BUNDESAMT FÜR
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HYDROGRAPHIE

Standards for Environmental Impact Assessments

Impacts of offshore wind turbines on the marine environment

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of Offshore Wind Turbines in the Marine Environment

Status: 25. February 2003

Issued by Bundesamt für Seeschifffahrt und Hydrographie BSH,
(Federal Maritime and Hydrographic Agency), in cooperation with:

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Part A General conditions

1. Preliminary remarks

Within the framework of the approval procedure for offshore wind farms in the Exclusive Economic Zone (EEZ), potential adverse impacts of the projected facilities on the marine environment have to be assessed. Besides, following the amendment to the Seeanlagenverordnung effective 5 April 2002, an Environmental Impact Assessment according to Art. 2a, Seeanlagenverordnung, is now mandatory for most projects. In the Standards for Environmental Impact Assessments, information is provided to applicants on the scope of investigations required by the approval authority, with all relevant details and explanations.

The Standards for Environmental Impact Assessments constitute a framework of the thematic and technical minimum requirements for marine environmental surveys and monitoring in order to assess compliance with Art. 3, Seeanlagenverordnung.

The first update on the Standards for Environmental Impact Assessments is based on experience that has been gained with the version of 20 December 2001. Apart from the general increase in knowledge, experience from the German Marine Monitoring programme in the North Sea and Baltic Sea, the Helsinki Convention on the Protection of the Marine Environment of the Baltic Sea Area, and the OSPAR Convention for the Protection of the North Sea and North-East Atlantic has been taken into account as well.

It should be noted that the Standards for Environmental Impact Assessments have been developed in consultation with numerous experts. The fact that various concepts discussed in the course of the decisionmaking process have not been considered in the Standards for Environmental Impact Assessments does not imply any criticism of such concepts. The approval authority, after having consulted the experts and studied the different concepts, in each case selected one of several possible solutions and also allowed alternatives considered suitable for the procedure.

2. Possible adverse impacts

Regarding possible impacts of offshore wind farms on the marine environment, various risks have been identified for the construction, operation, and decommissioning phases. They can be summarized as follows:

2.1 Construction phase

- Visual and acoustic effects
- Annoyance by vehicles/vessels and machinery during construction
- Loss of habitats (e.g. resting and feeding areas) due to construction activities
- Pollutant emissions
- Turbidity of water due to sediment disturbance during foundation installation, cable laying and anchoring/propping of vessels and machinery on the seabed.

2.2 Operation phase

- Visual impact and annoyance due to noise emission of turbines
- Shadow flicker from rotor blades
- Vibration (noise emission)
- Additional electric and magnetic fields
- Land use by the required infrastructure (foundations, cables etc)
- Potential discharge of pollutants (oils, greases)
- Changed sediment distribution and dynamics
- Changed current patterns
- Impact on water quality
- Collisions with wind turbines (birds)
- Barrier effect on fauna (e.g. barrier effect on birds during migration, or blocking of paths between different resting and/or feeding areas
- Disturbances (e.g. birds, long-term loss of resting and feeding areas)
- Adverse impacts of maintenance and repair operations

2.3 Removal phase

- Visual and acoustic annoyance
- Annoyance from vehicle and machinery operation during dismantling activities
- Loss of habitats (resting and feeding areas) due to removal activities
- Pollutant emissions
- Turbidity of water due to sediment disturbance during the dismantling of foundations (piles), lifting of cables, propping/ anchoring of vehicles and machinery on the seabed

3. Objectives

Investigation of impacts on environmental features to be protected, i.e. fish, benthos, birds, and mammals in order to:

- determine their spatial distribution and temporal variability in the pre-construction phase (baseline survey)
- monitor the effects of construction, operation and removal.
- The baseline data will serve as a basis for evaluating the monitoring results
- The purpose of the preliminary fish studies is a quantitative determination of the near-bottom stationary fish species to the extent that suitable methods are available.

4. Deviation from the Standards for Environmental Impact Assessments, updating

If it is found during data acquisition and evaluation that parts of the monitoring programme are inadequate or dispensable, either with respect to the locations chosen or for any other reason, or if it is found that programme implementation is either impossible,is not feasible in the proposed way or would require disproportionate effort and expense, the approval authority may modify the

monitoring programme in general or in individual cases. Justified deviations from the concept, e.g. due to experience gained or an improved knowledge base, may be applied for or made mandatory at any time.

5. Quality assurance

For a proper evaluation, the collected data must be correct and comparable.

Those participating in the surveys have to be adequately qualified and able to prove that they have acquired sufficient experience. The names of the observers have to be noted on the survey forms.

In the planning and implementation of monitoring programmes at sea and in the evaluation of results, currently valid national and international scientific standards shall be applied. Quality requirements have to be met. Participation in quality assurance programmes, national and international inter-laboratory tests and in quality assurance workshops or programmes is required

Ship surveys of seabirds are only allowed to be carried out by teams which have at least received instructions or preferably intensive training, e.g. by members of ESAS (Garthe et al. 2002).

With respect to aircraft surveys of seabirds, it is essential that the observers have a secure knowledge of bird species and are familiar with aerial counting. New observers, therefore, first have to be trained in the counting method during training flights (Diederichs et al. 2002).

Observers in radar surveys must have received instructions in radar technology and optimal operation of radar equipment from an experienced radar observer (Hüppop et al. 2002).

The contents and implementation of such instructions have to be documented.

Proof of adequate qualification for noise and vibration measurements has to be furnished (e.g. accreditation according to DIN EN 45001 for noise and other measurements of wind turbine emissions).

6. Pilot phase

Large-scale wind farm projects presently have to be preceded by a pilot phase to find out whether the requirements for their authorization are met. Prior to and after the pilot phase, baseline surveys and monitoring have to be carried out following notification of the probable scope of the investigations on the basis of the Standards for Environmental Impact Assessments. The scope of monitoring will depend on the results of the baseline surveys, taking into account experience gained in the process.

7. Expansion phase

For every expansion step following the pilot phase, baseline surveys and monitoring in accordance with the Standards for Environmental Impact Assessments will be mandatory. Modifications required at individual sites will be laid down in the notification concerning the scope of monitoring.

8. Removal phase

The wind turbines including their foundations have to be removed completely, with subsequent onshore disposal.
In principle, the monitoring requirements during this phase correspond to those in the construction phase as specified in the Standards for Environmental Impact Assessments. Possible environmental impacts depend mainly on the dismantling techniques used, which are expected to undergo major developments during the coming decades when numerous oil and gas platforms are due for removal. Therefore, the scope of monitoring will be determined at a later date**.**

9. Landscape

Within the framework of the baseline survey preceding the pilot phase, a photorealistic simulation (text and visualisation) of the landscape affected by the project has to be presented, unless the project is located farther than 50 km from the nearest point on the coast.

The visualisation should include the following:

- visualisation from coastal sites close to the project location, both at beach level and from prominent points (lighthouses, beach promenades, seawalls etc.)
- visualisation of the 1st expansion stage/pilot phase and of the entire wind farm in its fully expanded stage
- visualisation under conditions of optimal visibility
- visualisation shall be made from a normal perspective, i.e. no wide-angle or tele lens perspective
- visualisation with scale bar (2.40 m high, 20 cm scaling, 7 m distance from the observer) in the foreground (to demonstrate size relations)
- turbine hub height and distance between the observation point and the wind farm (kilometres) as well as position and height of the observation point, to be shown at the lower edge of the visualisation image
- presentation of an outline map indicating angle of vision

10. Risk analysis

A state-of-the art risk analysis assessing the probability of a ship collision with a wind turbine, including an exemplary study of the consequences of a potential pollutant spill, has to be carried out and presented in the framework of the baseline surveys preceding the pilot phase.

11. Procedure for the implementation and evaluation of studies relating to the construction and operation of offshore wind farms

Application for the erection of offshore wind turbines

Presentation of the following documentation:
- Literature study to characterise the planning area
- Proposal of an investigation programme in accordance with the Standards for Environmental Impact Assessments

⇓

Environmental Impact Assessment - baseline survey: a) preliminary studies

- Characterisation of the planning area in order to determine the project area, monitoring programme, and reference areas for the environmental features to be protected

⇓

Environmental Impact Assessment – baseline survey: b) status assessment

- Investigations prior to the start of construction to characterise the environmental features of the project and reference areas, particularly with a view to species and their seasonal dynamics

⇓

Environmental Impact Assessment – monitoring of construction phase

- Investigations in the project and reference areas to assess impacts of the construction phase on the marine environment

⇓

Environmental Impact Assessment – monitoring of operation phase

- Investigations in the project and reference areas to assess impacts of the operational phase on the marine environment

12. Assessment period

The assessment periods described in the following apply to all project phases (pilot phase, expansion phases).

12.1 Baseline survey

Prior to the start of construction, in accordance with the Standards for Environmental Impact Assessments, a baseline survey has to be performed which covers the investigations made during two successive, complete seasonal cycles, without any interruption. One seasonal cycle comprises 12 calendar months including the month in which the survey begins.
The baseline survey remains valid for two complete years. If construction work is not begun in the third year after completion of the baseline survey, the baseline survey shall be updated with an additional seasonal cycle. Other details regarding the follow-up period will be dealt with in the individual case.

12.2 Construction phase

The construction phase covers the period from the start of construction work until completion of the construction project. Construction-phase monitoring has to be performed throughout this period. If essential components are put into operation prior to completion of the construction project, operation monitoring in the project section concerned may be started in co-ordination with the approval authority. However, it must be ensured that such continued construction activities do not have a significant impact on the results of operation monitoring. The precise time for stopping the construction monitoring will be determined by the approval authority in each individual case.

12.3 Operation phase

The Standards for Environmental Impact Assessments define the operation phase as the phase following the completion of construction work, when the wind turbines are put into operation. After the wind farm has become operational, operation monitoring has to be performed for a period of at least three years or, if required, up to five years in the entire project area. The end of operation monitoring will be determined by the approval authority in each individual case.

13. Assessment areas

Assessment areas in each case are the project area (pilot phase, expansion phases) and the reference area. When indicating the size of a project area, the safety zone should not be included. The individual environmental features to be protected require different assessment areas in terms of size and location. If the specific conditions in individual cases are such that the size of a assessment area does not conform to the requirements for assessment areas as indicated below, such assessment areas have to be adjusted to local conditions in agreement with the approval authority.

13.1 Project area

13.1.1 Benthos / fish

The assessment area has the same size as the project area.

13.1.2 Birds

- **Ship based counts:**
  The assessment area of a project area must cover at least 200 km^2 in principle. The whole project area must always be surrounded by a 2 nm wide assessment area.

- **Aerial counts**:
  The area including the reference area must cover at least 2,000 km^2

13.1.3 Mammals

- **Aerial counts:**
  The assessment area including the reference area must cover at least 2,000 km^2 and the assessment area must have a rectangular shape. The project area should be located in the middle of the assessment area if possible. The distance between the boundaries of the wind farm and those of the assessment area must be at least 20 km.

- **Ship based counts:**
  The assessment area has the same size as the assessment area for birds (see 13.1.2).

13.2 Reference areas

Reference areas will be used for comparison, to document the development of the environmental features to be protected without the impact of wind turbines. Reference areas should be located outside the planning areas for later wind farm expansion phases and should also be suitable as reference areas for such expansion phases. They may also be needed in later expansion stages of a wind farm. The natural ambient conditions in the reference area (location, current conditions, water depth, sediment properties, distance from the coast, size, species spectrum, number of individuals) must correspond to those in the project area concerned. The reference area should be free of any direct influences from wind turbines. If the reference area chosen for the pilot phase is located within the planning area for later expansion phases, the following shall be taken into account:

- the distance must be large enough to avoid any impacts from pilot phase activities

- a reference area is also required for the expansion phase

The individual environmental features to be protected require reference areas of different size, location, and quality.

13.2.1 Benthos / fish

The size of the reference area should correspond to that of the project area. If the habitat of the project area is very heterogeneous (e.g. different sediment properties, hydrography or water depth), a reference area should be chosen which has a very similar habitat pattern. If such conditions do not exist in a single reference area, the reference area may also be composed of several smaller areas whose habitat patterns, in combination, correspond to that in the construction area. The individual areas should be located as close together as possible.

The reference area should be located in the vicinity of the project area but should be largely free of any impacts from the construction area. This implies also that it must be outside the propagation range of operational noise from the wind farm. Whether and to what extent wind farms affect the individual environmental features to be protected often cannot be determined prior to the operation phase. Therefore, the minimum distance should be 500 m for benthos (infauna) and 1 km for fish and epifauna.

Anthropogenic influences in the reference area should be comparable to those in the construction area but without the impact of the construction activities, turbine operation and related activities.

The location of reference areas for macrozoobenthos and fishes should be largely identical.

13.2.2 Birds

- **Aerial counts**
  See project area (13.1.2)

- **Ship based counts**
  The size of the reference area corresponds to the size of the assessment area for the project area.

13.2.3 Mammals

- **Aerial counts**
  See project area (13.1.2)

- **Ship based counts**
  The size of the reference area corresponds to the size of the assessment area for the project area.

14. Reporting

The results of the baseline surveys and monitoring have to be submitted to the approval authority in the form of comprehensible expert reports. The complete raw data and investigation documents in their original form shall be stored in a suitable

way by the applicant or holder of the permit and shall be made available in whole or in part to the approval authority upon request. Different storage arrangements for the raw data may be agreed with the approval authority. The data formats to be used have to be agreed with the approval authority.

14.1 Baseline surveys

After completion of the baseline surveys, an Environmental Impact Assessment (EIA) shall be presented to the approval authority. If an EIA has already been made on the basis of a study covering one annual cycle, it has to be supplemented with the data of the second annual cycle. The research data shall be provided to the approval authority upon request, but not later than the date on which the EIA is submitted.

If the planning area is located in a National Park or in its vicinity, in a Marine Protected Area or an area that has been classified as ecologically valuable by conservation experts, an FFH study must be submitted in addition to the EIA in order to obtain approval (Art. 34, BNatSchG -Federal Nature Conservation Act).

14.2 Monitoring

The monitoring data shall be presented to the approval authority once a year, four months after completion of the annual cycle in each case. The monitoring data shall include a documentation of the status before the construction phase and of developments and changes during and after the construction phase.
On the basis of the monitoring results, the approval authority will decide on the type and scope of further investigations. Unless the applicant or permit holder in charge of the investigations proposes further investigations differing from the scope of investigations specifed in the notification and from the present Standards for Environmental Impact Assessments, the existing arrangements and monitoring periods specified in the Standards for Environmental Impact Assessments shall continue to apply.

Part B: Technical instructions

15. Environmental features to be protected

Technical details of the investigation and monitoring to be carried out in order to protect benthos, fish, birds, and mammals will be provided in the following. The scope and targets of the investigations, methods to be used, and the evaluation basis are described for each of the environmental features to be protected.

15.1 Benthos

The benthos investigations and monitoring comprise

- investigation of the sediment and habitat structure and their dynamics using side scan sonar and sediment sampling
- investigation of epifauna using video equipment and beam trawl/dredge
- investigation of infauna by means of grab sampling
- investigation of fouling on piles and foundations, and
- investigation of macrophytobenthos, if present in the area investigated.

During the above investigations, measurements of salinity, temperature and oxygen levels have to be carried out at the sea surface and near the bottom in order to obtain a representative picture of the hydrographic situation in the area.

Additionally, the sediment properties grain size distribution and organic carbon content have to be determined per station and throughout the assessment period.

The investigations should be carried out at the same time as the fish investigations if possible, but mutual disturbance should be avoided.

In homogeneous sandy areas, side-scan sonar surveys have to be carried out with 500 m spacing. Areas with a heterogeneous sediment structure have to be covered completely by the surveys.

The results of the sedimentological and benthological investigations should be combined in a single study.

15.1.1 Sediment structure and dynamics
Side scan sonar (SSS)

	Baseline survey a) Preliminary investigations	Baseline survey b) Status assessment	Monitoring construction phase	Monitoring operation phase
Targets	Investigation of bottom morphology and type of substratum for benthos programme planning and interpretation of benthos data. Verification by means of video and/or grab sampling (ground truthing)	In the case of heterogeneous distributions, control survey to identify possible changes	Determination of substratum for benthos data interpretation	Determination of substratum for benthos data interpretation
Scope	Before deciding on the sampling design, an SSS survey of the seabed has to be made in order to determine the characteristic sediment structure (complete area should be covered if possible, with a transect spacing of 500 m as a minimum)	SSS survey covering the complete project and reference areas if possible (with a track spacing of 500 m as a minimum)	Surveys in the area of the single installations scheduled for biological studies Running of SSS transect lines	Surveys in the area of the single installations scheduled for biological studies
Timing	Once	Once a year after the winter season if required	As required	As required
Method	Side scan sonar (SSS), vessel speed max. 4 knots			
Presentation of results	Maps of bottom morphology and substratum type (GIS format with the specifications: latitudes and longitudes in WGS84)			

15.1.2 Epifauna – video

	Baseline survey a) Preliminary investigations	Baseline survey b) Status assessment	Monitoring construction phase	Monitoring operation phase
Targets	Baseline description of epifauna in the project area and determination of a suitable reference area	Medium and small scale survey of *status quo ante* as a basis for evaluating potential impacts of wind turbines	Medium and small scale survey of impacts from construction activities	Medium and small scale survey of impacts in the operation phase
Scope	Video transects in the area of all beam trawl surveys (small beam trawl) and/or dredge surveys. The minimum number of video transects and/or photo stations is 10. Video surveys have to be carried out together with the epifauna sampling.			
Timing	Together with the other benthos investigations			
Method	Video transects of about 15 - 30 min duration with a drift velocity of max 1 knot, geographic positioning of the transect and/or photo (high-resolution 6x6 camera) with 10 to 20 photos per station. The video surveys should be made using a digital camera, with each picture showing the station number, GPS data, date, and water depth if possible. At least the geographic positions have to be recorded.			
Presentation of results	Video recordings and/or photos showing at least the following details: • Abundance/frequency of rocks, shell banks etc. • Frequency of epifauna (percent cover) • Traces/dwellings of infauna (e.g. Lanice tubes) • Visible disturbances of the sediment surface (e.g. caused by fisheries) The geographic position must be allocated to each recording. A cut of the videos has to be presented.			

15.1.3 Epifauna - beam trawl / dredge

	Baseline survey a) Preliminary investigations	Baseline survey b) Status assessment	Monitoring construction phase	Monitoring operation phase
Targets	Baseline description of the project area and determination of a suitable reference area	Medium and small scale survey of *status quo ante* including seasonal dynamics, to be used as a basis for assessing possible impacts of wind turbines	Medium and small scale survey of relevant impacts of construction measures on epifauna communities and their seasonal development	Medium and small scale survey of impacts of the operation phase on epifauna communities and their seasonal development
Scope	The number of beam trawl or dredge hauls per area (project/reference) depends on the number of infauna stations. Half of the infauna stations have to be surveyed by means of beam trawls or dredge hauls. In smaller areas (<20 square nautical miles), at least 10 beam trawl surveys or dredge hauls should be conducted.			
	Random distribution of stations taking into account the complete habitat pattern determined in the side scan sonar and video surveys.		Installation-oriented impact monitoring **is** additionally required in the construction phase	An installation oriented sampling design according to the OSPAR Guidelines for Monitoring the Environmental Impact of Offshore Oil and Gas Activities (OSPAR Commission 2001) has to be carried out additionally at two wind turbines as a minimum
	Once, in spring if possible	2/year: in spring and autumn		
Timing	Once, may serve as part of the status assessment	At least two consecutive complete seasonal cycles prior to the start of construction	Throughout the construction phase	At least three years, up to five years if required, after commissioning
Method	North Sea: Beam trawl with a width of 2 –3 metres and a mesh size of 1 centimetre, dredge in exceptional cases Baltic Sea: Optionally beam trawl with a width of 2 –3 metres and a mesh size of 1 centimetre or dredge Changes in the equipment standard are not allowed! Duration of bottom trawling 5 minutes, trawling speed 1 – 3 knots (trawling time 10 minutes if the hauls are also used for demersal (bottom dwelling) fish fauna) Biomass: wet weight per species			
Presentation of results	• Total number of individuals per area, • Total biomass per area • Number of individuals per species and area • Biomass per species and area • Dominance structure (related to number of individuals and biomass) • Diversity/evenness for community analysis, cluster analysis or multi-dimensional scaling			

15.1.4 Infauna – grab sampling

	Baseline survey a) Preliminary investigations	Baseline survey b) Status assessment	Monitoring construction phase	Monitoring operation phase
Targets	Baseline description of the wind farm project area and determination of a suitable reference area	Medium and small scale survey of *status quo ante* including seasonal dynamics as a basis for assessing potential impacts of wind turbines	Medium and small scale survey of relevant impacts of construction activities on communities and their seasonal development	Medium and small scale survey of impacts of the operation phase on communities and their seasonal development
Scope	Coarse station grids (spacing should not exceed 1 nm) in the project and reference areas. At least 20 stations in small areas (< 20 square nautical miles). In large homogeneous areas, a spacing larger than 1 nm is possible in agreement with the approval authority			
			Installation-oriented impact monitoring is additionally required in the construction phase	An installation oriented sampling design according to the OSPAR Guidelines for Monitoring the Environmental Impact of Offshore Oil and Gas Activities (OSPAR Commission 2001) has to be carried out additionally at two wind turbines as a minimum
	At least 3 parallel samples per station	At least 2 parallel samples per station		
	Once, in spring if possible	2 samplings: in spring and autumn		
Timing	Once, may serve as part of the status assessment	At least 2 consecutive, complete seasonal cycles prior to the start of construction	Throughout the construction phase	At least three years, up to five years if required, after commissioning
Method	Modified Van Veen grab, 0.1 m^2 sampling surface, 70-100 kg, sieve covered lid, warp-rigged. Sieve with 1000 µm mesh size; in case of large proportion of coarse and medium-grained sand or gravel, the sample should first be decanted through a sieve and rinsed at least five times. Documentation of the sample processing method has to be provided. Fixation in buffered 4% buffered formalin, determination of number and composition of species , number of individuals per species, and biomass (wet weight) per species.			
Presentation of results	• Total number of individuals per area, • Total biomass per area • Distribution map of the numbers of individuals and biomass of the dominant species • Dominance structure (related to number of individuals and biomass) • Diversity/evenness for community analysis, cluster analysis or multi-dimensional scaling • Hydrographic data (T, S, O_2) • Occurrence and distribution of Red List species			

15.1.5 Fouling on structures

	Baseline survey a) Preliminary investigations	Baseline survey b) Status assessment	Monitoring construction phase	Monitoring operation phase
Targets			Investigation of fouling on piles and foundations	
Scope			Survey of the piles / foundations of at least two installations at three different water depths each (near surface, medium level, near bottom)	
Timing			After erection of piles / foundations	At least three years, up to five years if required, after commissioning
Method			Taking of scratch samples by divers, and photo/video documentation Determination of the number of species and species spectrum, number of individuals per species, and biomass (wet weight) per species	
Presentation of results			• Total number of individuals per area • Total biomass per area • Individuals per species and area • Biomass per species and area • Dominance structure (related to number of individuals and biomass) • Species specific and absolute coverage • Diversity/evenness for community analysis, cluster analysis or multi-dimensional scaling • Comparison with natural hard-substrate communities - if available	

15.1.6 Macrophytobenthos

Macrophytobenthos may occur at wind farm sites in shallow water. Where macrophytobenthos is found, an additional monitoring programme has to be included.

	Baseline survey a) Preliminary investigations	**Baseline survey b) Status assessment**	**Monitoring construction phase**	**Monitoring operation phase**
Targets	Baseline description of the project area and determination of a suitable reference area	Medium and small scale survey of *status quo ante* as a basis for assessing potential impacts of wind turbines	Medium and small scale survey of relevant impacts of the construction phase on communities	Medium and small scale survey of relevant impacts of the operation phase on communities
Scope	Transect lines with 500 m spacing – video survey of stocks in order to select assessment areas	At least 3 transects in each habitat type occurring in the project area		
	Once, in the period from June to September	1/year in the month of the baseline survey a)		
Timing	Once, may serve as part of the status assessment	At least two consecutive complete seasonal cycles prior to the start of construction	Throughout the construction phase	At least three years, up to five years if required, after commissioning
Method	According to the HELCOM Guidelines ”Monitoring of benthic plant and animal communities”: Mapping by divers (for safety reasons only at depths <30m) and/or use of optical methods (digital video/photo), with coupling to the navigational system (navigation data visible) in order to monitor the species composition, distribution, and coverage			
Presentation of results	Mann-Whitney U - Test or Kruskal-Wallis test to investigate inter-annual differences, and diversity index to study changes in the species composition			

15.2 Fish

Fish surveys and monitoring have to be carried out using bottom trawls and/or beam trawls. Additionally, measurements of weather, depth, salinity, temperature, and oxygen levels have to be made and recorded.

15.2.1 Beam trawl / bottom trawl

<table>
<tr><th></th><th>Baseline survey
a) Preliminary investigations</th><th>Baseline survey
b) Status assessment</th><th>Monitoring
construction phase</th><th>Monitoring
operation phase</th></tr>
<tr><td>Targets</td><td>Single survey of fish fauna in the project area and in a suitable reference area</td><td>Characterisation and identification of fish fauna in the project area and in a suitable reference area</td><td>Assessment of the impacts of activities in the project area and comparison with a suitable reference area</td><td>Assessment of the impacts of wind turbine operation in the project area and comparison with a suitable reference area</td></tr>
<tr><td rowspan="2">Scope</td><td colspan="2">Alternative 1:
• In project and reference areas >100 km^2, the minimum number of hauls should be 30 each. 20 hauls will be sufficient if a beam trawl is used
• In planning, reference, and pilot areas < 100 km^2, the minimum number of hauls should be 20 each. 15 hauls will be sufficient if a beam trawl is used.</td><td colspan="2">• In planning and reference areas >100 km^2, the minimum number of hauls should be 30 each. 20 hauls will be sufficient if a beam trawl is used.
• In project and reference areas < 100 km^2, the minimum number of hauls should be 20. 15 hauls will be sufficient if a beam trawl is used.
• Additionally, installation based studies at two installations (about 6 days/year)</td></tr>
<tr><td>Spring or autumn</td><td>Twice a year:
spring and autumn</td><td colspan="2">Once a year in autumn</td></tr>
<tr><td rowspan="2"></td><td colspan="4">Alternative 2:
At least 10 hauls per area</td></tr>
<tr><td>Spring or autumn</td><td colspan="2">Three times a year: in spring, summer, autumn</td><td>Twice a year: in spring and autumn</td></tr>
<tr><td>Timing</td><td>Once, may serve as part of the status assessment</td><td>At least two consecutive complete seasonal cycles before the start of construction</td><td>Throughout the construction phase</td><td>At least three years, up to five years if required, after commissioning</td></tr>
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	Baseline survey a) Preliminary investigations	Baseline survey b) Status assessment	Monitoring construction phase	Monitoring operation phase
Method	**Equipment standard / North Sea – two alternatives:** 1. 6-8 m beam trawl (proposed specification in Annex 15.2.1-1) 2. Otter trawl in combination with a 3 m beam trawl **Equipment standard / Baltic Sea:** Otter trawl (wind farm trawl) - Annex 15.2.1-2 Cod ends must have an inlet with a mesh opening of about 38 mm (mesh size 20 mm). The duration of hauls should be 30 minutes, and the towing speed 3 to 4 knots. **Sampling strategy – two alternatives:** Taking into account the specific conditions of the project, a random station grid is to be preferred in principle to a fixed station grid. Sampling should be carried out during the same narrow time window each year. Fish sampling should be carried out only during the day (sunrise to sunset). **Alternation between sampling strategies or equipment standards is not allowed!** The treatment of catches should be documented and standardised (e.g. recording of rare species in the **total catch**). Documentation must also be provided on the fishing gear used. **The following data have to be recorded:** • Shooting and hauling positions, towing time, area covered • Per fish species (acc. to ICES table): weight, number, length distribution • Brief, semi-quantitative description of invertebrate by-catch • Hydrographic and meteorological data			
Presentation of results	Documentation of status and changes (before/after) as follows: • Total number of individuals per area • Total biomass per area • Number of individuals per species and area (species table) • Biomass per species and area • Dominance ratios (related to number of individuals and biomass) • Diversity • Length frequency distribution of dominant species • Community analysis			

15.3 Resting and migratory birds (avifauna)

15.3.1 Avifauna – foraging, moulting and resting birds

	Baseline survey a) Preliminary investigations	Baseline survey b) Status assessment	Monitoring construction phase	Monitoring operation phase
Targets	Large-scale survey of the distribution and density of birds and observation of bird behaviour (flying habits, sensitivity to disturbance) in order to assess the project area's importance as a resting, feeding and/or moulting area, selection of a reference area	Survey of bird densities and distributions to assess the area's importance as a resting, feeding and/or moulting area prior to construction	Observation of impacts and adaptation behaviour during the construction phase	Monitoring of impacts and adaptation behaviour during the operation phase
Scope	Throughout the year: one ship based count and one aerial count per month. Twelve additional ship based counts per year: seasonal distribution depending on area and seasonal occurrence of species. Transects cover 10% of the assessment area in each case.			
Timing	Once, may be used as part of the status assessment	At least two consecutive complete annual cycles before the start of construction	Throughout the whole construction phase	At least three years, up to five years if required, after commissioning
Method	**Ship transect surveys** **(according to Garthe et al. 2002, unless otherwise specified below)** Transect spacing • about 3 km (no smaller spacing to minimise disturbance) Transect width • In good weather conditions, observation of 300 m on either side of the vessel with two observers on each side In poor weather conditions, observation of 300 m on one side of the vessel Transect direction • Cross shore if possible; i.e. in the German Bight off the coast of Schleswig-Holstein preferably east-to-west, off the coast of Lower Saxony preferably north-to-south. Cruising speed • Between 7 and 16 knots. Counting intervals • Stationary birds should be counted and recorded continuously (basis: 10-minute recording periods) • As a matter of principle, all birds observed on either side of the vessel have to be recorded. Geographic positions are allocated at 1-minute intervals using automatic positioning via GPS and a digital clock (time has to be identical to GPS time!). For details see Annex 15.3.1 "Seabirds at Sea (SAS) Position Form" and "How to complete the SAS Position Form". • A complete record of all flying birds is also required , with an indication of the flight altitude in each case. To determine bird densities, additional application of the snapshot method is indispensable during which, at 1-minute intervals (digital clock!), all birds in the transect section are recorded as "in transect" (see Annex 15.3.1, Fig. 1 and Garthe et al. 2002). The length of the section is determined by the ship's speed. With fast vessels (from 15 knots) the interval between snapshots has to be reduced to 30 seconds because the section ahead is too large for 1-minute intervals (see Annex 15.3.1, Table 1, from Garthe et al. 2002). An SAS bird form has to be used for the bird survey. Details see Annex 15.3.1 "SAS Bird Count Form" and "How to complete the SAS Bird Count Form". Observer position • Top deck or wing of the navigating bridge, eye level of the observer at least 5 m (better: 7 m) above water level. Weather related survey stop • At sea states >4 the survey has to be interrupted.			

	Baseline survey a) Preliminary investigations	Baseline survey b) Status assessment	Monitoring construction phase	Monitoring operation phase
Method	**Aircraft transect surveys** **(unless otherwise specified below, according to Diederichs et al. 2002)** Transect spacing • about 5 km (no smaller spacing to minimise disturbance) Transect width • On either side of the aircraft 90° to the flight direction, three distance classes (transect bands: band A: 60° to 26°, band B: 25° to 11°, and band C: 10° to the middle between the transects (see Annex 15.3.1, Fig. 2, and Annex 15.3.1, Table 2) Transect direction • Cross shore if feasible; i.e. in the German Bight off the coast of Schleswig-Holstein preferably east-to-west, off the coast of Lower Saxony preferably north-to-south. Counting intervals • All observations have to be recorded with an accuracy of min. 4 seconds (corresponding to a flying distance of about 200 metres) using a dictaphone. In case of very high bird densities, summaries covering maximally 10 seconds are allowed. Type of aircraft • In offshore surveys, only twin-engined aircraft are allowed for safety reasons. High-wing propeller aircraft should have bubble windows. Flight speed • Approx. 180 km/h Altitude • 250 feet (about 80 metres) (a special permit from the aviation authority is required) Flight data • GPS position recording every 250 m (corresponding to about five seconds) and linkage of all observation times through GPS-synchronised digital clocks Weather conditions • Surveys should only be made when the water surface is calm and there are no breaking waves, max. sea state 3 (corresponds to wind speeds of max. 10 knots - approx. 5 m/s or 3 Bft). Visibility should be at least five kilometres.			
Presentation of results	Comparison of own results with those of available studies. Ship transect surveys • Table showing mean bird densities per km^2 or, in the case of less abundant species, average number of individuals per kilometre covered, broken down by months indicating the value range and number of mapping cruises (density calculations for swimming birds have to be corrected on the basis of published factors or according to Buckland et al. (2001) based on own data). • Cartographic representation of densities (computation cf. above) or individuals per kilometre travelled for the most common species, on a month-by-month basis. The geographic reference for all computations is rectangles of 3' latitude and 6' longitude. The rectangles should be aligned with the geographic grid. Aircraft transect surveys (Diederichs et al. 2002) • Bird densities are computed exclusively on the basis of birds in transect band A. • Positions are indicated for all observations, linking the recorded observation time and GPS time in a Geographic Information System (GIS). • Point maps showing the distribution of birds in the assessment area, broken down by species. • Grid maps showing use of the area by abundant species, cumulative and adjusted according to observation effort			

15.3.2 Avifauna – bird migration and other flight movements in the survey area

15.3.2.1 Radar surveys

<table>
<tr><th></th><th>Baseline survey
a) Preliminary investigations</th><th>Baseline survey
b) Status assessment</th><th>Monitoring
construction phase</th><th>Monitoring
operation phase</th></tr>
<tr><td>Targets</td><td>Monitoring of bird movements (migration, foraging, flights between feeding and resting grounds)</td><td>Recording of status quo ante including seasonal dynamics</td><td>Observation of impacts and adaptation behaviour during the construction phase. Documentation of any evasive behaviour observed</td><td>Observation of impacts and adaptation behaviour during the operation phase. Documentation of any evasive behaviour observed</td></tr>
<tr><td>Scope</td><td colspan="3">Survey frequency in the main migration periods 7 days/month (not in a single block, if possible).
Main migration periods:
• North Sea: March to May, and mid-July to mid-November
• Baltic Sea: March to May, and mid-July to the end of November
• A survey day covers 24 hours. Daylight surveys can also be made en route.
• At least 50 survey days have to be planned.
• Continuous deployment. In routine operation, storage of radar images every 5 minutes (see Hüppop et al. 2002).
Observation of flying birds reaction to the turbines (changes in flight direction/altitude, collisions), to be recorded using state-of-the-art methods (representative samples)</td><td></td></tr>
<tr><td>Timing</td><td>Once, may be used as part of the status assessment</td><td>At least two consecutive complete annual cycles before the start of construction</td><td>Throughout the whole construction phase</td><td>At least three years, up to five years if required, after commissioning</td></tr>
<tr><td>Method</td><td colspan="4">Radar surveys
(unless otherwise specified below, according to Hüppop et al. 2002)
Location
• Radar surveys should preferably be made at stationary locations, or alternatively on board vessels which should be anchored during night-time surveys but may be en route by day. During the construction and operation phases, the vessel or platform's location relative to the construction site should be in the direction from where most of the birds come to ensure optimal detection of the evasive movements of flying birds.
Vertical radar - mandatory
• Quantification of flight intensities at different altitudes
• Estimation of seasonal flight intensities
• Rough estimate of flight directions
<u>Survey conditions:</u>
• Deployment also possible in stronger winds (up to min. 7 Bft or 2 m wave height)
<u>Radar specifications:</u>
• Vertical radar with an output of min. 10 kW, a vertical beam width of 20° to 25° and a horizontal beam width of 0.9° to 1.2°, and a transmission frequency of about 9.4 GHz (x-band radar).
<u>Standard operating range:</u>
• The standard operating range should be 1.5 nm. Exceptions are only allowed to track, e.g., evasive behaviour of birds.
Surveillance radar - recommended
• Observation of flight direction and intensities
<u>Survey conditions:</u>
• Max. 4 or 5 Bft
<u>Radar specifications:</u>
• Horizontally scanning radar with an output of min. 25 kW.
<u>Standard operating range:</u>
• The standard operating range should be 3 nm. Exceptions are only allowed to track, e.g., evasive behaviour of birds.</td></tr>
<tr><td>Presentation of results</td><td colspan="4">Results of the radar observations. A distance correction is indispensable for altitude distribution. It takes into account the detectability and volume of the radar beam (see Annex 15.3.2.1, cf. Hüppop et al. 2002 and next chapter.)</td></tr>
</table>

15.3.2.2 Visual observations / recording of flight calls

	Baseline survey a) Preliminary investigations	Baseline survey b) Status assessment	Monitoring construction phase	Monitoring operation phase
Targets	Monitoring of bird movements (migration, foraging, flights between feeding and resting grounds)	Survey of status quo ante including seasonal dynamics	Observation of flight movements near the boundary of the construction area and documentation of any evasive behaviour observed	Observation of flight movements near the boundary of the construction area and documentation of any evasive behaviour observed
Scope	Simultaneous to the radar surveys			
Timing	Once, may be used as part of the status assessment	At least two consecutive complete annual cycles prior to the start of construction	Throughout the whole construction phase	At least three years, up to five years if required, after commissioning
Method	**Visual observations / recording of flight calls** • To determine the species spectrum of the birds detected by radar, parallel daytime visual observations and recording of flight calls at night have to be carried out. <u>Survey frequency:</u> • As a minimum, a 15-minute recording period per hour has to be chosen, or preferably two 15-minute periods per hour. The recording periods have to be separated by breaks of at least 15 minutes to prevent observer fatigue. <u>Location</u> • The surveys should be preferably conducted using stationary platforms, or alternatively from vessels. During the construction and operation phases, the surveys should be carried out near the boundary of the construction area in order to be able to observe evasive behaviour of birds (details see radar surveys) **Visual observations** • Communication by voice between the observer watching the radar display and the visual observer may be useful. The registrations have to be made independently, however. • Registration of the species spectrum and number of birds counted in an angular field of view extending from the horizon to 45° (10 x 40 mm binocular or larger front lens) up to 15 km distance. Also undetermined birds have to be registered (e.g. as ”pipit spec." or ”gray geese”). • The flight altitudes can be estimated by reference to the height of the vessel deck/mast or, during the construction and operation phases, the dimensions of the wind turbines. Altitudes should be categorised as follows: 0 - 5 m, 5 - 10 m, 10 - 20 m, 20 - 50 m, 50 - 100 m, 100 - 200 m, and over 200 m. • Where a platform is available, birds have to be additionally registered by means of a spotting scope with a defined field of view (seawatching). The field of view depends on the spotting scope’s magnification and angle of view (all birds up to 5 km distance). A wide-angle spotting scope with 30 x magnification and at least 80 mm objective diameter should be used. **Registration of flight calls** • At night, flight calls have to be registered. Communication by voice between the observer watching the radar display and the flight call observer may be useful. The registrations have to be made independently, however. Use of a directional microphone to document bird calls may be useful.			
Presentation of results	List of bird species observed, broken down by day, night, and months. Registration of: • relative flight intensities per observation day/night, in tables (e.g. birds/h or calls/h) • mean relative flight intensities in the course of the day (compiled by months) • relative distribution of flight altitudes (using above levels) and flight directions for each observation day/night, in tables or as graphs averaged on a monthly basis (time-of-day distribution) • same procedure for seawatching, broken down by the most frequent species/species groups Comparison of own investigations with available data.		Exemplary demonstration of flight behaviour of birds approaching the turbines, recording of all reactions/ non-reactions, especially changes in flight directions and altitudes, in tabular form	

15.4 Marine mammals

The investigations and monitoring relating to marine mammals comprise studies of their abundance and distribution, possibly their habitat use, as well as noise emission and immission studies.

Sightings while running transects allow conclusions as to the abundance and distribution of marine mammals in the assessment area.

Stationary click detectors allow continuous monitoring of the habitat use of harbour porpoises. Click detectors have to be deployed in addition to ship and aerial surveys as a monitoring basis.

During the construction and operation of wind turbines, a broad-band noise spectrum (including structure-borne and air-borne noise) is likely to be emitted into the water. The occurrence of interferences cannot be ruled out. Measurements of immissions at particular locations and of emissions at the noise source should be made during the construction and operation phases.

Not only the emitted frequencies but also the noise characteristics (impulsiveness/tonality) have to be recorded. Via propagation computations, predictions of the expected noise pollution have to be made using noise emission data of the turbines and suitable models.

15.4.1 Abundance, distribution

	Baseline survey a) Preliminary investigations	Baseline survey b) Status assessment	Monitoring construction phase	Monitoring Operation phase
Targets	Stock inventory of marine mammals in the assessment area in order to assess the ecological importance of the project area for marine mammals		Monitoring of the impacts of construction activities on the abundance and habitat use of marine mammals in the assessment area	Monitoring of the impacts of operational activities on the abundance and habitat use of marine mammals in the assessment area, taking into account different operating modes (full load, partial load)
Scope	The surveys shall be conducted 12 times per year. If they are conducted together with the bird surveys (observers must be qualified for both groups), six additional aerial surveys per year covering only marine mammals have to be made. Four aerial surveys shall be made monthly from May to August. In addition, two surveys should be conducted in autumn and winter. Combined bird and mammal surveys are not allowed to be conducted in areas of high seaduck concentration (e.g. Pomeranian Bight).			
Timing	At least two consecutive, complete seasonal cycles before the start of construction		Throughout the construction phase	At least three years, up to five years if required, after commissioning
Method	**Line transect method** According to the method description "Introduction into Distance Sampling" (Buckland et al., 2001). Monthly aircraft transect surveys are mandatory. Additional ship transect surveys are recommended. **Aircraft transect surveys** • **Altitude**: a constant altitude for the monthly aerial surveys must be determined and adhered to. The altitude may range between 250 and 600 feet. The six special surveys of harbour porpoises have to be conducted at an altitude of 600 feet. • **Type of aircraft:** twin-engined, high-wing propeller aircraft with bubble windows. • **Flight speed** Approx. 160 km/h (80 – 100 knots). • **Number of transects /spacing**: at least 10 transects. The transect spacing should be min. 3 km and max. 10 km. • **Transect length**: 700 km; in well-founded special cases the transect length may be shorter but it must be at least 500 km. • **Observation method**: visual observations from aircraft require 2-3 observers. Because of the high speed of the aircraft, dictaphones must be used for recording the observations because written notes would lead to observation gaps. The parameters in the attached form (Annex 15.4.1) must be taken into account. • **Weather-related cancellation:** reliable data can only be obtained in good weather conditions (up to sea state 2), i.e. visibility must be over 5 km, sea state not over 2 according to the Petersen scale (wind: max. 10 knots). **Ship transect surveys** • Conducted together with the bird surveys (see 15.3.1). Marine mammals are recorded using the attached form (Annex 15.4.1). • **Hydrophones**: use of towed hydrophones and click detectors is recommended in order to increase the efficiency of visual harbour porpoise surveys.			
Presentation of results	Comparison with other areas. **Abundance**: • Seasonal cycle of the number of animals per km transect line (monthly data on relative frequency). • Seasonal cycle of the number of animals per km^2 (monthly data on absolute frequency) – if the correction factor g (0) can be determined. • Seasonal cycle of group sizes (monthly data on single animals and mother/calf pairs). • Rough characterisation of behaviour (diving times, swimming directions). • Changes in abundance during the observation period. **Distribution** • Distribution of animals in the near and far fields of the site using point maps. • Changes in the distribution of animals in the near and far fields of the site during the study, based on point maps.			

15.4.2 Habitat use

	Baseline survey a) Preliminary investigations	Baseline survey b) Status assessment	Monitoring construction phase	Monitoring Operation phase
Targets	Frequency of occurrence, behaviour, and time spent by harbour porpoises in the project area and at reference stations outside the project area during the seasonal cycle.		Frequency of occurrence, behaviour, and time spent during the construction activities	Frequency of occurrence, behaviour, and time spent near, and at various distances from, the installations taking into account different operating modes (full/partial load)
Scope	Continuously throughout the seasonal cycle			
Timing	At least two consecutive complete seasonal cycles prior to the start of construction		Throughout the construction phase	At least three years, up to five years if required, after commissioning
Method	**Requirements:** In the first year of the study, use of 3 click detectors (TPODs) in order to test the method in the individual assessment areas. If the method is found useful, the number of detectors has to be increased to at least 9 after maximally one year. In case bottlenecks occur in the delivery of the required equipment, the approval authority has to be informed of this fact. Before using the equipment, and with regard to data analysis, the Help file of the TPOD programme used has to be studied. **Calibration:** Prior to permanent deployment, a calibration among all click detectors is required. For that purpose, all detectors to be used have to be deployed together with a TPOD defined as standard. The distance among the units to be calibrated should be 0.3 to 1.5 m. The calibration period depends on the abundance of harbour porpoises in the area and must provide statistically relevant data. A correction factor relative to the standard unit should be calculated for all calibrated detectors. The standard unit preferably should not be used in the main investigation. Besides, calibration of the units in a calibration tank is recommended (suppliers are listed in the Help file of the TPOD programme). **Positioning**: The units should be deployed in the form of a three-pointed star (Mercedes logo), optimally with 3 TPODS in the centre of the planning area, 3 in a radius of about 12 km, and another 3 in a radius of about 25 km on the axes of the star. In the first year of the study, one of the 3 click detectors has to be deployed in the centre of the assessment area, and the other 2 at two different positions on the three-pointed star. If the method is found to be useful, additional TPODs have to be deployed at the other positions. In the second half of the monitoring phase, the radii of the star should be reduced in order to to investigate the impact of the installation in the near field. **Deployment:** The deployment depth of the detectors should be at least 5 metres below the water surface but may be deeper. All detectors must stay at the same depth throughout the study period. All units have to be used with the same settings (recommended for 1st deployment: porpoise only, normal sensitivity, detection mode = normal, to be adjusted after first data analysis if necessary). The "minimum intensity" setting may differ during the calibration phase to compare sensitivities, but afterwards each detector should be operated with an unchanged setting. Versions of detectors with an identical, or similar, sensitivity factor as that specified by the manufacturer should preferably be used. It is also recommended to deploy the same TPOD, or a TPOD of similar sensitivity (or expected comparable results based on the calibration, cf. above) at a particular position. This facilitates data analysis. **Data evaluation**: Habitat use (frequency of occurrence and time spent in the area) is evaluated on the basis of porpoise positive days / hours (= days/hours during which harbour porpoise sounds are recorded). The number and duration of click events (encounters, see Help file of TPOD programme) are to be used for interpreting habitat use, with a silent period of 10 minutes be kept as recommended (TPOD programme). **Boundary conditions:** Fisheries investigations should not be conducted in areas where click detectors are deployed in order to avoid loss of or damage to the detectors.			
Presentation of results	Habitat use (e.g. daytime pattern, seasonal use) at each position and change of habitat use over time and in comparison with the other positions. Comparison of the results with transect data.			

15.4.3 Emission and immission of waterborne noise

	Baseline survey a) Preliminary investigations	Baseline survey b) Status assessment	Monitoring construction phase	Monitoring Operation phase
Targets	• Prediction of noise propagation during the construction and operation phases and comparison with specific background noise measured at the location in order to obtain data for possible design improvements in order to minimise annoying noise emissions. • Measurement of hydroacoustic background noise at each location prior to construction.		Monitoring of waterborne noise emission and immission	Monitoring of waterborne noise emission and immission near the wind turbines
Scope	The expected levels of waterborne noise due to the construction and operation of the planned offshore wind farm have to be determined by means of forecast computations. A background noise measurement must be made in each target area prior to the start of construction activities. The measurements shall be made during calm weather (wave height below 1 m, no precipitation). During the construction phase, monitoring measurements have to be made during noisy work phases (e.g. pile-driving). After completion of all construction activities and commissioning of all installations, check measurements have to be made in the vicinity of the wind farm.			
Timing	• The immission prediction must be completed prior to the start of construction, and prior to the granting of approval. • Measurement of hydroacoustic background noise at the site prior to the start of construction		During the construction phase	At least 6 months after commissioning of the entire wind farm
Method	**Immission forecast** • Noise immission into the water body during the construction and operation of the planned wind farm shall be determined by forecast computations in which the noise levels of any existing installations must be taken into account. • The following measurements are required: - for the operation phase: the equivalent noise pressure level (unweighted) in 1/3-octave bands in the range of the emitted frequencies (at least 1 Hz -20 kHz) as a function of location - and for the construction phase: the maximum sound pressure Lpeak as a function of location. • With regard to the operation phase, the criterion for the minimum size of the area to be covered by the noise propagation forecast shall be the hearing threshold of marine mammals and, with regard to the construction phase, the levels which are safely below those levels at which a hearing threshold shift may occur in marine mammals. **Background noise measurements** • Background noise at the planned wind farm site has to be measured. Background noise comprises the sum of all natural sounds in the planning area excluding wind farm construction and operation noise and should also largely exclude noise from ships. • The noise measurements must cover the 1 Hz - 20 kHz frequency range. If it is found in future that due to technological progress in the construction of wind turbines water-borne noise is likely to be emitted also in the frequency range above 20 kHz, this frequency range must also be included in the background noise measurements. • To minimise extraneous noise, the measurements shall be made by use of autonomous or ship-uncoupled systems. The measurements shall not cover extraneous noise (due to pitching of the ship, ship's machinery, crew movements). Manual measurements are indispensable in identifying sources of extraneous noise events. • The measurements shall cover 48 hours as a minimum. • Data should be recorded at 1-minute intervals. • The ambient conditions should be suitable for minimising extraneous noise and maximising reproducibility. The measurements should be made during predominantly calm weather without precipitation. Wave height should not exceed 1 m. To minimise attenuation effects of the seafloor, the hydrophones should be located about 3 m above the seafloor, but not higher than half the water depth. • The measurement evaluation should be based on a 1/3 octave band analysis and include the following information: - energy-averaged sound level Leq, time evaluation "slow", reference time 1 hour - sound level extreme values Lmax, Lmin, time evaluation "slow", reference time 1 hour each			

	Baseline survey a) Preliminary investigations	Baseline survey b) Status assessment	Monitoring construction phase	Monitoring Operation phase
Method	**Monitoring in the construction phase** • During noisy construction activities (e.g. pile driving), check measurements have to be made in the environment of the construction site. Spot check measurements have to be made for each type of foundation to be used in the wind farm. • If sediment properties differ strongly at the individual installation sites, this fact must be taken into account in the selection of the installation to be monitored. Monitoring should be performed at the installation where the highest noise immissions are to be expected. • The unweighted sound pressure in the 1 Hz - 20 kHz frequency range is measured including. - the peak sound pressure level Lpeak. - the sound exposure level SEL (frequency resolved in 1/3-octave spectra). **Check measurements after commissioning** Proof of compliance with the predicted values has to be provided. • At least 6 months after the commissioning of all wind farm installations, check measurements have to be made of noise immissions in the environment of the wind farm. All wind speeds suitable for electricity production must be taken into account. • The measurement evaluation should be based on a 1/3 octave band analysis and include the following information: - energy-averaged sound level Leq, reference time one minute. - sound level extreme values Lmax, Lmin, reference time one minute each. • The measurement results have to be compared with the immission forecast data. Proof of compliance with the predicted values has to be provided.			
Presentation of results	• Detailed calculation of noise propagation during construction and operation of the turbines. • Distances of endangering / noise annoyance to marine fauna due to noise pollution during the construction and operation of wind turbines. • Comparison of predicted and measured immissions. • Report on source noise and noise characteristics (impulsiveness / tonality) during noisy construction activities. • Report on source noise and noise characteristics (impulsiveness / tonality) during the operation phase. • Forecast and definition of impact zones (fish, marine mammals) of noise immission during the construction and operation phases. • Report on correlation of noise immission and changes in the abundance and/or species composition of marine fauna.			

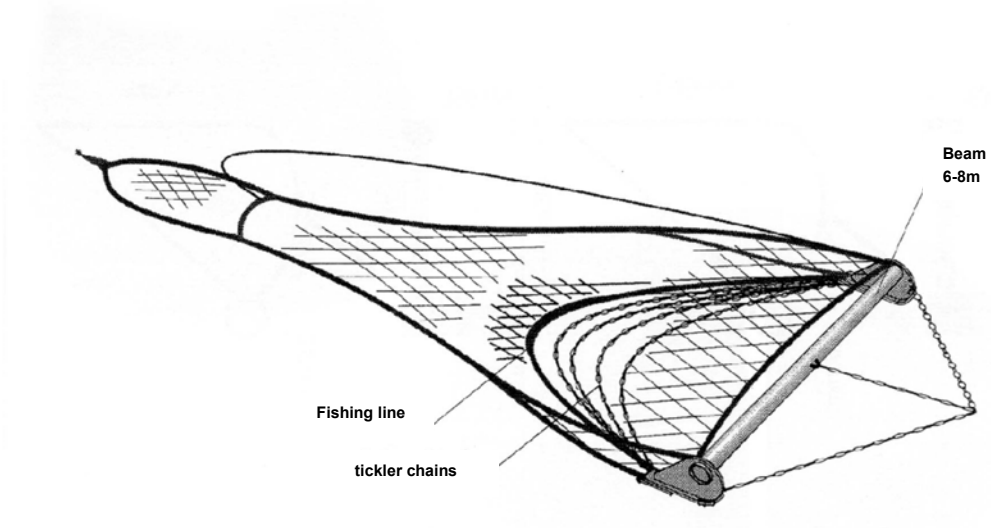
ANNEX

Annex 15.2.1 Standard nets

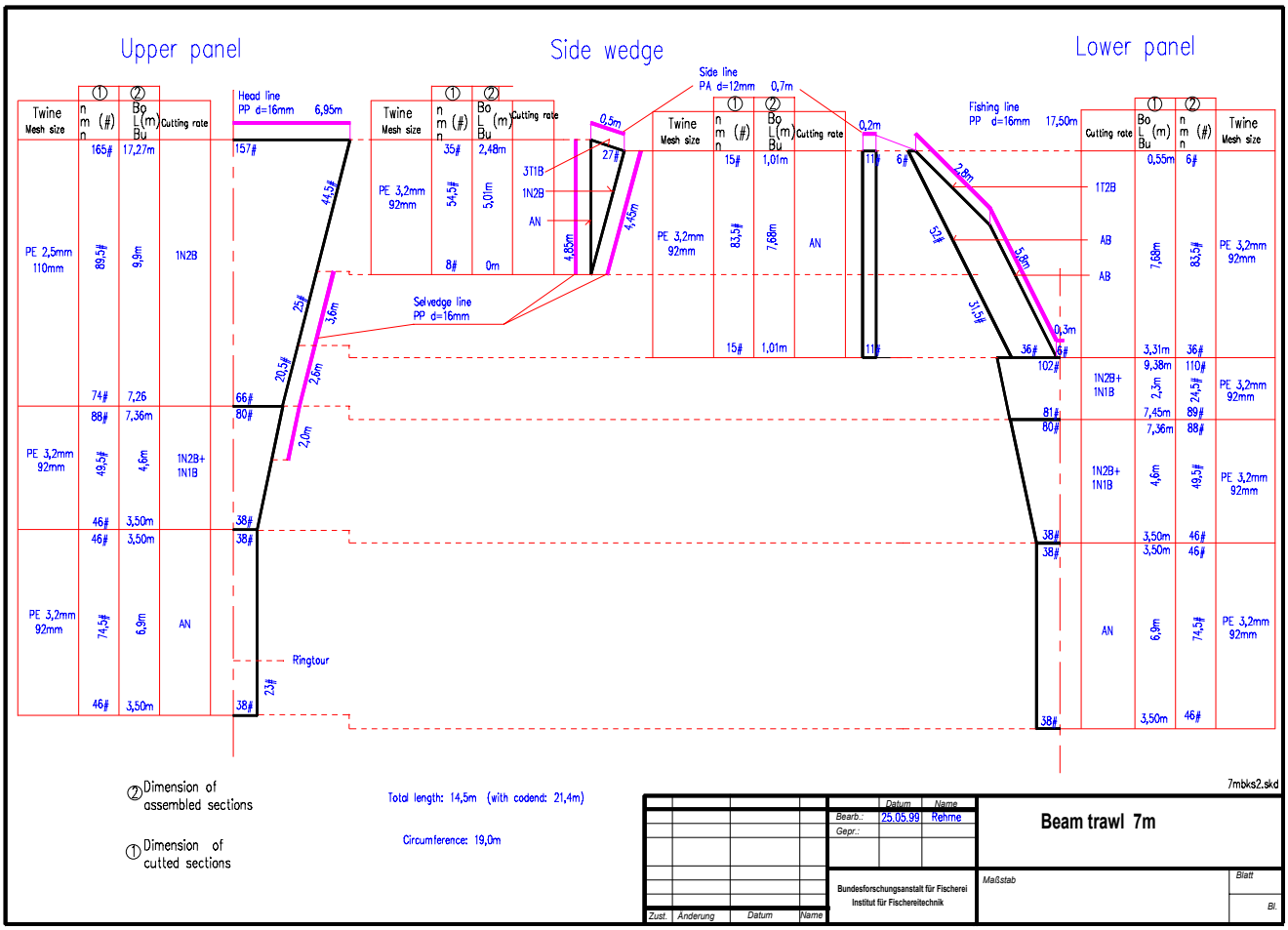
Annex 15.2.1 - 1: Beam trawl for the North Sea

In the Standards for Environmental Impact Assessments, a beam trawl with a beam length of 6 - 8m is specified as the standard net for fish fauna studies. A 7m beam trawl is described in the following. The beam trawl described is standard fishing gear use on board FFK Solea. Deviations from the standard are possible but have to be documented in a gear specification.

The beam trawl consists of an iron beam with trawlheads and the net. Fig. 1 shows a sketched beam trawl. The length of the net is 21.4 m, its circumference 19 m. It consists of an upper belly, wings, and lower belly. Information about the net material cut, and assembly is provided in Fig. 2. The footrope of the net is a rope-wrapped chain. To catch smaller fish as well, the codend is lined with an inside webbing (inner codend) with 18 mm mesh size (10mm mesh bar).
The iron trawl beam has a total length of 7.45 m, and the clearance between the trawlheads is 7.15 m. The height of the trawlheads on either side of the beam is 70 cm and exceeds that of the beam by 15 cm, so that the beam is 55 cm above ground. Each trawlhead is 21 cm wide.
5 tickler chains of different lengths are mounted in front of the mouth of the trawl. The chain length increases by 80 cm each from fore to aft (length of the first chain 13.3 m).



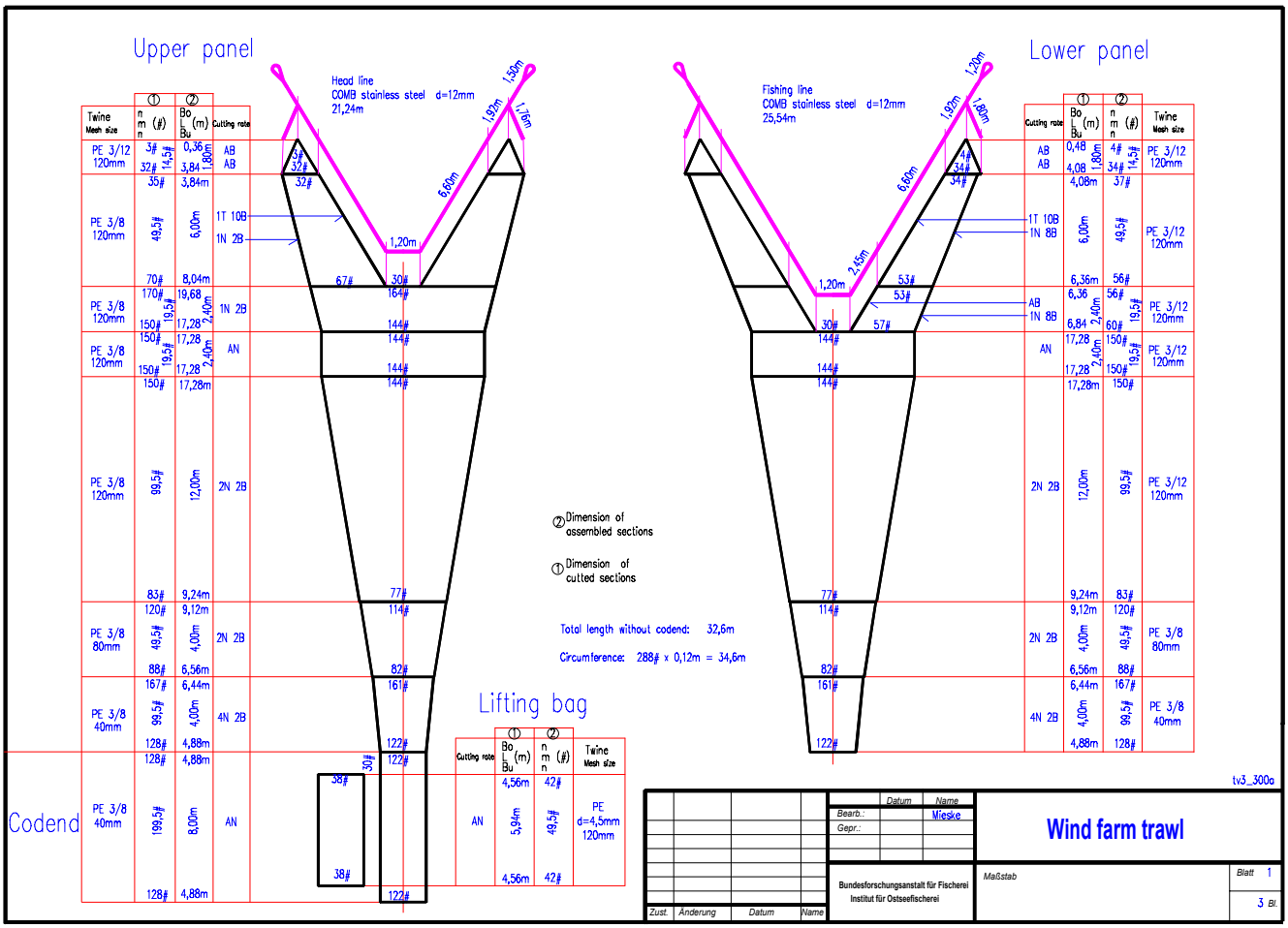
Annex 15.2.1-1 Fig. 1: Beam trawl (Diagram)



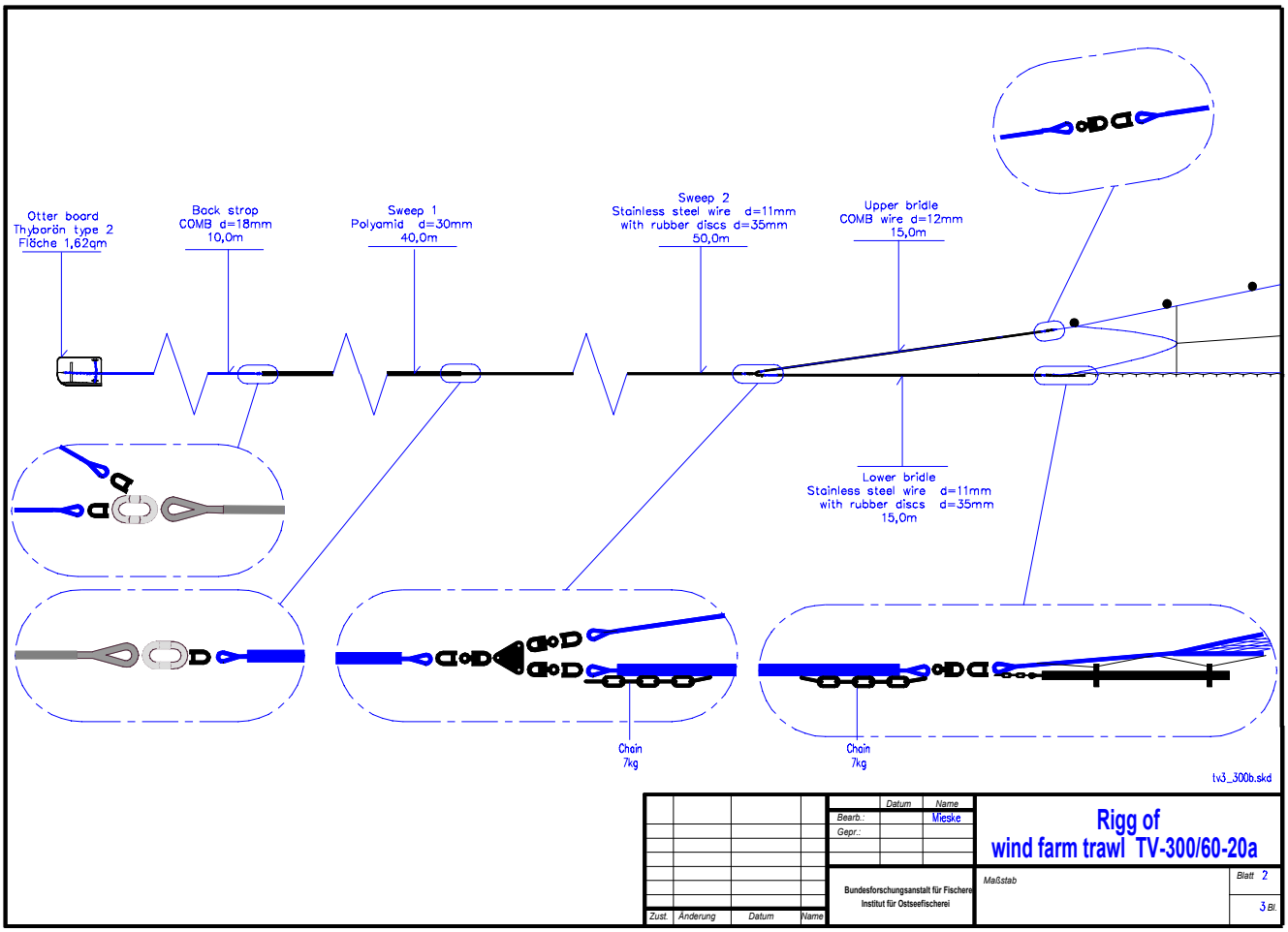
Annex 15.2.1.-1 Fig. 2: 7m beam trawl: material, cut, and assembly of the net

Annex 15.2.1 2 Standard net - Otter trawl for the Baltic Sea (wind farm trawl)

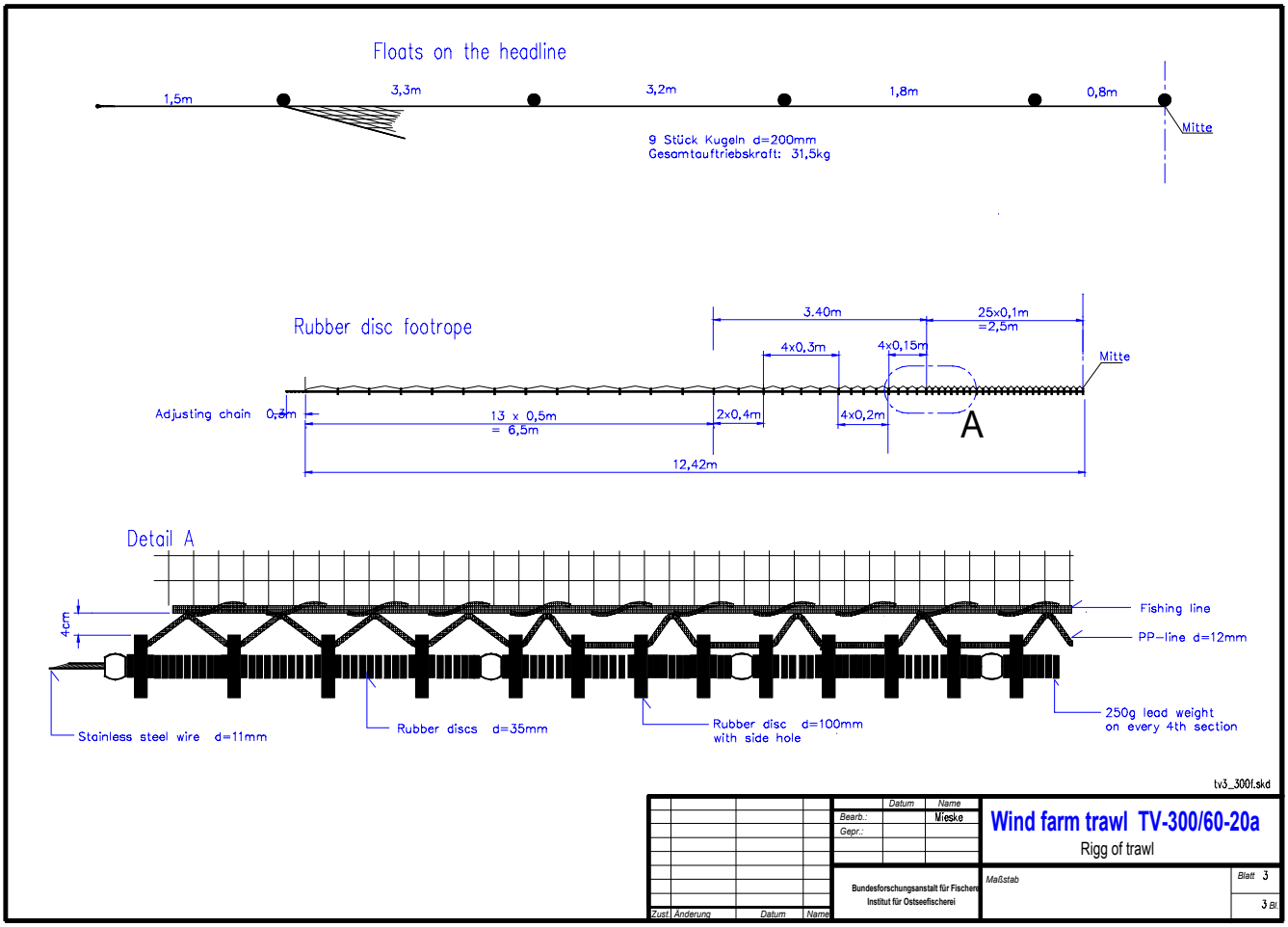
The Standards for Environmental Impact Assessments specify an otter trawl for use in the Baltic Sea. The net shown in the drawing below has been developed especially for such ecological studies. The trawl consists of an upper belly and a lower belly. It has a total length of about 40 m (incl. codend) and a circumference of 32.6 m. Details of the required net material, cut, and assembly are given in Fig. 1. The codend is lined with a webbing (inner codend) of 38 mm mesh size (20 mm mesh bar). Details of the set of bridles are shown in Fig 2, of the head and foot ropes in Fig. 3.
At the projected wind farm depths, the vertical opening of the net will be about 1.5m on average, and the horizontal opening between the wing tips about 10m.



Annex 15.2.1-2 Fig. 1: Wind farm trawl: material, cut, and assembly of the net



Annex 15.2.1-2 Fig. 2 Wind farm trawl: set of bridles



Annex 15.2.1-2 Fig. 3: Wind farm trawl: head and foot ropes

Annex 15.3.1: SAS POSITION FORM (translated from Garthe et al. 2002)

SHIP: ..... OBSERVER:.....

DATE: ....

NUMBER OF SAS OBS. SHEETS:..... PORTSIDE.../...STARBOARD

METHOD:
all species ..... Transect width: ..... m
Flight directions: .....

SHIP TYPE: ..... SPEED: ..... knots

POSITION OF OBSERVER: Top deck
.....
..... Navigating bridge wing .....

OBSERVATION CONDITIONS:
SEA STATE: ..... VISIBILITY: ..... km

WEATHER:
.....
.....

REMARKS:
.....
.....
.....
.....

POSITIONS:

TIME	GEOGRAPHIC POSITION		REMARKS
	Latitude	Longitude	

Annex 15.3.1: How to complete the "SAS Position Form" (translated from Garthe et al. 2002)

Ship: Name of ship.

Date: Day, month, year.

Number of SAS observation forms: Total number of SAS observation forms (see below) completed per ship, day and (in case of double transects) ship side (port/starboard).

Observer: Name of observer(s) (please write full first name(s) and surname). Wherever possible, there should be at least two observers..

Counting side: Please indicate whether the counts were made generally on the port side (P), starboard side (Stbd), or alternately depending on local conditions.

All species: Please tick in case all species are recorded. (Groups of) species that have to be omitted must be indicated.

Flight directions: Indicate whether the bird flight directions noted on the observation forms are the absolute or relative flight directions (details see SAS bird form).

Transect width: With acceptable weather conditions and sufficiently high observer position: 300 m. To be reduced to 200 m in poor weather and/or low observer position (e.g. R.B. "Aade"). Changes made during the observation must be recorded!

Ship type: e.g. research vessel, ferry

Observer position: Top deck (uppermost place on the ship), wing of the navigating bridge ("balcony" at the end of the bridge)

Speed: In knots **over ground**, any speed changes should be noted in the table under "remarks", e.g. the transition from normal to slow speed. If necessary, information can be obtained on the bridge.

Observation conditions: Information on the sea state **must** always be provided, information on visibility should be provided if possible. Since conditions may change frequently during a count, this information may/should (also) be included in the SAS Bird Count Forms.

Sea state: Scale from 1 - 8 describing wave conditions (sea state), and thus the quality of observation conditions. In principle, the scale is based on wind speed in Beaufort (Bft). However, wind speed and sea state are only comparable if the wind acts on a large sea area for a sufficient period of time, from a particular direction and with constant wind speed (DIETRICH et al. 1975) - a situation which hardly ever occurs in the German North and Baltic Seas waters. **Therefore, the sea state should not be classified according to the current wind speed but exclusively on the basis of own observations using the following scale**. At scale 7 or earlier, the counting has to be interrupted (to keep the stomach content from being erupted). Changes in the sea state have to be noted in the SAS Bird Count Form or under "Position: remarks".

0 Sea like a mirror
1 Very small ripples
2 Small wavelets; crests have a glassy appearance and do not break
3 Large wavelets; crests begin to break; scattered white foam crests
4 Waves become longer; frequent white foam crests
5 Moderate waves; many white foam crests; some spray
6 Large waves; white foam crests are extensive everywhere; more spray; reduced appetite
7 Sea heaps up; white foam from breaking waves is blown in streaks along the direction of the wind; rougher conditions; nausea increases

Visibility: To be estimated in relation to, e.g., other ships, buoys and other aids to navigation. If the visibility is ≥ 10 km, 10 is noted in the column "visibility"; if it is below that, the number of kilometres is noted. Changes in the visibility should be noted on the SAS Bird Count Form.

Weather: Information about the weather is not absolutely necessary for the counts, but is desirable in principle. Especially extreme conditions should be noted (i.e. conditions impairing the accuracy of the records, especially due to precipitation but also, e.g., dazzling light).

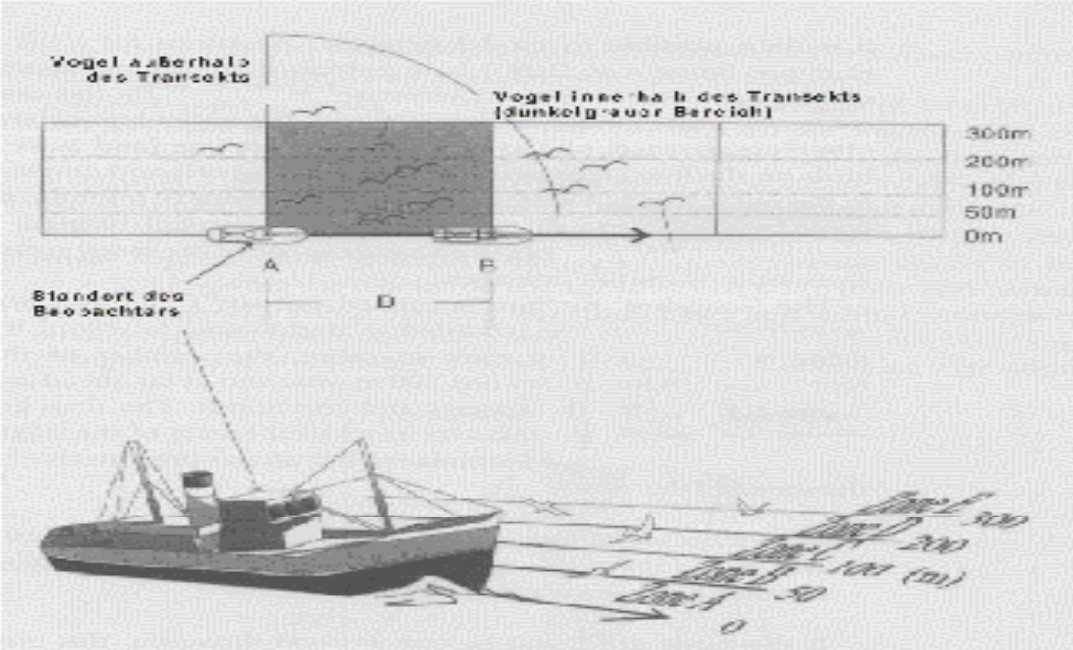
Positions: Parallel to the bird counts, the ship positions have to be recorded regularly in order to be able to refer the observations to geographic positions. On most research vessels, the positions can be recorded automatically, e.g. at one-minute intervals. On other vessels, it may be useful to bring one's own GPS equipment and to record the position every minute. If none of these alternatives is feasible, the data sheet on the opposite side should be used for recording the positions, which may be taken directly from the navigational equipment on the bridge. Also in the latter case, the geographic position should be recorded as often as possible, but at least once an hour (preferably more often) and whenever the ship changes its course (> 10°) or makes a major speed change. On board the passenger vessels to and from Helgoland, positions can also be derived from the buoys marking the fairway. Observers not familiar with buoys are urgently requested to first talk to experienced observers before adopting this method.

Time: UTC, corresponding to GMT (Greenwich Mean Time). UTC corresponds to German winter time less 1 hour, or German summer time less 2 hours.

Geographic position: In degrees, minutes, and hundredths of minutes (as shown on GPS equipment, e.g. 54° 52.79' N), or as a decimal value (e.g. 54.8765° N).

Remarks: Here, changes in the ship's speed, stops, deployment and recovery of nets are recorded, inter alia. Also changes in the wind direction and speed may/should be noted here.

Annex 15.3.1 Fig. 1: Principle of transect counting after Garthe et al. (2002). The ship is at position B, one or half a minute after having left position A (depending on cruising speed, and thus length of the snapshot area)



Annex 15.3.1 Table 1: Length of snapshot areas as a function of ship's speed (translated from Garthe et al. 2002)

Speed (knots)	Distance covered (m)		Speed (knots)	Distance covered	
	in 1 min	in 30 s		in 1 min	in 30 s
7	216	108	13	401	201
8	247	123	14	432	216
9	278	139	15	463	232
10	309	154	16	494	247
11	340	170	17	525	262
12	370	185	18	556	278

Annex 15.3.1: SAS Bird Count Form (translated from Garthe et al. 2002)
BSH version (February 2003)

SHIP: ....OBSERVER: ....DATE: ....SHEET NO:.........OF.........

Distance:	Flight direction:	Associated with:	Behaviour:	
F = flying	**1** = undirected	**12/13** = front/foam line	**30** = + fish	**48** = pursuit diving, not fleeing!
A = swimming, 0-50m	otherwise: all flight directions accurate to 10° acc. to compass rose	**14/15/16** = wood/ garbage / oil	**31** = - fish (Alcidae, terns)	**49** = foraging
B = swimming, 50-100m		**17** = algae, seaweed	**33** = feeding, no details	**111** = NOT foraging
C = swimming, 100-200m		**18/21** = own / other ship	**36** = pursuit flying, e.g. Skua	**60** = resting, sleeping
D = swimming, 200-300m	(10° - 360°)	**19** = ON own ship	**40** = scavenging	**61/65** = courtship/with chicks
0 = swimming, A-D		**26** = fishing vessel	**41** = feeding discards	**66** = preening
E = swimming, >300m		**22** = buoy or other aid to navigation	**42/43** = dipping/surface seiz.	**67** = (high) circling (gulls)
W = swimming, wrong side	**Transect:**	**28/29** = land, sand bar	**44** = surface pecking	**90** = attacked by cleptoparasite
	1 = outside, **2** = inside		**45/46** = deep/shallow plunging	**97/98/99** = oiled/sick/dead

Time	Species	Age	Plumage Cal. year	Number	Grp.	Dist.	Transect	Flight direct.	Assoc.	Behav.	Flight altit.	Notes
		SS:			**Visibility**					**Counting side:**		

Flying altitude: 1 = 0 - 5 m, **2** = 5 - 10 m, **3** = 10 - 20 m, **4** = 20 - 50 m, **5** = 50 - 100 m, **6** = 100 - 200 m, **7** = > 200 m

Annex 15.3.1: How to complete the SAS Bird Count Form (translated from Garthe et al. 2002)

Please note the ship's name, observer, date, and sheet no. at the top of each SAS Bird Count Form. Also the sea state (SS) and visibility should be noted on each page; this information is very important (see above) because conditions are frequently changing. Unfortunately, it is sometimes omitted in the records.

Time: The exact time (in hours and minutes, UTC) has to be recorded for each bird observation.
IMPORTANT: at the beginning of each count, the minute *must* be recorded as well as the word START, irrespective of whether or not a bird has been observed in that minute. At the end of counting, i.e. also during brief interruptions, the word STOP has to be noted together with the exact minute. At the top of each form, the complete time (hour and minutes) has to be noted.

Species: Abbreviations may be used for frequently observed species. Use of different abbreviations for a particular species is *not permitted*. Likewise, these abbreviations must not be used for other species.

Age: A = adult, IM = immature or juvenile (age in calendar years may be recorded under Plumage).

Plumage: W = winter plumage, B = breeding plumage, T = transient plumage.
With respect to adult gulls, plumage information refers mainly to the head plumage.
Gannet: plumage code from 1 to 5 as shown in the Figure in Annex 3 (in Garthe et al. 2002), or A (for adult).
Fulmar: L (for the typical, light-coloured North Sea birds; corresponds to the formerly used LL) or C (for all "coloured" individuals).
Ducks: M = male, F = female (never use W! It stands for winter plumage).
Skuas: L = light morph, I = intermediate morph, D = dark morph.

A first-year bird thus is recorded as IM 1. Attention: after new year, this bird becomes IM 2. It is important to record only the *observed* plumages (not the most likely plumage for the season).

Number

GROUP: Birds belonging to the same flock of birds should be recorded using identical numbers or braces.

Distance: Use letters for swimming birds:

A = 0 - 50 m
B = 50 - 100 m
C = 100 - 200 m
D = 200 - 300 m
E = more than 300 m (outside transect!)

Flying birds always get the letter F, irrespective of their distance.

Swimming birds in transect whose precise distance cannot be determined because, e.g., there is not enough time, are recorded as 0, which corresponds to the distance A to D (0-300 m). The same applies to individuals lifting off from the water at a distance ahead of the ship that is too great to allow their allocation to strips A, B, C or D.

W is to be used for swimming birds on the other side of the ship, irrespective of their distance from the ship (no details required because this is not the counting side; such birds consequently cannot be in transect).
The distance always has to be estimated perpendicular to the ship's keel line. The direct distance from the observer is not relevant. Distance estimates should be checked routinely against small (!) ships and boats, buoys or the like using radar, a commercially available range-finder, or a calliper scale (range finder according to HEINEMANN 1981)! 1 nautical mile (nm) corresponds to 1852 m (1/2 nm = 926 m, 1/4 nm = 463 m, 1/8 nm = 232 m).

Transect: In transect? Yes = 2 No = 1

Flight direction: In the case of migrating birds or other directed bird flight (without the observer needing to know where the birds are headed), the flight direction should be indicated in degrees (with a precision of 10°, taking into account the vessel's movement). Directed flight of birds carrying prey (e.g. fish) is particularly important as they may head towards a colony. Observers should record the absolute (= true) direction using a compass rose, a shipboard compass, or the compass of a GPS unit. If these methods are not applicable, the flight direction may also be recorded in relation to the ship's heading (this must be noted on the form!). 360° on the compass rose is dead ahead, 90° starboard beam (= 90° to the right), 180° dead astern (= back), 270° port beam (= 90° to the left). The direction indicated in this way is converted to the absolute direction during data input or evaluation. Relative flight directions may be shown as arrows (upward = direction of ship movement).

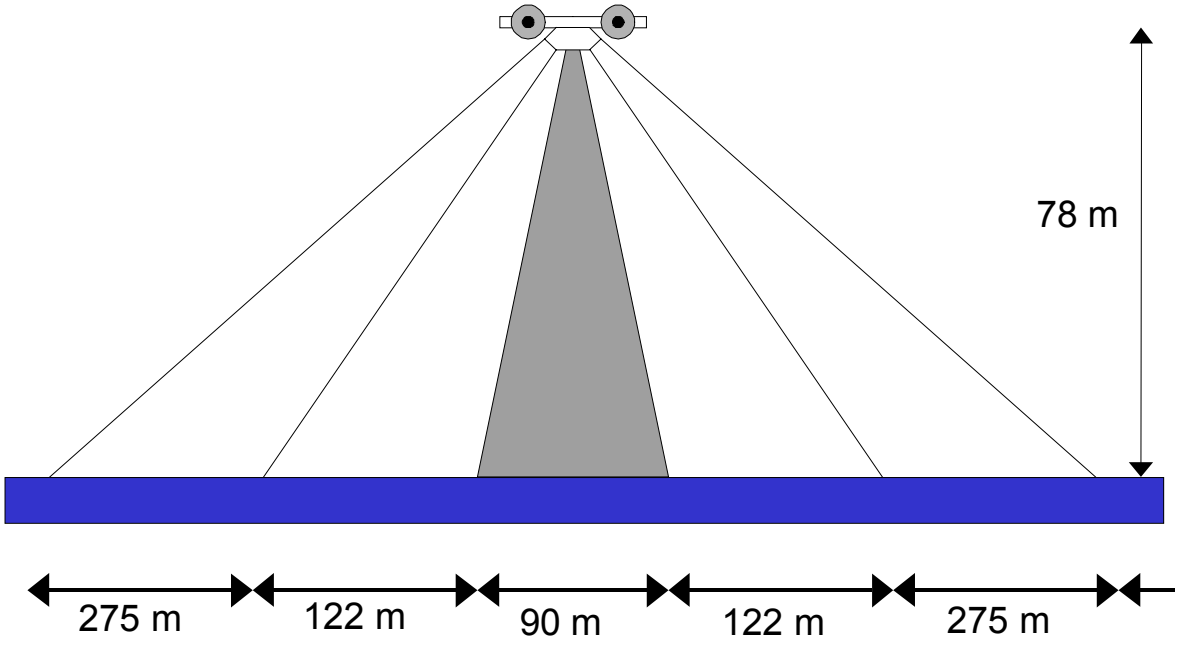
Associations: Here, associations with one's own ship or other ships as well as association with other objects on/in the sea should be noted; details are given in the appropriate box in the heading of the form. The general rule is that individuals associated with one's own ship should always be recorded as not in transect. Only in exceptional cases should they be recorded at all, e.g. in case of special observations (= rare species), extraordinary seasonal observations. At fisheries, plankton, and hydrographic stations, flocks of fulmars and gulls are often observed through which the vessels passes after the completion of sampling. Such individuals should not be counted.

Behaviour: This category, like "Associations" is highly relevant to explain the distribution and abundance of individual bird species at sea. Such distribution patterns at sea may vary considerably for different behaviours (e.g. different distribution of feeding and resting places). The behaviour categories to be distinguished are indicated in the bird count forms.

Prey: In case the prey of sea birds, or objects carried by sea birds, has been identified it is very important to note it on the forms. Details are given at the bottom of the form.

Remarks: This column is for additional details not covered by the other columns. In case of doubt, better include more details than too few.

Annex 15.3.1 Fig. 2: Goniometric determination of transect bands at an altitude of 78 m (from Diederichs et al. 2002)



Annex 15.3.1 Table 2: Transect widths in aerial surveys at a transect spacing of 3 km (from Diederichs et al. 2002)

	Band A	Band B	Band C
Distance from plane	45 – 167 m	168 – 442 m	443 - 1500 m
Transect band width	122 m	275 m	1057 m

Annex 15.3.2.1: Distance correction for radar equipment (translated from: Hüppop et al. 2002)

Whether or not a bird is detected by radar depends on quite a number of factors (Eastwood 1967, Bruderer 1997a, b). The volume covered by a radar beam increases with distance. On the other hand, the energy density of emitted radar beams decreases by the factor $4\pi R^2$ (R = distance), and the same energy loss occurs with the radar beams reflected by birds. This results in a complex relation between distance and the probability of an object being detected by radar. In order to compensate the distance-related "sensitivity" of radar equipment regarding quantitative assessments, e.g. regarding the altitude distribution, the number of echos recorded has to be corrected. We decided not to apply an experimental approach to equipment calibration (e.g. by using a model plane) but an empirical approach using collected data which was based on the assumption – confirmed by visual observations – that, firstly, there exists no land-sea gradient in bird density off Helgoland and, secondly, flight directions within the distance covered by radar are evenly distributed. Accordingly, distance correction for detectability was performed for the 50 – 150 m altitude range according to Buckland et al. (2001) using the programme Distance 3.5 (www.ruwpa.st-and.ac.uk/distance/index.html). The 50 – 150 m altitude range was chosen for two reasons: it is an altitude characterised by high bird densities, and the observation angle from the horizontal plane is almost unchanged. This helps to minimise errors attributable to the fact that the radar cross-sections of birds vary according to azimuth (angle of vision) (see Fig. 3.3 in Eastwood, 1967).

A half-normal model with cosine series expansion (Buckland et al. 2001) was used, with three parameters to be estimated (a_{1-3}), which constitute a good compromise between a good fit (assessed according to the Akaike Information Criterion) and easy handling of the model:

$$y = e^{(-x^2/2\,a_1^2)} \cdot (1 + \sum_{j=2}^{3} a_j \cdot \cos \frac{j \pi x}{w})$$

where x = distance from the radar [m], and y = detection probability, w = transect width (here: 2,500 m). The result of our modelling is shown in Fig. 3. Accordingly, the sum of all echoes for each 100 m x 100 m field of the total radar range up to 1,800 m was corrected for distance, with the maximum of the correction curve = 1 (corresponding to the assumption that all birds have been discovered within this distance).

This method is entirety satisfactory for the determination of relative flight intensity up to distances of just under 2,000 m. At larger distances, the density of values per 100 m x 100 m field is too low. A distance correction has to be performed for each individual radar unit because of production-related differences and different equipment settings. Settings must not be changed after this "calibration".

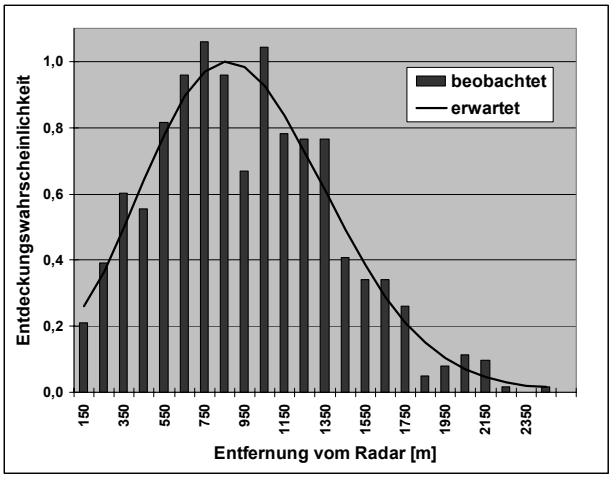


Fig. 3: Bird detection probabilities as a function of distance (n = 694, after Hüppop et al. 2002)

Annex 15.4.1: Observation record - mammals - Page 1

Date: / / Weather sheet Page .____ of ___

Time	Sea state	Swell height (m)	Cloud cover	Glare	from	to	Visib.	Precip.	BB	REK	SB	Notes
:			/8		°	°						
:			/8		°	°						
:			/8		°	°						
:			/8		°	°						
:			/8		°	°						
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:			/8		°	°						
:			/8		°	°						

Annex 15.4.1: Observation record – mammals Page 2

Date: Page of

															Observer
															Sighting number
															Time (UTC)
														GGG°mmm'	**Position North**
														GGG°mmm'	**Position East**
														Estimate	**Distance**
														Ruler	
														Binocular	
														000°	**Angle**
															Total number
															Number of calves
															Behaviour
															Direction of movement
															Cue
															Comment

Annex 15.4.1: Observation record - mammals - Page 3

Abbr.	German term	English term
pp	Schweinswal	harbour porpoise
pv	Gemeiner Seehund	common seal
hc	Kegelrobbe	gray seal
fk	Fischerboot	fishing vessel
netz	Netz	net
bag	Sandvorspülboot	pipeline dredge
seg	Segelboot	sailing vessel
frei	Freizeitboot / Yacht	leisure boat / yacht
müll	Müll	litter

Cue	German term	English term
body	Körper	body
fin	Finne	fin
blow	Blas	blow
bird	Vögel	birds
splash	Spritzer	splash

Behaviour	German term	English term
tr	gerichtetes Schwimmen	travelling
mi	ungericht. Schwimmen	milling
fe	jagen	feeding
other	anderes	other
un	unbekannt	unknown

Distance	
Estimated	estimate
Binocular	read from reticle large mark = 1 small mark = 0,5
Ruler	read from ruler each mark = 0,1

Observer: abbreviated name
Sighting number: use a, b, c, ...for repeated sightings of the same animal

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