneme* (pond bat) and *M. daubentonii* (Daubenton's bat) that breed over much of Jutland in the summer but concentrate in a few limestone caves during the hibernation season in the winter (Egsbaek et al., 1971).

However, the behaviour of bats during migration at sea has been studied only relatively recently, and such studies have been restricted to the brackish waters around Denmark and southern Sweden such as the Baltic Sea and Øresund (Ahlén, 1997; Ahlen *et al.*, 2007 and 2009). Generally, no less than 11 out of the 19 species known from the region (Baagøe, 2001) more or less frequently make use of the open sea either during migration or when hunting insects over the water, sometimes as much as 19 km from the shore. Hence, migration and foraging over the marine environment by bats is a rather common in certain Danish and South Swedish areas. All bats observed over the sea used normal echolocation, as they do when they fly over land (Ahlén *et al.*,2009).

Migrating bats arrive in Denmark and Scandinavia in the spring (April and May) and depart again in the autumn (August and September). Studies in the Baltic Sea and Øresund indicate that the bats normally arrive to the shore dispersed one by one, but that they usually depart in smaller groups, consisting of 2-3 and sometimes up to 20 individuals. Over land, migrating bats seem to follow obvious landscape features such as coastlines (Petersons, 2004) and river beds (Furmankiewicz and Kucharska, 2009) and, as a consequence, they tend to concentrate in particular sites such as peninsulas that may function as take-off points (Ahlen, 1997). Examples of such departure sites are the southern tips of Lolland, Falster, Bornholm, Øland, Gotland, south of Gothenburg (Onsala), Skåne (Falsterbo) and Blekinge (Torhamn) (Figure 13-1). Groups of up to 250 individuals have been registered at such departure sites (Ahlén, 1997). Generally, these sites are those that are also known as migration sites for birds, and it seems likely that the behaviour of migrating bats is similar to that of birds in this respect. However, the behaviour of bats during migration has been studied only through acoustic and visual observations from the ground, and not using radar that may reveal what happens at high altitudes. Hence, it remains possible that much of the bat migration, as in birds, actually takes place at higher altitudes.

The shortest distance from the departure site at the southern tip of Gotland to the Polish coastline is 225 km and the distance to the German coast is 400 km. Assuming that the common migratory bat species *Pipistrellus nathusii* flies at a speed of about 20 km/h, the migration may take between nine and 20 hours non-stop. This is longer than the dark hours of the night even in the autumn, and, therefore, bats starting their over-sea journey sometimes arrive to the opposite shore in broad daylight the following morning (Ahlén *et al.*,2009).

Bats can fly long distances to forage over the sea. This applies both to the migratory species such as the noctule *Nyctalus noctula* and the pygmy pipistrelle *Pipistrellus pygmaeus* and the non-migratory ones such as the pond bat *Myotis dasycneme* and Daubenton’s bat *Myotis daubentonii*. The migratory species *Nyctalus noctula* has been observed foraging over the sea in Kalmarsund and Øresund, returning before dawn to roost in same land areas from which they departed at dusk (Ahlén *et al.*,2007; Ahlén *et al.*,2009).

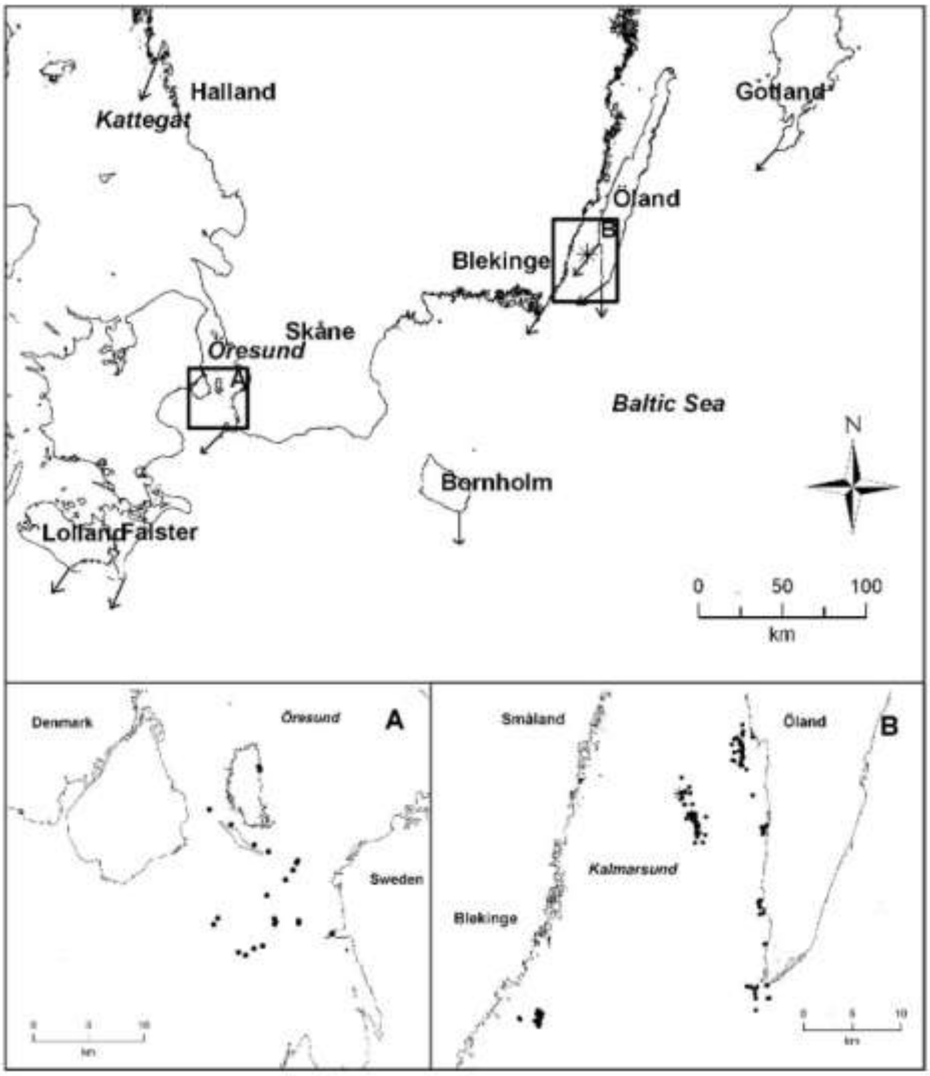


Figure 13-1 Observations (dots) and departure sites (arrows) for bats in Kattegat, the Baltic Sea and Øresund (Ahlén *et al.*,2009).

It has recently become evident that bats may be killed due to collision with the wings of the wind turbines. Generally, the risk for bats is highest if the wind turbines are placed in areas where the bats accumulate. Such places include coastlines and river beds used by migrating bats (Rydell, pers. comm.). However, it seems likely that bats are attracted to wind turbines as insects concentrate in these places (Rydell, 2010b). Offshore wind turbines may also be attractive foraging areas for bats that forage over sea (Ahlén, et al., 2007; Baagøe, 2010; Ahlén, et al., 2009).

The wind turbine towers and blades may attract insects sitting on or flying around the turbines. One possible reason for this may be radiation of heat. There are also other hypotheses (Kunz *et al.,* 2007a, 2007b; Arnett *et al.,* 2008; Rydell *et al.,* 2010a, 2010b, 2011).

13.2.1 Potential impacts on bats from offshore wind farming

Bats have been observed to feed on insects attracted to wind turbines at sea. Ahlén (2003) and Ahlén *et al.,* (2007, 2009) noticed that bats (common noctules and pygmy pipistrelles) show the same behaviour at two wind farms up to 10 km from land in the Baltic Sea (near Öland) as they normally do when they feed on insects at wind turbines on land. The insects were apparently drifting or migrating across the Baltic Sea. Ahlén *et al.* (2007) also provides evidence that bats sometimes, after having fed, may stay at sea until the next evening, finding suitable roosts in the towers or nacelles of wind turbines offshore.

Nevertheless, not much is known about potential bat mortality caused by offshore wind turbines or about what effects the wind farms may have on the bat populations. The species observed feeding at wind farms at sea are generally the same as those that commonly feed around wind farms on land, including species of the genera *Nyctalus* and *Pipistrellus* (mostly the common noctule *Nyctalus noctula* and the pygmy pipistrelle *Pipistrellus pygmaeus*) and probably also the particoloured bat *Vespertilio murinus*. The other two species that regularly feed over brackish waters, namely Daubenton's bat (*Myotis daubentonii*) and the pond bat (*M. dasycneme*) usually fly very low over the water and most likely do not normally come in contact with the rotors of wind turbines.

Table 13-1 Main impacts and effects on bats in relation to offshore wind farms

Impact	Source of impact	Effect
Collision	*During operation* Presence of turbines (i.e. rotating rotor blades)	Bat mortality in collision with wind turbines can be caused by external damage, such as wing fracture, but also by internal injuries due to rapid acceleration near the rotating turbine wings without suffering a direct collision (Regierungspräsidium Freiberg, Baden-Württemberg 2006)
Displacement	*During operation* Physical barrier of the turbines	Disturbance or severance of mitigation routes or local commuting routes (Rodrigues *et al.*,2008)

13.3 Key species

Key species in relation to the wind farm shall be identified as part of the EIA. Key species are bat species that may be affected by the development of wind farms. Key species can be numerous with high densities at the development sites but can also represent smaller populations of highly sensitive species. Local conditions and species abundance determine the key species of the specific site.

Pipistrellus pygmaeus is one of the smallest bat species in Denmark (Photo: Mnolf).

Pipistrellus pipistrellus (Photo: Barracuda)

13.3.1 *Designated sites and species protection*

Updated information on designated sites or species that may be impacted by the wind farm shall be identified and described as part of the EIA. Designated sites and breeding sites may be located far from the wind farm; however, it is essential to assess whether bat species will be impacted by the wind farm e.g. during foraging behaviour or through migration. The geographic range for the EIA can therefore cover large areas such as large parts of Øresund or the Baltic Sea.

Protection of bats in Denmark

All bat species and all bat habitats occurring in Denmark are protected according to the EU Habitats Directive appendices II and IV. It is prohibited to disturb bats, especially when they have pups or during hibernation and migration and to destroy breeding sites or resting places.

Furthermore, bats are among the protected species in several of the Danish Natura 2000 sites including coastal areas. There are two species of bats designated for Natura 2000 sites in Denmark. *Myotis dasycneme* is designated for 18 Natura 2000 sites and *Barbastella barbastellus* is designated for five Natura 2000 sites. Bats are equally protected irrespective of whether they are found inside or outside of Natura 2000 sites.

13.4 Existing data

Before planning field surveys, existing information on bats in the area shall be gathered. Based on assumptions on site-specific key species, the existing information shall undergo a preliminary assessment in order to determine if it is adequate for the EIA or if supplementary field surveys are necessary. Data can be gathered from other offshore projects or from monitoring programmes and studies – the Danish Zoological Museum collects information on bats in Denmark and performs monitoring.

13.5 Field surveys and data analyses

Based on existing knowledge about bats and the design and location of the wind farm, there should be an assessment in the early stage of the EIA of whether site-specific surveys are required as part of the EIA. If required, site-specific field surveys must be targeted at gathering relevant data on key bat species.

The sections below present an overview of field-survey methodologies which, according to existing knowledge, are recommended for offshore surveys of bats.

13.5.1 *Survey methods*

Investigations of the impact of OWFs on bats are sparse, and methods can be expected to be further developed and improved in the future. Since very few surveys have been conducted offshore, the most appropriate survey techniques still need to be proven. The height at which surveys are undertaken offshore should ideally reflect the proposed height of the wind turbines.

The methods recommended for bat surveys on OWFs correspond to those recommended in relation to land-based turbines. Surveys are, however, required to be undertaken from boats, lighthouses, etc. Recommended methods for registration of bats are (Rodrigues *et al.,* 2008; Ahlén *et al.,* 2007):

- Ultrasound detectors (automatic or hand-held)
- Radio tracking
- Direct observations combined with spotlight and/or infrared camera

With a hand-held bat detector in combination with visual observations it is usually possible to identify the species of bat and also to unambiuosly distinguish foraging individuals from those that do not forage. Bat detection combined with visual studies makes it possible to gather information about species identification, bat behaviour and separate foraging bats from passing animals (Rodrigues *et al.,* 2008). Radar should not be used as a tool on its own but must be used in combination with conventional methods (Rodrigues *et al.,* 2008).

Experience and results from the Baltic Sea indicate that it may be possible to combine observations from land and sea for wind farms relatively close to the coastline.

Survey period
Bat surveys related to OWFs will need to be planned according to the species specific knowledge.

The weather may have to be considered when conducting bat surveys offshore, as observations show that the timing of bat takeoff and flight across the sea may be affected by weather.

13.6 Impact assessment

Assessment of impacts on bats may be based on quantitative estimates of the direct or indirect impacts on bats and it needs to be assessed if the impact is significant.

13.7 Appropriate Assessment (AA)

In case of the identification of a likely significant effect on a Natura 2000-designated site or Annex 1 Habitat species, there will be a requirement to do an AA. The AA must comply with Danish and EU guidelines.

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15 USEFUL LINKS

www.ens.dk

www.naturdata.miljoportal.dk.

www.dofbasen.dk

www.fugleognatur.dk

www.neri.dk

www.naturdata.dk

http://miljoegis.mim.dk/cbkort?profile=miljoegis-natura2000
www.naturstyrelsen.dk

http://ec.europa.eu/environment/nature/natura2000/index_en.htm

www.naturdata.dk

www.arealinfo.dk

www.naturstyrelsen.dk/Naturbeskyttelse/Natura2000/

http://ec.europa.eu/environment/nature/index_en.htm

www.dce.au..dk

http://miljoegis.mim.dk/cbkort?profile=miljoegis-natura2000

http://www.chelonia.co.uk/html/pod.html

http://www.fao.org/fishery/topic/3384/en

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http://www.fao.org/docrep/003/AA044E/AA044E03.htm,

http://www.coastalwiki.org/coastalwiki/Sampling_tools_for_the_marine_environment

16 ANNEX 1 – ASSESSMENT METHODOLOGY

Method for assessing environmental impacts (EIA)

The following provides an overview of a method developed by NIRAS to provide a framework for the environmental impact assessment of infrastructure projects.

An assessment of environmental impacts aims at identifying and evaluating significant effects that are very likely to occur. The assessment focuses on the issues identified with most significant effects and not on concerns that the assessment indicates to be insignificant. An impact can be either positive or negative.

This note describes the general method for assessing environmental impacts. The method has been developed based on the criteria in annex 3 of the EU-EIA Directive (85/337/EEC). The assessment method is drawn up by NIRAS. The method is a working tool which can be continuously revised.

The main purpose of the method is to ensure that the assessments are based on specific terms and to increase the transparency of the assessments conducted. The objective is to propose possible mitigation measures and to define the residual impacts in order to support the decision-making process. It is important to point out that the method can never stand alone. It has not been the intention to try to establish a method that would predict the exact magnitude of the impact or change in all situations and the method cannot replace specialist knowledge and project-specific assessments.

The method can be used where there are no statutory requirements (such as threshold limit values). The method is not applicable to assessments in accordance with the EU-Habitat Directive and EU-Bird protection Directive (Natura 2000 sites).

Description of the method

Table 1 indicates the distinction between significant and not-significant impacts.

Table 1. Degree of environmental impact

Significance	Degree of impact
Significant	1. Major impact (positive/negative) 2. Moderate impact (positive/negative) 3. Minor impact (positive/negative)
Not significant	4. Negligible impact 5. No impact

Table 2 describes when mitigation measures are expected with a view to reducing a given environmental impact.

Table 2. Degree of remedial measures

Magnitude of impact	Mitigation measure
Major impact	Impact considered of sufficient importance to consider whether the project should be changed or whether mitigation measures should be made to reduce this impact
Moderate impact	Impact of a magnitude where mitigation measures are considered
Minor impact	Impact of a magnitude where it is not likely that mitigation initiatives are necessary.
Negligible impact and no impact	Impacts considered so negligible that they are not relevant to take into consideration when implementing the project

A number of criteria form part of the assessment of environmental impacts. Table 3 lists the most significant criteria. The likelihood of occurrence or the risk of an environmental impact taking place has been divided into three groupings in the table; however, as is most often the case in respect of impacts on the natural environment, this division will be more varied and detailed.

Table 3. List of criteria for assessment of environmental impacts

Criteria	Factor
Importance of the issue	• Importance to international interests • Importance to national interests • Importance to regional interests • Importance to local interests • Importance in respect of the area with direct impact • Negligible or not important
Persistence	• Permanent impact (non-reversible) in the life of the project • Temporary for >5 years • Temporary for 1-5 years • Temporary for <1 year
Likelihood of occurrence	• High (>75 %) • Medium (25-75 %) • Low (<25 %)
Direct/indirect impact	Impact caused directly by the project or indirectly as a derived effect of a direct impact
Cumulative	An impact combined of other activities or other projects locally or re-gionally

The tables below (Table 4, 5 and 6) indicatesthe process of assessing the magnitude of individual environmental impacts in connection with a project. The following is a description of the table: Column 1 states the degree of disturbance: The extent of the disturbance is assessed as high, medium or low. Column 2: assesses whether the disturbance is important to international, national/regional or entirely local interests. Column 3 indicates the likelihood that the assessed disturbance occurs. Column 4 shows the persistence of the disturbance. By combining these four factors the magnitude of impact is found in column 5.

One of the purposes of the method is to ensure that the assessments are based on the terms laid down: degree of disturbance, importance, likelihood of occurrence and persistence. At the same time, the purpose is to increase the transparency of the assessments conducted and ensure supplementary argumentation. It is important to point out that it is a matter of estimating the likely degree of impact, and that the method can never stand alone. It is not possible to establish a method in which the degree of impact can always be predicted when the method is to cover environmental assessments within all relevant topics. The method cannot replace specialist knowledge and project-specific assessments, and therefore the assessments must be made on the basis of a specialist insight and with sufficient argumentation. This can lead to the resultant degree of impact becoming different from what the method immediately predicts.

Table 4. Assessment of degree of impact (high degree of disturbance) (NIRAS, 2012).

Degree of disturbance	Importance	Likelihood of occurrence	Persistence	Magnitude of impact
High	International interests	High (>75 %)	Permanent (> 5 years)	Major
			Temporary (1-5 years)	Major
			Short-term (0-1 year)	Moderate
		Medium (25-75 %)	Permanent (> 5 years)	Major
			Temporary (1-5 years)	Major
			Short-term (0-1 year)	Moderate
		Low (<25 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Moderate
			Short-term (0-1 year)	Minor
	National or regional interests	High (>75 %)	Permanent (> 5 years)	Major
			Temporary (1-5 years)	Moderate
			Short-term (0-1 year)	Moderate
		Medium (25-75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Moderate
			Short-term (0-1 year)	Minor
		Low (<25 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Minor
	Local interests (important for the area directly affected or for the immediate surroundings)	High (>75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Moderate
			Short-term (0-1 year)	Minor
		Medium (25-75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Minor

Degree of disturbance	Importance	Likelihood of occurrence	Persistence	Magnitude of impact
			Short-term (0-1 year)	Negligible/none
		Low (<25 %)	Permanent (> 5 years)	Minor
			Temporary (1-5 years)	Negligible/none
			Short-term (0-1 year)	Negligible/none
	Negligible/not important	High (>75 %)	Permanent (> 5 years)	Negligible/none
			Temporary (1-5 years)	Negligible/none
			Short-term (0-1 year)	Negligible/none
		Medium (25-75 %)	Permanent (> 5 years)	Negligible/none
			Temporary (1-5 years)	Negligible/none
			Short-term (0-1 year)	Negligible/none
		Low (<25 %)	Permanent (> 5 years)	Negligible/none
			Temporary (1-5 years)	Negligible/none
			Short-term (0-1 year)	Negligible/none

Table 5. Assessment of degree of impact – medium

Degree of disturbance	Importance	Likelihood of occurrence	Persistence	Magnitude of impact
Medium	International interests	High (>75 %)	Permanent (> 5 years)	Major
			Temporary (1-5 years)	Moderate
			Short-term (0-1 year)	Moderate
		Medium (25-75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Moderate
			Short-term (0-1 year)	Minor
		Low (<25 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Minor
	National or regional interests	High (>75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Moderate
			Short-term (0-1 year)	Minor
		Medium (25-75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Minor
		Low (<25 %)	Permanent (> 5 years)	Minor
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Negligible/none
	Local interests (important for the area directly affected or for the immediate surroundings)	High (>75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Minor
		Medium (25-75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Minor

Degree of disturbance	Importance	Likelihood of occurrence	Persistence	Magnitude of impact
			Short-term (0-1 year)	Negligible/none
		Low (<25 %)	Permanent (> 5 years)	Minor
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Negligible/none
	Negligible/not important	High (>75 %)	Permanent (> 5 years)	Negligible/none
			Temporary (1-5 years)	Negligible/none
			Short-term (0-1 year)	Negligible/none
		Medium (25-75 %)	Permanent (> 5 years)	Negligible/none
			Temporary (1-5 years)	Negligible/none
			Short-term (0-1 year)	Negligible/none
		Low (<25 %)	Permanent (> 5 years)	Negligible/none
			Temporary (1-5 years)	Negligible/none
			Short-term (0-1 year)	Negligible/none

Table 6. Assessment of degree of impact – low degree of disturbance

Degree of disturbance	Importance	Likelihood of occurrence	Persistence	Magnitude of impact
Low	International interests	High (>75 %)	Permanent (> 5 years)	Moderate
			Temporary(1-5 years)	Minor
			Short-term (0-1 year)	Minor
		Medium (25-75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Negligible/none
		Low (<25 %)	Permanent (> 5 years)	Minor
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Negligible/none
	National or regional interests	High (>75 %)	Permanent (> 5 years)	Moderate
			Temporary (1-5 years)	Minor
			Short-term (0-1 year)	Negligible/none
		Medium (25-75 %)	Permanent (> 5 years)	Minor
			Temporary (1-5 years)	Negligible/none
			Short-term (0-1 year)	Negligible/none
		Low (<25 %)	Permanent (> 5 years)	Minor
			Temporary (1-5 years)	Negligible /none
			Short-term (0-1 year)	Negligible/none
	Local interests (important for the area directly affected or for the immediate surroundings)	High (>75 %)	Permanent (> 5 years)	Minor
			Temporary (1-5 years)	Negligible/none
			Short-term (0-1 year)	Negligible/none
		Medium (25-75 %)	Permanent (> 5 years)	Minor
			Temporary (1-5 years)	Negligible/none

Degree of disturbance	Importance	Likelihood of occurrence	Persistence	Magnitude of impact
			Short-term (0-1 year)	Negligible/none
		Low (<25 %)	Permanent (> 5 years)	Minor
			Temporary (1-5 years)	Negligible/none
			Short-term (0-1 year)	Negligible/none
	Negligible/not important	High (>75 %)	Permanent (> 5 years)	Negligible/none
			Temporary (1-5 years)	Negligible/none
			Short-term (0-1 year)	Negligible/none
		Medium (25-75 %)	Permanent (> 5 years)	Negligible/none
			Temporary (1-5 years)	Negligible/none
			Short-term (0-1 year)	Negligible/none
		Low (<25 %)	Permanent (> 5 years)	Negligible/none
			Temporary (1-5 years)	Negligible/none
			Short-term (0-1 year)	Negligible/none