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Standard

Investigation of the Impacts of Offshore Wind Turbines on the Marine Environment (StUK4)

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Issued in co-operation with:

Ralf Aumüller
Lothar Bach
Hermann Baier
Holger Behm
Anika Beiersdorf
Michael Bellmann
Klaus Betke
Jan Blew
Axel Binder
Kristin Blasche
Maria Boethling
Uwe Böttcher
Alexander Braasch
Timothy Coppack
Michael Dähne
Hans-Peter Damian
Jennifer Dannheim
Ansgar Diederichs
Tobias Dittmann
Monika Dorsch
Siegfried Ehrich
Helena Feindt-Herr
Elvira Fredrich
Angelika Fuß
Joachim Gabriel
Marco Gauger
Stefan Garthe
Frank Gerdes
Lars Gutow
Brigitte Hielen
Reinhold Hill
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Ursula Verfuß
Felix Weiß
Veronika Wahl
Gottfried Walter
Helmut Wendeln
Manfred Zeiler
Carsten Zerbs

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Inhalt

Part A – Framework 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 planned facilities on the marine environment have to be assessed. Besides, in line with the German regulation § 3 Abs. 1 Nr. 1 UVPG i.V.m. Anlage 1, Nr. 1.6, an Environmental Impact Assessment (EIA) is now mandatory. In the Standard for Environmental Impact Assessments (StUK) at hand, information is provided to applicants on the scope of investigations required by the planning approval/approval authority, with all relevant details and explanations. Likewise, the planning approval/approval holders and operators of wind farms are provided with detailed information about the requirements for operation-phase monitoring, which is currently considered indispensable.

The StUK constitutes a framework of the current thematic and technical minimum requirements for marine environmental surveys and monitoring of constituent criteria as per § 5 Section. 6 No. 2 Seeanlagenverordnung (Marine Facilities Ordinance) from 23 January 1997 (BGBI – German Federal Law Gazette. I p. 57), last amended by Article 11 of the law from 21 January 2013 (BGBI. I p. 95), (hereinafter called SeeAnlV) as well as for monitoring during the construction and operation phase.

The third update of the StUK is based on experience that has been gained with the versions of December 2001, February 2003 and on data from the surveys conducted in the context of the research project “Ökologische Begleitforschung am Offshore-Testfeldvorhaben alpha ventus zur Evaluierung des Standarduntersuchungskonzeptes des BSH – StUKplus” (FKZ: 0327689A), funded by the German Ministry for the Environment, Nature Conservation and Nuclear Safety. Apart from a general increase in knowledge, the findings of environmental monitoring carried out under the German Federal and State 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 have been taken into account.

The following international documents based on mutual exchange of information have been published:

- OSPAR Commission (2008). Guidance on Environmental Considerations for Offshore Wind Farm Development (Replaces agreements 2003-16, 2005-2, 2006-5, 2007-9). Reference number: 2008/-3.
- OSPAR Commission (2004). Problems and Benefits Associated with the Development of Offshore Wind-Farms. ISBN 1-904426-48-4.
- OSPAR Commission (2008). Assessment of the environmental impact of offshore windfarms. Reference number: 2008/-385.
- OSPAR Commission (2006). Review of the Current State of Knowledge on the Environmental Impacts of the Location Operation and Removal/Disposal of Offshore Wind-Farms. Reference number: 2006/-278.

It should be noted that this standard, as well as its earlier versions, has been developed in consultation with numerous experts. The fact that various concepts discussed in the course of the decision making process have not been considered in the StUK does not imply any criticism of such concepts. The planning approval/approval authority, after having consulted the experts and having 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. These can be summarised as follows:

2.1 Construction phase

- Visual and acoustic stress due to building activities
- Sound and light emissions by vehicles/vessels and machinery during construction, amongst other things
- Temporary/permanent loss of habitats (e. g. resting, moulting and/or 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 during operation
- Shadow flicker from rotor blades
- Vibration
- 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
- Potential impact on water quality
- Collisions of birds with wind turbines
- 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 Decommissioning phase

- Visual and acoustic annoyance due to dismantling activities
- Annoyance from vehicle and machinery operation during dismantling activities
- Loss of habitats (resting and feeding areas) due to decommissioning activities
- Pollutant emissions
- Turbidity of water due to sediment disturbance during foundation removal, cable removal and anchoring/propping of vessels and machinery on the seabed.

3 Objectives

Investigation of impacts on features of conservation interest, i. e. fish, benthos, birds, and marine 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 decommissioning,
- establish a basis for evaluating the monitoring results.

4 Deviation from the StUK, updates

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 planning approval/approval authority may modify the monitoring programme in general or in individual cases. In case a Strategic Environmental Assessment is available for the project area, its results shall be taken into account when determining the scope of investigations for the particular project.

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 Positioning of measuring instruments

The planning approval/approval authority must be notified about the positioning of measuring instruments at the building site (e. g. click detectors, measuring instruments for underwater noise, wave buoy). The positioning of measuring instruments requires a permit in accordance with § 6 Section 1 SeeAnlV from the planning approval/approval authority.

The positioning of measuring instruments for recording underwater noise is subject to specific stipulations and must be co-ordinated with the planning approval/approval authority at least eight weeks prior to installation.

6 Quality assurance

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

Persons taking part in the surveys must have adequate qualification and expertise and must be able to prove it. The names of the observers have to be noted on the survey forms. The contents and implementation of instructions for the observers have to be documented.

In the planning and implementation of monitoring programmes 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.

Surveys of sea birds and marine mammals are only allowed to be carried out by teams who have previously received intensive training (e. g. Garthe 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 interpretation of bat call recordings and the identification of species are to be carried out by persons with long-standing experience in the bio-acoustic analysis of bat calls.

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

For the purpose of quality assurance, the submission of expert reports (Section 13) to the planning approval/approval authority must be supplemented by documentation of data collection and evaluation that is both reasonable and focused on features of conservation interest.

7 Decommissioning 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 StUK. Possible environmental impacts depend mainly on the dismantling techniques used, which are expected to undergo major technical improvement during the coming decades when numerous oil and gas platforms are due for decommissioning. Therefore, the final scope of standardised monitoring will be determined at a later date. Should the need arise in the meantime, the planning approval/approval authority shall establish a study framework for corresponding monitoring measures in the specific case.

8 Further studies and analyses

In addition to the studies described in the StUK at hand, further requirements may result from other regulations as well as from the incidental provisions of the respective planning approval decision/the respective permit. In particular, the standard at hand is closely linked to the other standards published by the BSH (Standard “Design of Offshore Wind Turbines” (BSH 2007), Standard “Ground Investigations for Offshore Wind Farms” (BSH 2008)); explicit reference is made here to their content (surveys in the context of collision and risk analysis, environmental impact studies in co-ordination with the design basis and preliminary draft, due consideration of the planned noise reduction measure when drawing up the basic design, etc.).

9 Procedure for the implementation and evaluation of studies relating to the planning as well as construction and operation of offshore wind farms

Application for the erection of offshore wind turbines: Request for briefing in line with § 5 UVPG

Presentation of the following documentation:

- Literature study to characterise the planning area
- Proposal of an investigation programme in accordance with the StUK.

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Environmental Impact Assessment – baseline study:

- Characterisation of the planning area regarding environmental features and species communities as a basis for the EIA as well as for the species, habitat and biotope protection law reports.
- Characterisation of the planning area in order to determine the survey area, monitoring programme and reference area (of the individual project/the cluster) for the individual features of conservation interest.
- Investigations prior to the start of construction to characterise the environmental features of the project and reference area (of the invidual project/the cluster), particularly with a view to species communities.

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Environmental Impact Assessment – monitoring of construction phase

- Investigations in the project and reference area (of the individual project/the cluster) to assess impacts of the construction phase on the marine environment.

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Environmental Impact Assessment – monitoring of operation phase

- Investigations in the project and reference area (of the individual project/the cluster) to assess impacts of the operational phase on the marine environment.

10 Assessment period

The following assessment periods apply to all projects, unless the technical instructions (Part B) for the individual features of conservation interest make different demands.

10.1 Baseline study

A baseline study over two successive, complete seasonal cycles has to be performed without any interruption to determine the status quo as a basis for construction and operation phase monitoring as well as for compilation of the Environmental Impact Assessment (EIA). One seasonal cycle comprises twelve calendar months including the month in which the survey begins.

After completion of the baseline study, an EIA must be submitted to the planning approval/approval authority. If an EIA has already been compiled on the basis of one seasonal cycle, it must be extended by inclusion of the results of the second seasonal cycle.

The baseline study must be updated by inclusion of a third survey year, if the time between end of baseline study and construction start exceeds two years. If more than five years pass between end of baseline study and construction start, a new, complete two-year baseline study must be carried out. It is possible to apply after six months for a reduction of the monitoring programme to one year (together with the submission of a detailed preliminary report), if the results of the investigations show that no significant changes in the conditions regarding location have occurred.

10.2 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 in line with requirements.

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 planning approval/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 planning approval/approval authority in each individual case.

10.3 Operation phase

The StUK defines the operation phase as the phase following the completion of construction work, as soon as the wind turbines have been put into operation; this is idenpendent of the BSH operation release according to Standard Design of Offshore Wind Turbines. After the wind farm has become operational, operation-phase monitoring has to be performed for a period of three to five years, depending on specific conditions regarding the site/project and the features of conservation interest, in order to verify the assumptions made in the approval (EIA). The precise time for beginning the operation-phase monitoring will be determined by the planning approval/approval authority and can vary between the respective featrues of conservation interests. After completion of the final year of regular operation-phase monitoring, the planning approval/approval authority shall determine in each individual case whether investigations beyond this period are required for the final assessment of impact assumptions.

Any additional marine environmental protection measures which are later found to be necessary on the basis of latest findings and/or the results of operation-phase monitoring shall be included in a suitable way in the monitoring schedule.

11 Cluster study

As far as different construction sites/projects take place in regional and temporal conjunction, the project surveys shall be conducted conjointly (cluster study).

However, the surveys for the features of conservation interest benthos and fish are to be conducted individually within the respective project areas. The reference areas may be used by one or conjointly by several project contractors (Section 12.2.1).

12 Assessment region

The assessment region is the total area in which the studies according to the StUK are carried out. It is comprised of the assessment area (including the project area) and the reference area.

The scope of assessment (methodology, purpose, and duration) in the assessment area shall not exceed applicable state-of-the-art scientific and technical requirements. The individual features of conservation interest require different assessment areas in terms of size and location. If legal or factual circumstances are such that the standard size of assessment areas as defined below appears to be inadequate or unsuitable, such assessment areas shall be adjusted to local conditions by the planning approval/approval authority.

12.1 Project area and assessment area

The project area is the area designated for the construction of the wind farm and defined by the respective coordinates as given in the application papers, without inclusion of a subsequent safety zone.

The assessment area comprises the project area and, depending on the individual features of conservation interest, surrounding areas that are required for the professional investigation of a given feature of conservation interest.

12.1.1 Benthos/fish

The size of the assessment area corresponds to the current size and location of the wind farm.

12.1.2 Avifauna/marine mammals

- Aerial surveys:

The area must cover at least 2,000 km^2. The wind farm shall be at the centre of the assessment area. The distance between the sides of the wind farm and the margins of the assessment area shall principally be at least 20 km.

- Ship based surveys:

The assessment area must cover at least 200 km^2. The distance between the sides of the wind farm and the margins of the assessment area shall principally be at least 4 km.

12.2 Reference areas

Reference areas will be used for comparison to document the development of features of conservation interest without the impact of the wind farm. In addition, this renders visible the impact of offshore wind turbines and area closure on certain other users (e.g. fishing).

Reference areas should be located outside the project areas for other construction projects. Moreover, they should be suitable also for projects that are to be implemented at a later date. The natural ambient conditions in the reference area (location, current conditions, water depth, sediment properties, size, species spectrum, number of individuals) should be largely comparable to those in the project area concerned. As far as possible, the anthropogenic influences in the reference area should be likewise comparable to those in the construction area, with the exemption of fishing, wind turbine construction activities and their operation.

If the reference area is part of another project area, it must be made sure that the reference area remains free of construction activity during the assessment period.

12.2.1 Benthos/fish

The location of the reference areas for benthos and fish must largely correspond. The size of the reference area must correspond to that of the project area. If the habitat of the project area is abiotically very heterogeneous (e.g. different sediment properties, hydrography or water depth), a reference area should be chosen which has very similar properties. 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 project area (construction/operation noise, turbidity plumes). To what extent wind farms affect the individual features of conservation interest often cannot be determined prior to the construction/operation phase. Therefore, the minimum distance should be 1 km.

The joint carrying out of studies in one or several reference areas by several project contractors is explicitly desired, if the reference area is suitable for the respective project areas (Cluster study, Section 11). A scientific analysis of data from all affected project and reference areas is required to determine that the reference area/areas is/are sufficiently representative for all concerned projects (joint analysis, cluster analysis, MDS plot).

12.2.2 Avifauna/marine mammals

- Aerial surveys:

  A separate reference area is not necessary.

- Ship based surveys:

  The size of the reference area corresponds to that of the assessment area. If a survey of a separate reference area is not possible, the assessment area must comprise at least 400 km^2.

13 Reporting

The results of the baseline study and monitoring have to be submitted to the planning approval/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 planning approval/permit and shall be made available in whole or in part to the planning approval/approval authority upon request. Different storage arrangements for the raw data may be agreed with the planning approval/approval authority. The data formats to be used have to be agreed with the planning approval/approval authority.

The raw data from underwater noise measurements has to be archived exclusively by the planning approval/approval authority. The exchange of raw data is prohibited. The data has to be kept solely in processed form for the purpose of further use. For detailed data handling procedures, please contact BSH.

13.1 Baseline study

The baseline study raw data has to be submitted to the planning approval/approval authority the latest two months prior to submission of the expert report.

If the planning area is located in a national park (or in the vicinity of expected impacts), in a marine protected area or in 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 – German Federal Nature Conservation Act). Moreover, a species protection law report (§§ 44 ff. BNatSchG) and, as far as there is indication of an existing habitat in the project area, a biotope protection law report (§§ 30 ff. BNatSchG) must be submitted.

A report documenting any actual changes as well as changes in the impact prediction must be submitted four months after completion of the annual cycle in each case.

13.2 Monitoring

The monitoring data shall be presented to the planning approval/approval authority once a year, four months after completion of the annual cycle in each case. The monitoring data shall include 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 planning approval/approval authority will decide on the type and scope of further investigations. Unless the applicant or planning approval/permit holder in charge of the investigations proposes further investigations differing from the scope of investigations specified in the notification and from the present StUK, the existing arrangements and monitoring periods specified in the StUK shall continue to apply.

Part B – Technical instructions for surveys of features of conservation interest

Features of conservation interest

Technical details of the investigation and monitoring to be carried out in order to protect the features of conservation interest, i.e. benthos, fish, birds and marine 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 features of conservation interest.

1 Benthos

The benthos investigations and monitoring comprise:

- Investigation of the sediment and habitat structure and their dynamics using side scan sonar (Table 1.1).
- Video survey of epifauna, macrophytes and habitat structure (Table 1.2).
- Grab sampling survey of infauna (Table 1.3).
- Beam trawl survey of epifauna (Table 1.4).
- Installation-based grab sampling survey of infauna (Table 1.5).
- Investigation of growth and demersal megafauna on the underwater construction structure (Table 1.6).
- Investigation of benthos and habitat structures in the context of installation of cable routes for connecting offshore wind farms (Table 1.7).

Additionally, the sediment properties per grab sampler (short core sampler 4.5 cm inner diameter, 6 cm penetration depth) have to be determined:

- Grain size distribution (silt/clay, fine sand, medium-grained sand, coarse sand, gravel/ rubble) (according to DIN EN ISO 14688-1-2003).
- Loss on ignition (according to DIN EN-12879:2001-02).

During the above investigations, measurements of salinity, temperature and oxygen levels (according to UNESCO 1988) have to be carried out at the sea surface (- 0.5 m) and near the seabed in order to obtain a representative picture of the hydrographic situation in the area.

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

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

The application documents for the wind farm project must include area demarcation of the habitats protected by § 30 Section 2 p. 1 No. 6 BNatSchG on the basis of the respectively valid German Federal Agency for Nature Conservation (BfN) mapping guidelines for the German EEZ (where available).

In the third year after the end of the baseline study, the area studies of benthos (see Table 1.3 and 1.4) shall be resumed in this section for those areas, where installation of foundations and infield cabling has been completed. The studies follow the methodology of operation-phase monitoring.

Table 1.1: Side scan sonar (SSS) survey of sediment and habitat structure and its dynamics.

	Baseline study	Construction phase	Operation phase
Objectives	Investigation of ground morphology and type of substratum for benthos programme planning, for determining a suitable reference area, for interpretation of benthos data and for demarcation of habitat types protected by § 30 BNatSchG. Verification of images by grab sampling (ground truthing).		Investigation of ground morphology and substratum for small and medium scale detection of relevant impacts caused by wind turbines.
Scope	SSS studies and ground truthing at seabed surface shall be conducted in juncture with the geological investigations for a geotechnical survey of wind turbine and cable route sites. The investigations shall be carried out in both the project and the reference area and have to take into consideration the scope of the Geotechnical Site Investigation Standard (see Table 4 and Table 10, BSH 2013). The survey results collected in the context of geological monitoring must be used for the ecological evaluation of the sediment and habitat structure and its dynamics.		SSS studies and ground truthing at seabed surface shall be conducted in juncture with the geological monitoring of wind turbines and cable routes. The investigations have to take into consideration the scope of the Geotechnical Site Investigation Standard (see Table 4 and Table 10, BSH 2013). The survey results collected in the context of geological monitoring must be used for the ecological evaluation of the sediment and habitat structure and its dynamics.
Timing	Once (see Geotechnical Site Investigation Standard, Table 4 and Table 10, BSH 2013).		In the third and fifth year of operation phase, in co-ordination with the annual geological monitoring (see Geotechnical Site Investigation Standard, Table 4 and Table 10, BSH 2013).
Method	Carrying out of SSS studies and grab sampling (ground truthing) according to Geotechnical Site Investigation Standard (see Table 4 and Table 10, BSH 2013).		Carrying out of SSS studies and grab sampling (ground truthing) according to Geotechnical Site Investigation Standard (see Table 4 and Table 10, BSH 2013).
Presentation of results	Compilation of ground morphology and substratum type maps: • GIS or CAD format (the data must be provided compatible with the xy standard). • Geodetic reference system: Lat/ Long (WGS 84). • Illustration of ground truthing stations. The station grid for the subsequent infauna programme shall be determined on the basis of the SSS results (see Table 1.3). Figure 1, p. 42 provides an assessment regarding the occurrence of homogeneous and heterogeneous sediments in the EEZ of the North Sea.		

Table 1.2: Video survey of epifauna, macrophytes and habitat structure.

	Baseline study
Objectives	Description of epifauna and habitat structure as well as investigation of potential existence of macrophyte benthos in the event of heterogeneous habitat structure of the project area.
Scope	Once a year in autumn. In the first year of the baseline study, description of seasonal conditions in the project area requires investigations in spring and in autumn.
	Use of underwater video only in the event of heterogeneous habitat structure.
Timing	At least two consecutive complete seasonal cycles prior to the start of construction.
Method	5 video transects of about 15 min. duration with a drift velocity of max. 1 knot shall be carried out in the project area. Geographic positioning of the transect must be documented. The video surveys should be made using a camera (compliant with DIN EN 16260, investigation type “Preliminary Study”), with each picture showing the station number, GPS data, date, and water depth. The seasons are defined as follows: Spring: 01.03.–15.05./Autumn: 15.08.–15.11.
Presentation of results	Description of epifauna, macrophyte benthos and habitat structure by exemplary illustration of: • Abundance/frequency of rocks, shell banks etc. • Frequency of epifauna (cover percentage). • Traces/dwellings of infauna (e. g. Lanice tubes). • Abundance/frequency of macrophytes (according to HELCOM guidelines “Monitoring of phytobenthic plant and animal communities”). • Visible disturbances of the sediment surface (e. g. caused by fishing). • The submitted video has to be a representative cut of the individual transects and potentially occurring peculiarities.

Table 1.3: Grab sampling survey of infauna.

	Baseline study	Construction phase	Operation phase
Objectives	Description of infauna in the project area and reference area and determination of a suitable reference area. Medium and small scale survey of status quo, to be used as a basis for assessing possible impacts of wind turbines.		Medium and small scale survey of relevant operation phase impacts on species communities.
Scope	Once a year in autumn. In the first year of the baseline study, description of seasonal conditions in the project area and reference area requires investigations in spring and in autumn. In the first year of the baseline study, the homogeneity of assessment areas must be investigated in autumn.		
	A rough station grid (spacing 1 nmi) shall be established in the project and reference areas. The distribution of stations follows the habitat structures as determined by the SSS (see Table 1.1) as well as the wind turbine sites and, in the event of similar stations, is assigned randomly. At least 20 stations must be established in small areas (< 20 nmi^2). In large homogeneous areas, station spacing > 1 nm is possible in agreement with the BSH. Identified areas suspected to be protected habitat types as per § 30 BNatSchG shall be demarcated by additional investigations according to the currently valid mapping guidelines of the BfN. In the event of numerous small scale areas, the representative distribution of sampling stations is possible in agreement with the BSH.		
Timing	At least two consecutive and complete years prior to construction start.		In the first, third and fifth year of the operation phase.
Method	**Sampling strategy:** • The sampling dates are to observe the same limited time frame each year. The sampling interval in the project and reference areas must not exceed 2 weeks. The installation-based investigations (see table 1.5) shall be carried out in conjunction with the station grid. • The seasons are defined as follows: Spring: 01.03.–15.05./Autumn: 15.08.–15.11. • Equipment standard: Modified Van Veen grab, 0.1 m^2 sampling surface, 60–80 kg, sieve covered lid, warp-rigged. Grab sampling depth may vary depending on sediment conditions. Should the grab sampler weight require adaptation to the sediment structure (e. g. 25–40 kg for muddy/silted sand and 70–100 kg for coarser sediments, depending on the grab sampler's starting weight), this must be effected in such a manner so as to maintain the comparability of sampling stations with similar sediment structure. • Three parallel samples shall be taken per station. • Sieve with 1,000 µm mesh size. In case of large proportion of coarse and medium-grained sand or gravel, the sample should first be decanted through the sieve and rinsed at least five times. This is followed by batch-wise sieving. Fixation of the sample in 4 % buffered formalin. • Documentation of the sample processing method has to be provided (according to ISO/DIS 16665). The condition of the catching device must be documented. • Biomass shall be determined as wet weight per species (according to ISO/DIS 16665, Annex C). Moreover, the following information must be determined and documented: • Hydrographic (T, Sal, O_2) and meteorological data.		

	Baseline study	**Construction phase**	**Operation phase**
Presentation of results	**Documentation of condition and modification per project and reference area *(described in separate chapters)* by illustration of:** • Total number of individuals per area/number of individuals per species and area (species table). • Total biomass per area/biomass per species and area. • Dominance structure (related to number of individuals and biomass). • Occurrence and distribution of Red List species. • Diversity/evenness for community analysis, cluster analysis or multi-dimensional scaling, univariate analyses, significance tests. • Evaluation according to BACI design with suitable statistical methods.		

Table 1.4: Beam trawl survey of epifauna.

	Baseline study	Construction phase	Operation phase
Objectives	Description of epifauna (macrobenthos, demersal fish) in the project and reference areas. Medium and small scale survey of status quo, to be used as a basis for assessing possible impacts of wind turbines.		Medium and small scale survey of relevant operation phase impacts on species communities.
Scope	Once a year in autumn. In the first year of the baseline study, description of seasonal conditions in the project area and reference area requires investigations in spring and in autumn. The number of beam trawl per area (project/reference area) depends on the number of assessed infauna stations (see Table 1.3). Half of the infauna stations have to be surveyed by means of beam trawls. In smaller areas (< 20 nmi^2), at least 10 beam trawl surveys should be conducted.		
Timing	At least two consecutive and complete years prior to construction start.		In the first, third and fifth year of the operation phase.
Method	**Sampling strategy:** • The sampling dates are to observe the same, limited time frame each year. The sampling interval in the project and reference area must not exceed 2 weeks. • The seasons are defined as follows: Spring: 01.03.–15.05./Autumn: 15.08.–15.11. • Equipment standard: 2 m beam trawl (mesh size 1 cm). Duration of ground-level trawling should be 5 min., trawling speed should be 1–3 kn. • Documentation of the sample processing method has to be provided (according to ISO/DIS 16665). The condition of the catching device must be documented. • Biomass shall be determined as wet weight per species (according to ISO/DIS 16665, Annex C). Moreover, the following information must be determined and documented: • Shooting and hauling positions, towing time, area covered. • Hydrographic (T, Sal, O_2) and meteorological data.		
Presentation of results	**Documentation of condition and modification per project and reference area *(described in separate chapters)* by illustration of:** • Total number of individuals per area/number of individuals per species and area (species table). • Total biomass per area/biomass per species and area. • Dominance structure (related to number of individuals and biomass). • Occurrence and distribution of Red List species. • Diversity/evenness for community analysis, cluster analysis or multi-dimensional scaling, univariate analyses, significance tests. • Evaluation according to BACI design with suitable statistical methods.		

Table 1.5: Installation-based grab sampling survey of infauna.

	Operation phase
Objectives	Ascertainment of installation-based impacts of operation phase on infauna species communities.
Scope	Once a year in autumn.
	An installation-based sampling design has to be carried out at two wind turbines, subject to the wind farm safety regulations (see study design, fig. 2, p. 43).
Timing	In the third and fifth year of the operation phase.
Method	**Sampling strategy:** • The sampling dates are to observe the same, limited time frame each year. The installation-based surveys shall be carried out together with the area-based infauna surveys (see Table 1.3). • The seasons are defined as follows: Autumn: 15.08.–15.11. • Equipment standard: Modified van Veen grab, 0.1 m^2 sampling surface, 60–80 kg, sieve covered lid, warp-rigged. Grab sampling depth may vary depending on sediment conditions. Should the grab sampler weight require adaptation to the sediment structure (e. g. 25–40 kg for muddy/silted sand and 70–100 kg for coarser sediments, depending on the grab sampler‘s starting weight), this must be effected in such a manner so as to maintain the comparability of sampling stations with similar sediment structure. • Three parallel samples shall be taken per station. • Sieve with 1,000 µm mesh size. In case of large proportion of coarse and medium-grained sand or gravel, the sample should first be decanted through the sieve and rinsed at least five times. This is followed by batch-wise sieving. Fixation of the sample in 4 % buffered formalin. • Documentation of the sample processing method has to be provided (according to ISO/DIS 16665). The condition of the catching device must be documented. • Biomass shall be determined as wet weight per species (according to ISO/DIS 16665, Annex C). Moreover, the following information must be determined and documented: • Hydrographic (T, Sal, O_2) and meteorological data.
Presentation of results	**Documentation of condition and modification by illustration of:** • Total number of individuals per area/number of individuals per species and area (species table). • Total biomass per area/biomass per species and area. • Dominance structure (related to number of individuals and biomass). • Occurrence and distribution of Red List species.

Table 1.6: Investigation of growth and demersal megafauna on underwater structures.

	Operation phase
Objectives	Investigation of growth (macrophytes and macrobenthos) and demersal megafauna on piles, foundations and scour protection.
Scope	Once a year in autumn.
	Survey of piles, foundations and scour protection on at least two wind turbines per foundation type.
Timing	In the third and fifth year of the operation phase.
Method	**Sampling strategy:** • The sampling dates are to observe the same limited time frame each year. • The seasons are defined as follows: Autumn: 15.08.–15.11. • Up to 10 m water depth, pile survey to be made by research divers. Taking of 3 quantitative scratch samples (20 cm x 20 cm) each at three depths (1 m, 5 m, 10 m – mean tidal high water) for the quantitative assessment of growth community and quantification of species. • At greater depths, the foundations and scour protection survey and determination of species of mobile, demersal megafauna (≥ 2 cm) shall be effected by consulting the video footage of the technical construction monitoring (see Standard “Design of Offshore Wind Turbines”, Table 1, BSH 2007). • Biomass shall be determined as wet weight per species (according to ISO/DIS 16665, Annex C). Moreover, the following information must be determined and documented: • Hydrographic (T, Sal, O_2) and meteorological data.
Presentation of results	**Documentation of condition and modification by illustration of:** • Total number of individuals per area/number of individuals per species and area (species table). • Total biomass per area/biomass per species and area. • Dominance structure (related to number of individuals and biomass). • Species specific and absolute coverage. • Comparison with natural hard-substrate communities (if available).

Table 1.7: Investigation of benthos, habitat structures and habitat types in the context of installation of cable routes for connecting offshore wind farms. The in the following described monitoring programme has to be conducted by the grid operator.

The following investigations have to be implemented by the grid operator.

	Baseline study	**Construction phase**	**Operation phase**
Objectives	Description of infauna and epifauna, habitat structure and habitat types as a basis for evaluating potential impacts by connecting offshore wind farms to the grid.		Medium and small scale survey of infauna and epifauna as a basis for assessing potential impacts during the construction phase.
Scope	The distribution of stations follows the habitat structures as determined by SSS/ground truthing (SSS investigations by transmission system operator). Each determined habitat structure along the cable route must be covered by at least 3 cross-transects. Both at the beginning and end of the cable route an additional cross-transect must be established. Each cross-transect consists of 5 stations (see study design, fig. 3, p. 43). The central station is located on the planned cable route. 2 stations are located in 100 m and, respectively, 1,000 m distance above and below the central station.		
	Identified areas suspected to be protected habitat types as per § 30 BNatSchG shall be demarcated by additional investigations according to the currently valid mapping guidelines of the BfN. In the event of numerous small scale areas, the representative distribution of stations is possible on the basis of the SSS investigations and in agreement with the BSH.		
Timing	Once in autumn.		Once in autumn one year after commissioning of the cable.
Method	**Sampling strategy infauna:** • The seasons are defined as follows: Autumn: 15.08.–15.11. • 5 stations per cross-transect are investigated, each consisting of 3 parallel samples. • Equipment standard: Modified van Veen grab, 0.1 m^2 sampling surface, 60–80 kg, sieve covered lid, warp-rigged. Grab sampling depth may vary depending on sediment conditions. Should the grab sampler weight require adaptation to the sediment structure (e. g. 25–40 kg for muddy/silted sand and 70–100 kg for coarser sediments, depending on the grab sampler's starting weight), this must be effected in such a manner so as to maintain the comparability of sampling stations with similar sediment structure. • Sieve with 1,000 µm mesh size. In case of large proportion of coarse and medium-grained sand or gravel, the sample should first be decanted through the sieve and rinsed at least five times. This is followed by batch-wise sieving. Fixation of the sample in 4 % buffered formalin. • Sample processing must be documented and standardised (according to ISO/DIS 16665). The condition of the catching device must be documented. • Biomass shall be determined as wet weight per species (according to ISO/DIS 16665, Annex C).		

	Baseline study	Construction phase	Operation phase
Method (continued)	**Epifauna sampling strategy:** • The seasons are defined as follows: Autumn: 15.08.–15.11. • 2 hauls per cross-transect shall be carried out (one each across the central and one of the outer stations). • Equipment standard: 2 m beam trawl (mesh size 1 cm). Duration of ground-level trawling should be 5 min., trawling speed should be 1–3 kn. • Biomass shall be determined as wet weight per species (according to ISO/DIS 16665, Annex C). • Sample processing must be documented and standardised (according to ISO/DIS 16665). The condition of the catching device must be documented. • If use of the beam trawl is not possible, a representative underwater video may be used in the event of heterogeneous habitat structure (according to DIN EN 16260, investigation type "Preliminary Study").		
	Moreover, the following information must be determined and documented: • In the event of beam trawl sampling: Shooting and hauling positions, towing time, area covered. • Hydrographic (T, Sal, O_2) and meteorological data. • At each station, a sediment sample is taken for determining the grain size distribution (according to DIN EN ISO 14688-1-2003) and loss on ignition (according to DIN EN-12879:2001-02).		
Presentation of results	**Documentation of condition and modification by illustration of:** • Total number of individuals per area/number of individuals per species and area (species table). • Total biomass per area/biomass per species and area. • Dominance structure (related to number of individuals and biomass). • Occurrence and distribution of Red List species. • Diversity/evenness for community analysis, cluster analysis or multi-dimensional scaling, univariate analyses, significance tests. • Comparison of own data with SSS investigation results of the transmission system operator. • Allocation of cross-transects to clusters with similar sediment characteristics or similar associations of macrobenthos (Pesch et al. 2008, Rachor & Nehmer 2003, Salzwedel et al. 1985) on the basis of community analyses (cluster analysis, MDS plot). • Documentation of sediment characteristics and hydrographic conditions in the project area. • Area demarcation of the habitats protected by § 30 BNatSchG within the area impacted on by the cable route corridor (compilation of a habitat type map).		

2 Fish

Fish surveys involve use of beam trawls in the North Sea and of otter trawls in the Baltic Sea (Table 2.1). The surveys have to be accompanied by representative measurements of weather, depth, salinity, temperature and oxygen (according to UNESCO 1988), which have to be recorded.

Installation-based surveys are to be carried out corresponding to the current state of technology and to the wind farm safety regulations. The concrete scope and methods are determined in co-operation with the planning approval/approval authority in the respective study scope.

In the third year after the end of the baseline study, the studies of fish shall be resumed in this section for those areas, where installation of foundations and infield cabling has been completed. The studies follow the methodology of operation-phase monitoring.

Table 2.1: Beam trawl/otter trawl survey (wind farm trawl).

<table>
<tr><th></th><th>Baseline study</th><th>Construction phase</th><th>Operation phase</th></tr>
<tr><td>Objectives</td><td>Description of fish fauna in the project and reference areas.
Medium and small scale survey of status quo, to be used as a basis for assessing possible impacts of wind turbines.</td><td></td><td>Medium and small scale survey of relevant operation phase impacts on the fish fauna.
Survey of small scale impacts on fish population in the wind farm by state-of-the-art installation-based surveys.</td></tr>
<tr><td rowspan="2">Scope</td><td colspan="3">Once a year in autumn. In the first year of the baseline study, description of seasonal conditions in the project area and reference area requires investigations in spring and in autumn.</td></tr>
<tr><td colspan="3">In project and reference areas of > 100 km², the minimum number of hauls should be 30 each when using an otter trawl. 20 hauls each will be sufficient if a beam trawl is used.
In project and reference areas of < 100 km², the minimum number of hauls should be no less than 20 each when using an otter trawl. 15 hauls each will be sufficient if a beam trawl is used.
In project and reference areas of < 30 km², the minimum number of hauls should be 15 each when using an otter trawl. 10 hauls each will be sufficient if a beam trawl is used.</td></tr>
<tr><td>Timing</td><td>At least two consecutive complete seasonal cycles prior to the start of construction.</td><td></td><td>In the first, third and fifth year of the operation phase.</td></tr>
<tr><td>Method</td><td colspan="3">Sampling strategy:
• Equipment standard North Sea: 7 m beam trawl (see p. 44)
• Equipment standard Baltic Sea: Otter trawl (wind farm trawl) (see p. 46).
• The same equipment standard must be used both in the project area and in the reference area. A change of equipment standard is not permitted!
• The duration of hauls should be 15 min., and the towing speed 3 to 4 kn. In beam trawl surveys, the respective hauls from both sides (starboard/port) must be surveyed. Employing stern trawlers, the duration of hauls must be prolonged to 30 min., and the respective haul of just one side (starboard or port) must be surveyed.
• Taking into account the specific conditions of the project, a random station grid is to be preferred in principle to a fixed station grid.</td></tr>
</table>

<table>
<tr><th></th><th>Baseline study</th><th>Construction phase</th><th>Operation phase</th></tr>
<tr><td>Method (continued)</td><td colspan="3">• The sampling dates are to observe the same limited time frame each year. The sampling interval in the project and reference areas must not exceed 2 weeks.
• The seasons are defined as follows:
North Sea: Spring: 01.04.–15.05./Autumn: 15.09.–15.11.
Baltic Sea: Spring: 01.04.–15.05./Autumn: 01.10.–30.11.
• Fish sampling must take place only from dawn to sunset.
• The treatment of catches should be documented and standardised (see process instruction p. 49).
• The condition of the catching device must be documented.
Moreover, the following information must be determined and documented:
• Shooting and hauling positions, towing time, area covered.
• Per fish species: weight, number, length distribution.
• Brief, semi-quantitative description of invertebrate by-catch.
• Hydrographic (T, Sal, O_2) and meteorological data.</td></tr>
<tr><td>Presentation of results</td><td colspan="3">Documentation of condition and modification per project and reference area (described in separate chapters) by illustration of:
• Total number of individuals per area/number of individuals per species and area (species table).
• Total biomass per area/biomass per species and area.
• Dominance structure (related to number of individuals and biomass).
• Diversity (e. g. Shannon-Wiener Index) and evenness (e. g. according to Pielou).
• Average number of species per haul.
• Length frequency distribution of dominant species.
• Analytical statistics (univariate analyses, community analysis (cluster analysis, MDS plot)).
• The catch (port/starboard) per haul should be documented both separately and combined.
• The fish documented during the benthos (epifauna) survey (see table 1.2 and 1.4) should be included to illustrate the fish species spectrum.</td></tr>
</table>

3 Avifauna

A single-species description is required for the following bird species:

- All species listed under Annex 1 to the EU Birds Directive.
- All regularly occurring migratory bird species according to Art. 4, para. 2, Birds Directive, which are not listed under Annex 1. However, a generally applicable and binding list of such vulnerable migratory bird species does not exist. Information about their conservation status is available, e. g., from the species classification by European SPEC categories (Species of European Conservation Concern, BirdLife International 2004), the European categories of conservation concern (Papazoglou et al. 2004) and the species' status according to the Action Plan under the "Agreement on the Conservation of African-Eurasian Migratory Waterbirds" (AEWA). Against that background, a single-species description has to be provided for all migratory bird species listed in any of the above lists.

As far as different construction sites/projects take place in regional and temporal conjunction, the surveys should be co-ordinated with the planning approval/approval authority according to site- and project-specific conditions (cluster study, Part A, Section 11). The carrying out of surveys should be jointly co-ordinated and data collation must be ensured.

3.1 Resting birds

Table 3.1.1: Survey of foraging, moulting and resting birds.

	Baseline study	Construction phase	Operation phase
Objectives	Survey of the status quo of distribution and abundance of birds and observation of bird behaviour in order to assess the assessment area's importance as a resting, feeding and/or moulting area.	Survey of distribution and abundance of birds and observation of bird behaviour in the assessment area in order to assess potential construction phase impacts.	Survey of distribution and abundance of birds and observation of bird behaviour in the assessment area in order to assess potential operation phase impacts.
Scope	Throughout the year: one ship based survey per month at regular intervals, if possible. Depending on site- and project-specific conditions, at least 6 more ship based surveys per year under observation of seasonal occurrence of species. Transects should cover at least 10 % of the assessment area.		
	Throughout the year: 8–10 digital aircraft based surveys (video/photo), depending on project or area and seasonal occurrence of species. The aerial surveys of resting birds takes place together with the aerial surveys of marine mammals (cf. Table 4.1).		
Timing	At least two consecutive complete seasonal cycles prior to the start of construction.	Throughout the entire construction phase.	At least three years, up to five years if required, after commissioning.

<table>
<tr><th></th><th>Baseline study</th><th>Construction phase</th><th>Operation phase</th></tr>
<tr><td rowspan="3">Method</td><td colspan="3">Ship transect survey:
After Garthe et al. (2002), unless otherwise specified below.
• Transect spacing: 3 km or up to 4 km, if required (no smaller spacing to minimise disturbance).
• Transect width: Observation of 300 m to either side of the vessel, each side covered by a team of two observers (port/starboard). If dazzling sunlight (glare) renders observations impossible on one side of the ship, observation on that side is suspended. Zoning of transect bands should follow suitable methods (see p. 53).
• Transect direction: Cross shore if possible, in order to record gradients; e. g. 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 kn, optimally 10 kn.
• Counting intervals: Survey in one-minute intervals. For geographical positioning the ship's position is recorded by GPS in the same interval.</td></tr>
<tr><td colspan="3">• All birds within the transect as well as their primary behaviour (unaffected by the survey vessel) and associated behaviour (e. g. influenced by the wind turbine) should be recorded according to the behaviour and association codes (see p. 54 f.). In addition, all birds outside the transect should be recorded including data regarding behaviour/associate behaviour. For birds in flight, the additional indication of flight direction (correct to 45°) and flight altitude should be recorded.
• To avoid double counts in determining bird densities of birds in flight, application of the snapshot method is indispensable, during which, at 1-minute intervals (digital clock), all birds in the transect section at the full minute are recorded as "in transect" (cf. fig. 9, p. 56). The length of the transect section is determined by the ship's speed (see table 3, p. 56). The bird survey follows the SAS bird (cf. p. 59 f.).
• 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. The survey must not be carried out from the bridge.
• Survey conditions: The survey has to be interrupted at sea state > 4. Visibility should not be less than 5 km. Surveys must take place only from dawn to sunset.
The following additional information should be recorded:
• Meteorological data.
• Shipping traffic on both sides of the transect line (in as far as possible).
• Operating status (on/off) of the wind turbines on both sides of the transect line (in as far as possible).</td></tr>
<tr><td colspan="3">Aircraft transect survey:
Digital video or photo survey is carried out with suitable methods in co-ordination with the BSH (see Groom et al. 2013, Buckland et al. 2012). The aerial survey results are used also for the assessment of marine mammals in the assessment area (see table 4.1).</td></tr>
<tr><td>Presentation of results</td><td colspan="3">Presentation of occurrence for relevant species:
• Presentation of seasonal mean values (see table 4, p. 62) and maximum value.
• Table showing seasonal cycle on the basis of monthly (mean) values of density.
• Table showing abundance of relevant species in the project area and within a radius of 1,000 m, 2,000 m and 4,000 m around the project area.
• Total species list indicating individuals observed (incl. animals observed outside the transect bands).</td></tr>
</table>

	Baseline study	Construction phase	Operation phase
Presentation of results (continued)	• Table showing mean bird abundance per km^2 or, in the case of less abundant species, average number of individuals per km covered, broken down by months indicating the value range and number of mapping cruises. When analysing ship based survey data, abundance calculations for swimming birds within the transect have to be corrected regarding distance according the (Distance) method described by Buckland et al. (2001) either on the basis of own data or alternatively on the basis of published factors (e. g. Garthe et al. 2007). • (Statistical) presentation of occurrence changes over the assessment period (baseline study-construction phase-operation phase, BACI design). **Presentation of distribution for relevant species:** • Point sightings maps with the original positions of the birds, the positions of ships present during the surveys, and the positions of wind turbines. • Separate monthly or seasonal grid abundance maps for the most frequently occurring species/groups of species. The geographic reference for all computations is rectangles of 2' latitude and 3' longitude (WGS 84, degree minute second). The rectangles should be aligned with the geographic grid. Size classes should be selected according to Garthe et al. (2004). • Movement of ships and helicopters should be documented on the basis of existing AIS data (AIS, GPS, VMS) and should be taken into account in the analyses. The cumulative evaluation of species that cannot be clearly identified at the species level should follow the next highest taxonomic level (e. g. Alcidae, Gaviiformes).		

3.2 Migratory birds

Table 3.2.1: Radar survey.

	Baseline study	**Construction phase**	**Operation phase**
Objectives	Recording of bird movements (migration, foraging, flights between feeding and resting grounds etc.).	Recording of impact due to construction (evasive behaviour, attraction etc.).	Recording of impact due to operation (evasive behaviour, attraction etc.).
Scope	Survey frequency in the main migration periods 7 days/month (not in a single block). Main migration periods: March to May and mid-July to November. In total, at least 50 survey days are required. During these periods, at least 900 survey hours must be suitable for evaluation. A survey day comprises 24 hours. The surveys should cover full, uninterrupted 24-hour cycles. The aim is to record bird migration and migration behaviour as evenly as possible in the course of a day (day- and night-time).		
		Observation of flying birds' reaction to the wind turbines (evasive behaviour, attraction etc.). In co-ordination with the BSH, the recording of birds in the rotor area should be recorded using state-of-the-art methods (optical systems (e. g. p. 62), radar detection).	
Timing	At least two consecutive complete seasonal cycles prior to the start of construction.	Throughout the entire construction phase.	At least three years, up to five years if required, after commissioning.
Method	Radar surveys (after Hüppop et al. 2002) to be carried out for determining migration intensity and flight altitudes. Location: If a platform is available that is suitable with regards to location and equipment (e. g. FINO, USPW), surveys should be carried out from the platform; otherwise, ship based surveys exclusively at fixed positions (e. g. anchoring buoy). A fixed position is obligatory for cluster studies. The location for ship based surveys should be chosen relative to the wind farm in the direction from where most of the birds come to ensure optimal detection of the evasive movements of flying birds.		
	Vertical radar: • Objective: Estimation of seasonal phenology of flight intensities. • Quantification of flight intensities at 100-m steps up to an altitude of 1,000 m, corrected. During construction and operation phase, migration rates must be assessed especially in the rotor area of wind turbines. • Survey conditions: Depending on the ship's configuration, the surveys can be usually carried out in stronger winds of up to 7 Bft and at wave heights of up to 2.5 m. Platform based surveys can be carried out at even higher wave heights. • Radar specifications: Vertical radar with an output of min. 25 kW, a vertical beam width of 20° to 25°, a horizontal beam width of 0.9° to 1.2° and a transmission frequency of about 9.4 GHz (x-band radar). The antenna's plane of rotation should preferably be aligned vertical to the assumed migratory direction. • Standard operating range: 1.5 km. • Comparability of results is essential in selecting equipment and making equipment settings. The filter for sea clutter (SEA) and rain (RAIN) should be set at 0. The GAIN filter should be determined individually for each radar device. Principally, the highest possible GAIN should be used, to avoid disturbance in the radar image. Identical radar device settings should be maintained throughout the entire assessment period.		

<table>
<tr><th></th><th>Baseline study</th><th>Construction phase</th><th>Operation phase</th></tr>
<tr><td rowspan="2">Method (continued)</td><td colspan="3">• The original radar display should be transferred with as little loss as possible to a computer that is equipped with suitable software for the capture and evaluation of radar images.
• For platform based surveys, the recommended alternative is a fixed pencil beam radar (radar with fixed dish aerial). Method and evaluation should be co-ordinated with the BSH (see Dittmann et al. 2013, Kulemeyer et al. 2011, Neumann et al. 2009).</td></tr>
<tr><td></td><td colspan="2">Surveillance radar:
• Objective: Recording of flight direction and intensities.
• Survey conditions: Depending on the ship's configuration, the surveys can be usually carried out in stronger winds of up to 3 Bft and at wave heights of up to 0.5 m. Platform based surveys can be carried out at even higher wave heights.
• Radar specifications: Horizontally scanning radar with an output of min. 25 kW (x-band radar). Specifications see vertical radar.
• Standard operating range: 3 km. Exceptions are only allowed for targeted observations (evasive behaviour).
• Comparability of results is essential in selecting equipment and making equipment settings.
• In the event of platform based surveys, a recommended alternative is the use of a radar device with rotating dish aerial. Method and evaluation should be co-ordinated with the BSH (see Hill et al. 2013, Hill et al. 2012).</td></tr>
<tr><td>Presentation of results</td><td colspan="3">Presentation of radar observation results:
• The altitude distribution requires a distance correction. It takes into account the detectability and volume of the radar beam and is individually calculated for each radar device (see p. 63).
• Results to be shown as echoes per hour and kilometre (e. g. Liechti & Schmaljohann, 2007).</td></tr>
</table>

Table 3.2.2.: Visual observations/recording of flight calls.

<table>
<tr><th></th><th>Baseline study</th><th>Construction phase</th><th>Operation phase</th></tr>
<tr><td>Objectives</td><td>Recording of bird movements (migration, foraging, flights between feeding and resting grounds etc.).</td><td>Recording of impact due to built structures (evasion movement, events of attraction etc.).</td><td>Recording of impact due to operation (evasive behaviour, attraction etc.).</td></tr>
<tr><td>Scope</td><td colspan="3">Survey frequency in the main migration periods 7 days/month (not in a single block). Main migration periods: March to May and mid-July to November.
In total, at least 50 survey days are required. During these periods, at least 900 survey hours must be suitable for evaluation.
A survey day comprises 24 hours. The surveys should cover full, uninterrupted 24-hour cycles. The aim is to record bird migration and migration behaviour as evenly as possible in the course of a day (day- and night-time).</td></tr>
<tr><td>Timing</td><td>At least two consecutive complete seasonal cycles prior to the start of construction.</td><td>Throughout the entire construction phase.</td><td>At least three years, up to five years if required, after commissioning.</td></tr>
<tr><td rowspan="2">Method</td><td colspan="3">To determine the species spectrum, parallel day-time visual observations and recording of flight calls at night have to be carried out (day/night according to civil twilight). Survey frequency: 2 observation units of 15 min. each per hour.
Location: If a platform is available that is suitable with regards to location and equipment (e. g. FINO, USPW), surveys should be carried out from the platform; otherwise, ship based surveys exclusively at fixed positions (e. g. anchoring buoy). A fixed position is obligatory for cluster studies. The location for ship based surveys should be chosen relative to the wind farm in the direction from where most of the birds come to ensure optimal detection of the evasive movements of flying birds.
Survey conditions: Depending on the ship’s configuration, the surveys can be usually carried out in stronger winds of up to 7 Bft and at wave heights of up to 2.5 m. Platform based surveys can be carried out at even higher wave heights.
Moreover, the following information should be recorded at 30 min. intervals: Meteorological data as well as, in the event of ship based survey, GPS position and heading, if need be. During construction and operation phase, the number of ships in the area that are associated with the wind farm must be recorded.</td></tr>
<tr><td colspan="3">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° (Binoculars with 10 x magnification) up to 1.5 km distance. Also undetermined birds have to be recorded (e. g. as “pipit spec.” or “grey geese”). In addition, birds in > 1.5 km distance should be recorded in a separate class.
• Distance of the bird/birds to the observer, flight height and association as well as, as far as possible, age, gender and plumage should be recorded for each observation.
• Observations are recorded on the basis of quarter-hour intervals; individual events within a quarter-hour interval are separately recorded (different parameter data).</td></tr>
</table>

<table>
<tr><th></th><th>Baseline study</th><th>Construction phase</th><th>Operation phase</th></tr>
<tr><td rowspan="2">Method (continued)</td><td colspan="3">• Flight heights can be estimated on the basis of the deck/mast height of the ship or, during the construction and operation phase, on the basis of the wind turbine measurements. Height classification is as follows: 0–5 m, 5–10 m, 10–20 m, 20–50 m, 50–100 m, 100–200 m and > 200 m. During construction and operation phase, additional height classification is as follows: „Below rotor area“, „Lower half of rotor blade“, „Upper half of rotor blade“ and „Above tip of rotor blade“.
• The assignation of flight direction data must be correct to 45° (N, NE, SE, S, SW, W, NW).
• Recording of reactions of flying birds when confronted with wind turbines should follow the behaviour and association codes (see p. 54 f.).
• Once per hour, the number of all ship associated birds should be recorded separately.
• Where a stable platform is available, birds have to be additionally registered by means of a spotting scope with a defined field of view (sea watching, see Dierschke et al. 2005). The field of view depends on the spotting scope’s magnification and angle of view (all birds up to a distance corresponding with the range of vision). A wide-angle spotting scope with 30 x magnification and at least 80 mm objective diameter should be used. The observation location must not be more than 80 m above sea level. In the event of sea watching, the horizon of the survey area should be panned at low speed two to three times per quarter-hour interval.</td></tr>
<tr><td></td><td colspan="2">• To identify potential evasive behaviour/attraction, 4 observation areas (sectors) of 90° are defined (depending on site conditions, 2 sectors of 180°). In the event of 4 possible sectors, at least one line of vision is towards the building site/wind farm, ideally two. If only 2 lines of vision can be surveyed, one must face the wind farm. The lines of vision are surveyed in alternating order for 15 min. each within one hour (in the event of two sectors, each twice for 15 min., alternating the line of vision) (see Aumüller et al. 2013).</td></tr>
<tr><td></td><td colspan="3">Recording of flight calls:
• At night, ship based recording of flight calls per species. In the event of platform based recording, automated flight call registration is preferred, in co-ordination with the BSH (see p. 64).</td></tr>
<tr><td rowspan="2">Presentation of results</td><td colspan="3">Presentation of migration observation results:
• Relative flight/call intensities per observation day/night, in tables (e. g. birds/h or calls/h).
• Mean relative flight/call 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, in tables or as graphs averaged on a monthly basis (time-of-day distribution).
• Same procedure for sea watching, broken down by the most frequent species/species groups (see p. 27).
• List of observed bird species broken down by day, night and months.</td></tr>
<tr><td></td><td colspan="2">• Comparison of species-related migration rates in all surveyed sectors, depending on “line of vision facing wind farm” and “line of vision turned away from wind farm”.
• Table showing all reactions and non-reactions, in particular changes in flight direction and height.</td></tr>
</table>

4 Marine mammals

The investigations and monitoring relating to marine mammals comprise:

- Surveys of abundance and distribution (Table 4.1).
- Surveys of habitat use (Table 4.2).
- Surveys of noise emission and immission (Table 4.3).

Visual ship based and aerial digital surveys allow conclusions as to the abundance and distribution of marine mammals and, at sufficient sightings, allow for estimates regarding the absolute density of the populations.

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

During the construction and operation of wind turbines, a broad-band and tonal noise spectrum is likely to be emitted into the water. The estimate of potential impacts and hazard potential requires knowledge regarding the intensity of noise emissions and regarding the effectiveness of stipulated preventive and noise reducing measures. Therefore, measurements of emissions at particular locations should be made during the construction and operation phases.

The positioning of measuring instruments for recording underwater noise (Part A, Section 5) and survey start must be co-ordinated with the planning approval/approval authority at least eight weeks prior to installation.

Depending on the characteristics of the construction site, the specification of emission method or in cases of cumulative impacts, additional measures may be prescribed to maintain efficiency and allow efficiency control.

Table 4.1: Survey of abundance and distribution of marine mammals.

	Baseline study	Construction phase	Operation phase
Objectives	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 abundance and distribution of marine mammals in the assessment area to assess potential impacts of construction work (in particular of pile driving).	Monitoring of the abundance and distribution of marine mammals in the assessment area to assess potential impacts during the operation phase.
Scope	Ship based surveys take place exclusively within the scope of the avifauna survey.		
	Throughout the year: 8–10 digital aircraft based suveys (video/photo), depending on project or area and seasonal occurrence of species. The aerial survey of marine mammals takes place together with the aerial survey of resting birds (see table 3.1.1). Transects should cover at least 10 % of the assessment area.		

<table>
<tr><th></th><th>Baseline study</th><th>Construction phase</th><th>Operation phase</th></tr>
<tr><td>Timing</td><td>At least two consecutive complete seasonal cycles prior to the start of construction.</td><td>Throughout the entire construction phase.</td><td>At least three years, up to five years if required, after commissioning.</td></tr>
<tr><td rowspan="2">Method</td><td colspan="3">Ship transect survey:
Ship based suveys of marine mammals take place exclusively within the scope of the avifauna survey (see table 3.1.1).</td></tr>
<tr><td colspan="3">Aircraft transect survey:
Digital video or photo survey is carried out with suitable methods in co-ordination with the BSH. The digital aerial survey results are used also for assessment of resting birds in the assessment area (see table 3.1.1).</td></tr>
<tr><td>Presentation of results</td><td colspan="3">Presentation of abundance:
• Seasonal cycle sighting rate (= sightings/effective transect line) (per flight or monthly data on relative frequency).
• Seasonal cycle of the number of animals per km^2 (per flight or monthly data on absolute frequency) – if the correction factor g(0) can be determined (under reserve).
• Seasonal cycle of group sizes (monthly data on single animals and mother/calf pairs).
• Rough characterisation of behaviour (swimming directions, behaviour, association).
• (Statistical) presentation of occurrence changes over the assessment period (baseline study-construction phase-operation phase, BACI design).
Presentation of distribution:
• Distribution of sighted animals as well as changes on the basis of point maps (per flight or monthly summary).
• Relative frequency and distribution of sighted animals as well as changes on the basis of monthly or seasonal grid density maps (absolute frequency under reserve).
• Anthropogenic influences, such as noise intensive construction measures, must be included in the analyses.
• Movement of ships and helicopters due to construction/maintenance activities should be documented on the basis of existing AIS data (AIS, GPS, VMS) and should be taken into account.
The POD survey results (see table 4.2) must be included.
The sonic survey results (see table 4.3) must be included.</td></tr>
<tr><td>Literature</td><td colspan="3">Further reading on methodology:
Buckland et al. (2012, 2004), Gilles et al. (2009), Scheidat et al. (2008), Scheidat et al. (2004), Thomas et al. (2010), Thomsen et al. (2004).</td></tr>
</table>

Table 4.2: Investigations of habitat use.

	Baseline study	Construction phase	Operation phase
Objectives	Assessment of the spatial and seasonal habitat use of harbour porpoises and classification of project area within the total spatial and seasonal context.	Survey of influence of noise intensive construction work on the spatial and seasonal habitat use of harbour porpoises (as far as quantifiable) and classification of the project area within the total spatial and seasonal context.	Assessment of spatial and seasonal habitat use of harbour porpoises (as far as quantifiable) in the vicinity of wind turbines and classification of the project area within the total spatial and seasonal context.
Scope	One POD station per project. At least 2 POD stations, if the project is in the vicinity (< 20 km) of a protected area of significance to harbour porpoises. The release position must be co-ordinated with the BSH.		
		To avoid potential displacement effects during noise intensive construction work, 4-5 stationary individual PODs should be installed in suitable distances to the wind turbines and depending on the actually emitted degree of underwater noise. For the purpose of randomised control of efficiency during noise intensive pile driving works, 2 mobile single PODs should be installed in 750 m and in 1,500 m distance to the pile driving location for a duration of 24 h (according to the windfarm's license provisions).	Depending on the wind farm size, at least 3 stationary single PODs should be installed within the wind farm.
Timing	At least two consecutive complete seasonal cycles prior to the start of construction.	Throughout the entire construction phase.	At least three years, up to five years if required, after commissioning.
Method	The same equipment standard (C-POD, chelonia.co.uk) must be used for all measurement positions throughout the entire measurement period to ensure comparability of data. **Calibration:** • The PODs must be calibrated before and after installation to ensure data quality. The POD calibration results must be taken into account in data evaluation (see process instruction p. 66). **POD station:** • To minimise data loss, 3 single PODs should be installed in one POD station (see fig. 11, p. 66). Depending on water depth, the measurement devices of one POD station should be anchored above ground at the following heights. All devices must be basically installed at the same water depth throughout the entire measurement period: Depth zone 0–20 m: 3 PODs at mean water depth Depth zone > 20 m: 2 PODs at 7–10 m and 1 POD at mean water depth.		

Method (continued)	**Single PODs:** • The devices should be anchored at mean water depths. The installation of stationary single PODs during the construction phase takes place in suitable distances to the construction site, depending on the underwater noise emitted by the construction work. The mobile single PODs are installed at 750 m and 1,500 m distance to the respective construction site (according to the windfarm's license incidential provisions). • Continuous POD measurement activity must be ensured. Data reading intervals should not exceed 2 months. **Settings:** • Principally, the POD default settings must be maintained (exception: mobile PODs at 750 m and 1,500 m). **Data evaluation:** • Evaluation and statistical analysis of collected POD data follows the process instruction on p. 66. • Principally, all collected data must be processed using the same cpod.exe software version. If the software is changed, it must be ensured that all data is processed using the same classifier (e. g. the KERNO classifier). The respective software version must be named and, as the case may be, included in the statistics. • Only harbour porpoise calls of the two highest quality classes ("high" and "moderate") should be used for evaluation purposes. • Habitat use (frequency and length of stay in the area) is evaluated on the basis of harbour porpoise-positive days, hours, 10-minute and minute periods (= days/hours/10 minutes/minutes during which harbour porpoise sounds are recorded). • During the noise-intensive construction phase, it is recommended to evaluate also the parameter "waiting time". • East of Darss Sill in the Baltic Sea, evaluation may be carried out using the Hel1 classifier. A randomised, visual review of data has to be conducted with regards to classification reliability and has to be documented (s. Gallus et al. 2012).
Presentation of results	• Individual presentation of habitat use (e.g. day-time pattern (ppm/hour)) and of seasonal use (pp10m/day) at each POD station and each POD single position as well as in geographical and seasonal comparison with the other positions. During the baseline study, the presentation of day-time pattern is waived. • Presentation of waiting time during noise-intensive construction work. • The aerial and ship transect survey results (see table 4.1) must be included. • The sonic survey results (see table 4.3) must be included.
Literature	Brandt et al. (2013), Brandt et al. (2011), Carstensen et al. (2006), Dähne et al. (2013), Diederichs et al. (2010), Scheidat et al. (2011), Teilmann & Carstensen (2012), Tougaard et al. (2009), Verfuß et al. (2007).

Table 4.3: Survey of waterborne noise emissions and immissions.

	Baseline study	Construction phase	Operation phase
Objectives	Prediction of noise immissions and propagation in the construction and operation phases for the efficient design of noise-mitigating measures. Measurement of waterborne background noise in the project area prior to construction.	Monitoring of waterborne noise emission and immission. Efficiency control of noise-mitigating measures.	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. The existing noise level by potentially existing wind turbines must be taken into account (immission forecast). Ambient noise measurement shall be made in each target area prior to the start of construction activities.	During noise-intensive construction work (e. g. pile driving), underwater noise measurements must be carried out in the area around the construction site. In particular, the efficiency of noise-mitigating measures must be assessed (according to incidential provision 14 and 20). The underwater noise measurements must be carried out for each pile driving site or at least until proof has been provided of continuous, reliable adherence to the noise prevention value. Randomised separate measurements from vibration pile driving must be carried out in co-ordination with the BSH.	After commissioning of all wind turbines, waterborne operating noise must be measured.
Timing	One time only.	Throughout the entire construction phase.	During the first year of the operation phase.
	The “Measuring instruction for underwater sound measurements” (BSH 2011) applies.		
Method	**Immission forecast:** • The forecast quality depends on the accuracy of the input data and the used models. The quality of input data and the parameters forming the basis for modelling must be documented. • The German language guideline ‘Prognosen für Unterwasserschall - Mindestmaß an Dokumentation’ (BSH 2013a) applies.	The efficiency of a noise reduction system must be assessed by suitable underwater noise measurements. The German language guideline “Anleitung für die quantitative Bestimmung der Wirksamkeit von Schalldämmmaßnahmen” (BSH 2013b) applies.	The measurements shall capture the three performance ranges “low”, “medium” and “rated output”.

Method (continued)	**Background noise measurements:** • Background noise comprises the sum of all natural sounds in the project area excluding construction noise. The existing sound of distant ships or operation noise from neighbouring wind turbines in the project area environment should be treated as background noise.		
Presentation of results	The "Measuring instruction for underwater sound measurements" (BSH 2011) applies.		
		In the event of multiple pile structures (like jacket or tripod), the measurement results for pile driving of individual piles shall be evaluated and presented.	

5 Bats

Table 5.1: Survey of bat migration activity in the offshore area of the Baltic Sea.

	Baseline study
Objectives	Survey of bat migration (species spectrum, event frequency, activity maxima etc.) for the evaluation of the importance of the assessment area as a migratory zone for bats in the offshore region of the Baltic Sea.
Scope	The surveys should be carried out parallel to the night-time flight call monitoring of migratory birds (see table 3.2.2) in windless nights (up to 3 Bft) (see process instruction, p. 70).
Timing	At least two consecutive complete seasonal cycles prior to the start of construction.
Method	Use of bat detectors for monitoring call activity (see process instruction, p. 70).
Presentation of results	The number of recorded call sequences constitutes the activity. The data is rendered as “activity density”. All bat observations are therefore to be evaluated as a relative measure (see process instruction, p. 70). The data evaluation must contain: • List of observed bat species. • Presentation of seasonal distribution of species-specific activity. • Presentation of call activity over the course of the day. • Blending of activity data with collected weather data.

6 Landscape

Within the framework of the baseline study, a photorealistic simulation 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. Moreover, the landscape should be illustrated in verbal-argumentative form in an open description.

Table 6.1: Landscape survey.

	Baseline study
Objectives	Presentation of the wind farm within the marine environment as basis for the assessment of potential impacts on the landscape as a feature of conservation interest.
Scope	Minimum scope of visualisation of coastal sites close to the project area: • Visualisation of beach level. • Visualisation of prominent vantage points (e. g. bluffs/cliffs, dunes, lighthouses, scenic range of hills in the hinterland). • As the case may be, additional visualisations may be prescribed for outstanding sites of cultural and natural history importance (e. g. Königstuhl).
Timing	One time only. Should significant parameter changes occur in the course of project execution, a renewed survey may be prescribed.
Method	The affected landscape must be presented in a photorealistic manner (text and visualisation). The line of vision is from the coast to the wind farm. The visual presentation of the wind farm derives from triangulation as well as from calculation of the earth curvature refraction loss of 10 %. A visibility range report must be compiled, including data regarding the visibility of the wind farm over the course of a year and of a day.
Presentation of results	Visualisation must be prepared as follows: • Presentation in normal perspective (no tele lens perspective) at a horizontal angle of 52°–54°. • Contrast presentation of full rotor blade width at optimal visibility conditions. • Visualisation with 2 m scale bar (7 m distance from the observer) to demonstrate size relations. Other items, such as persons in the image foreground, help to provide further scale. • The presentation must provide the visualisation parameters and the scale-dependent observation distance (normal perspective: DIN A3 ca 43 cm, DIN A4 ca 30 cm). • Presentation of an outline map indicating horizontal and vertical angles of vision, at which the wind farm will be visible from selected vantage points. • The wind farm must be visualised individually as well as accumulative with potentially neighbouring, approved or firmly planned wind farms. The visualisations should allow for assessment of the changes to the landscape between the approved status quo or the planned status quo and the planned completed state.
Literature	Behm (2010), Kraetzschmer et al. (in prep.), LUNG (2006), Runge & Nommel (2006).

Part C – Annex: Survey of features of conservation interest

1 Benthos

See table 1.1: Survey of the sediment and habitat structure and its dynamics using side scan sonar (SSS).

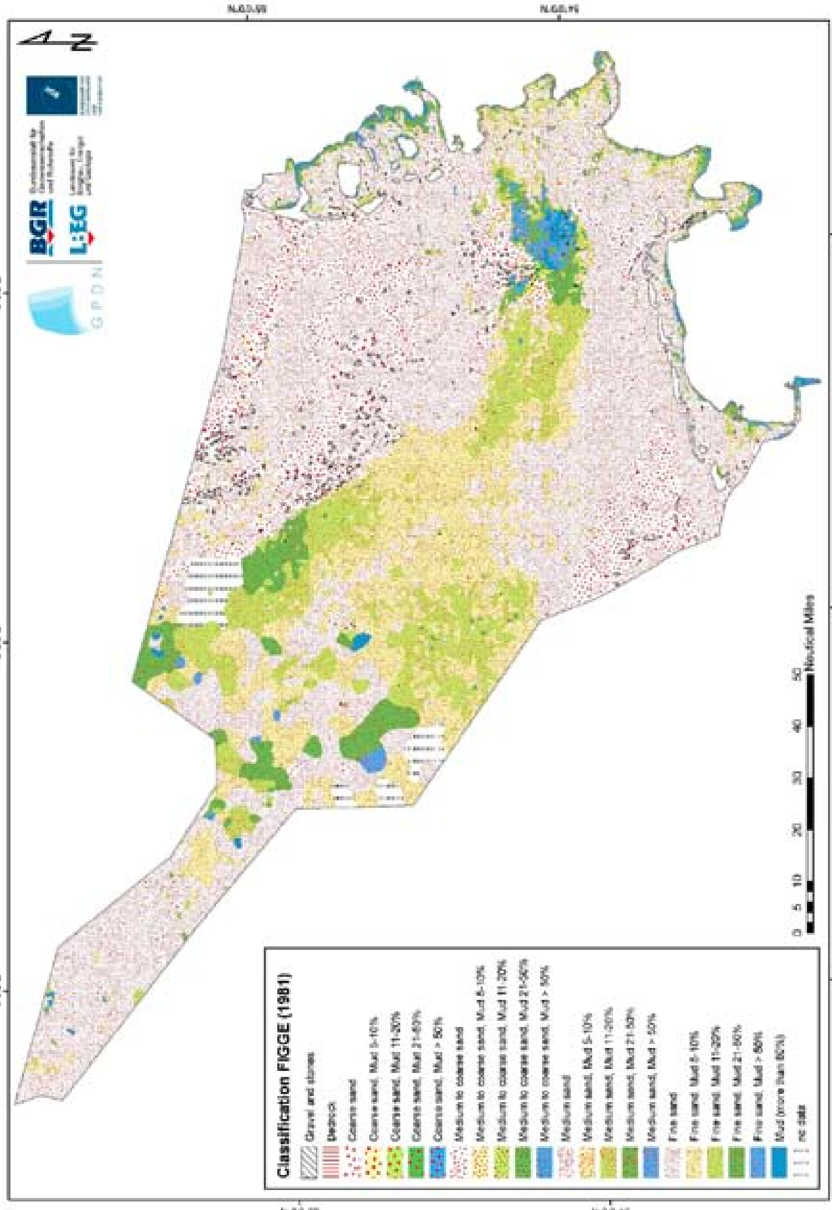


Figure 1: Sediment distribution in the German North Sea EEZ according to classification by Figge (1981). Source: Geopotenzial Deutsche Nordsee (GPDN, Status: January 2013).

See table 1.5: Installation-based grab sampling survey of infauna.

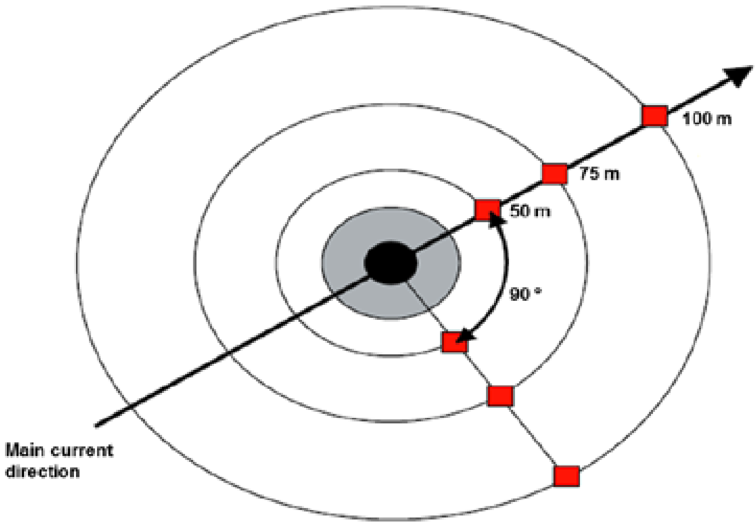


Figure 2: Sampling design for installation-based effect monitoring. Positions of sampling stations on a transect behind the pile in the main current direction and on a transect perpendicular to the main current direction. On each transect, three stations must be installed at a distance of 50 m, 75 m, and 100 m with three parallel samples each.

See table 1.7: Investigation of benthos, habitat structures and habitat types in the context of installation of cable routes for connecting offshore wind farms.

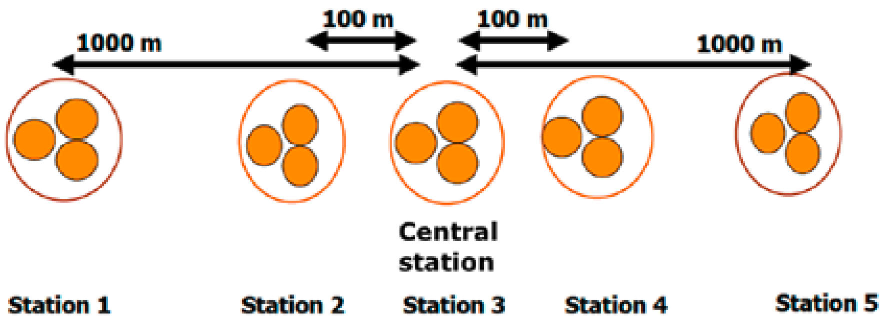


Figure 3: Relative positions of stations within a cross-transect (schematic diagram).

2 Fish

See table 2.1: Beam trawl/otter trawl surveys.

Standard nets

Equipment standard North Sea: Beam trawl

According to StUK, a beam trawl with a beam length of 7 metres is specified as the standard net for fish fauna studies. 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. 4). 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. 5. The footrope of the net is a rope-wrapped chain. To catch also smaller fish, the codend is lined with an inside webbing (inner codend) with 18 mm mesh size (10 mm mesh bar).

The iron trawl beam has a total length of 7.45 m; the clearance between the trawlheads is 7.15 m. The height of the trawlheads on either side of the beam is 70 cm, exceeding the height 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).

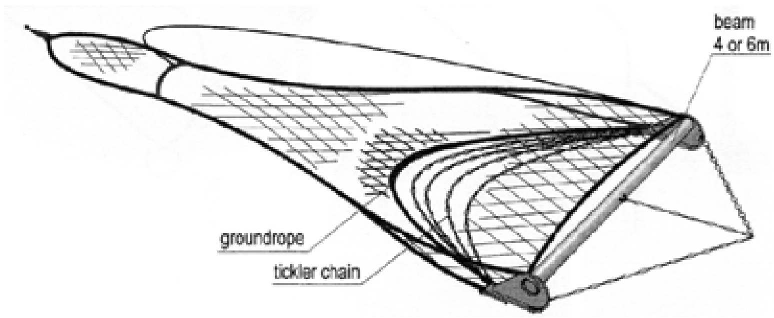


Figure 4: Beam trawl (sketch).

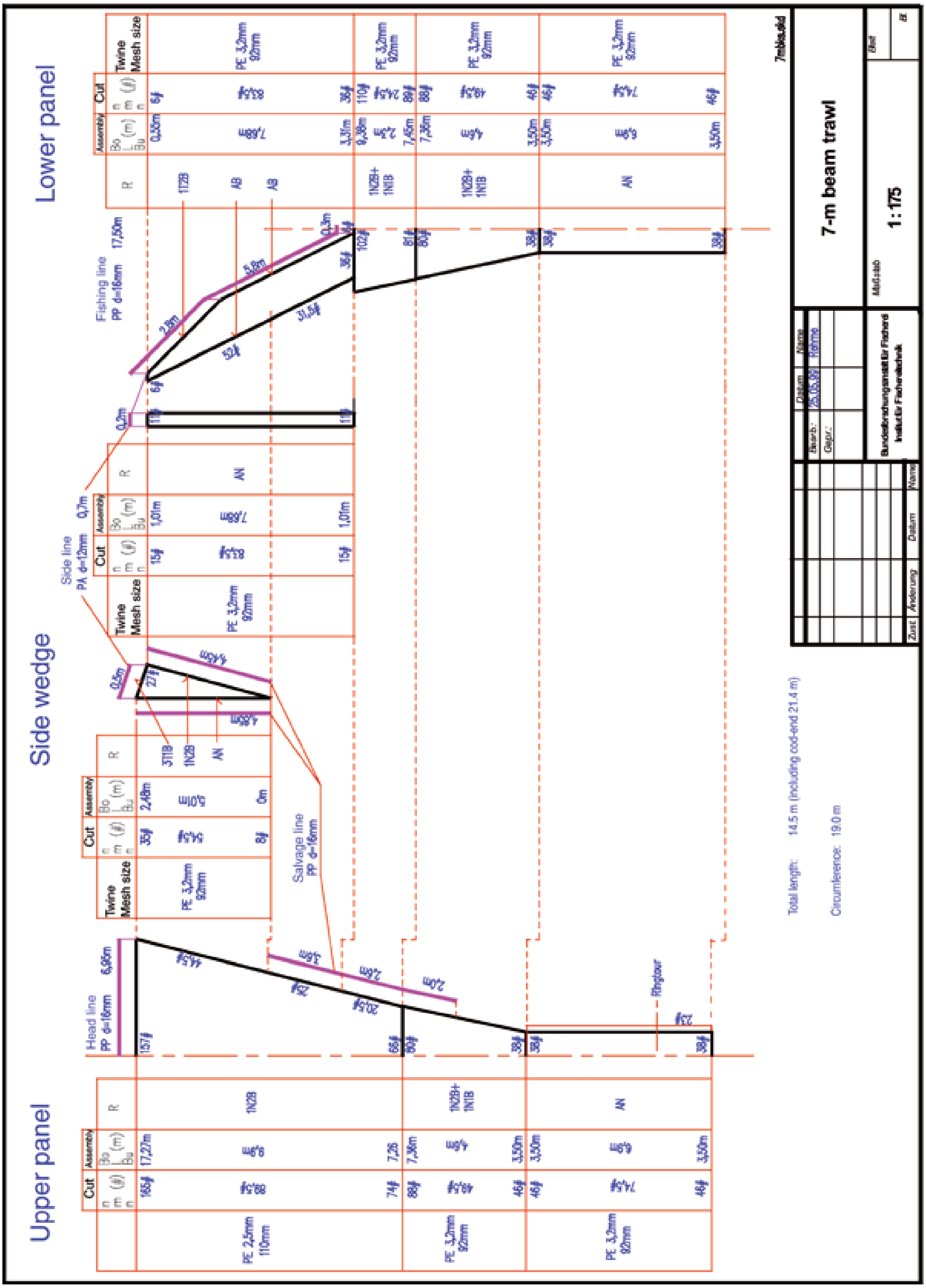


Figure 5: 7-m beam trawl: material, cut and assembly of the net.

Equipment standard Baltic Sea: Otter trawl (wind farm trawl)

The standard net for the Baltic Sea as prescribed by the StUK is an otter trawl. The net shown in the drawing below has been developed for ecological offshore wind farm surveys. The trawl consists of an upper belly and a lower belly. It has a total length of about 40 m (incl. cod end) and a circumference of 32.6 m. Details of the required net material, cut, and assembly are given in fig. 6. The codend is lined with an inside webbing (inner codend) with 38 mm mesh size (20 mm mesh bar). Details of the set of bridles are shown in fig. 7, of the head and foot ropes in Fig. 8.

At the projected wind farm depths, the vertical opening of the net will be about 1.5 m on average and the horizontal opening between the wing tips about 10 m.

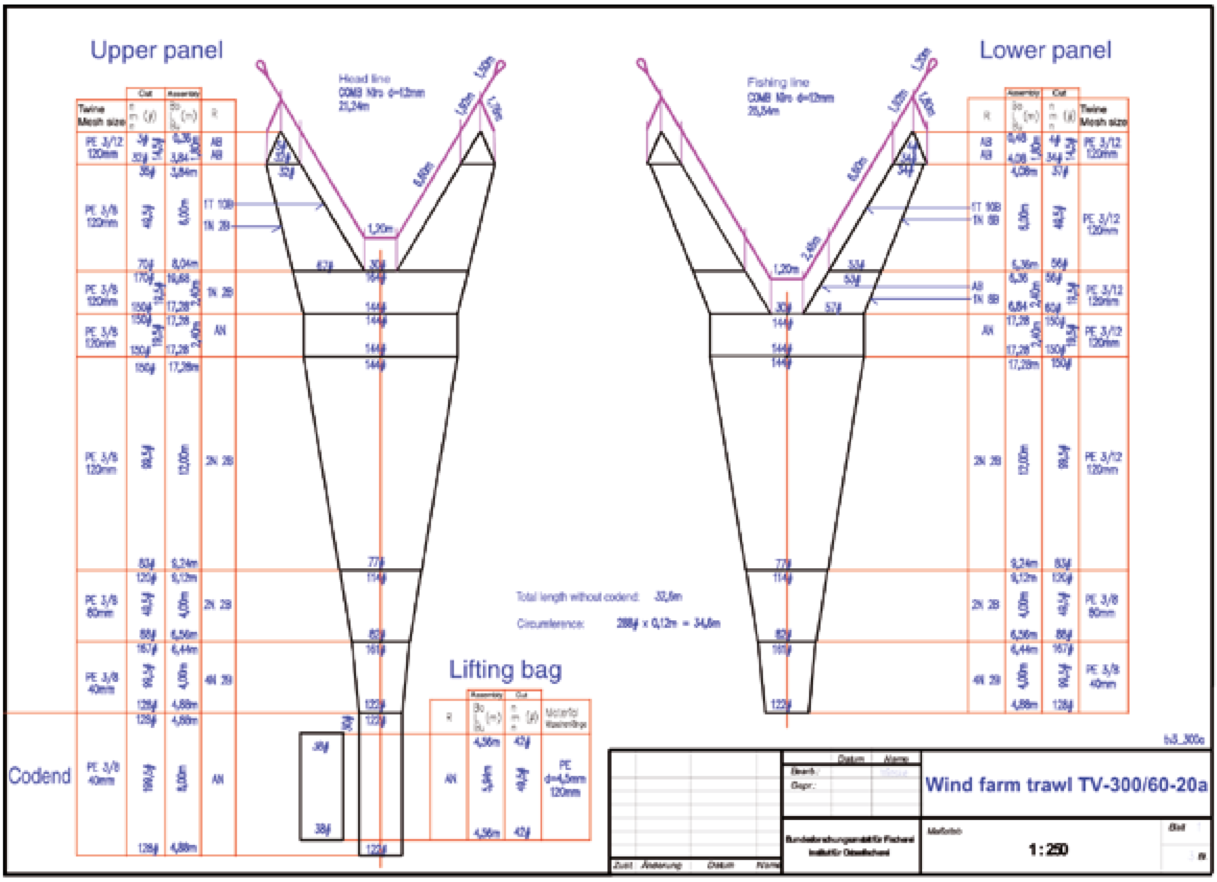


Figure 6: Wind farm trawl: material, cut, and assembly of the net.

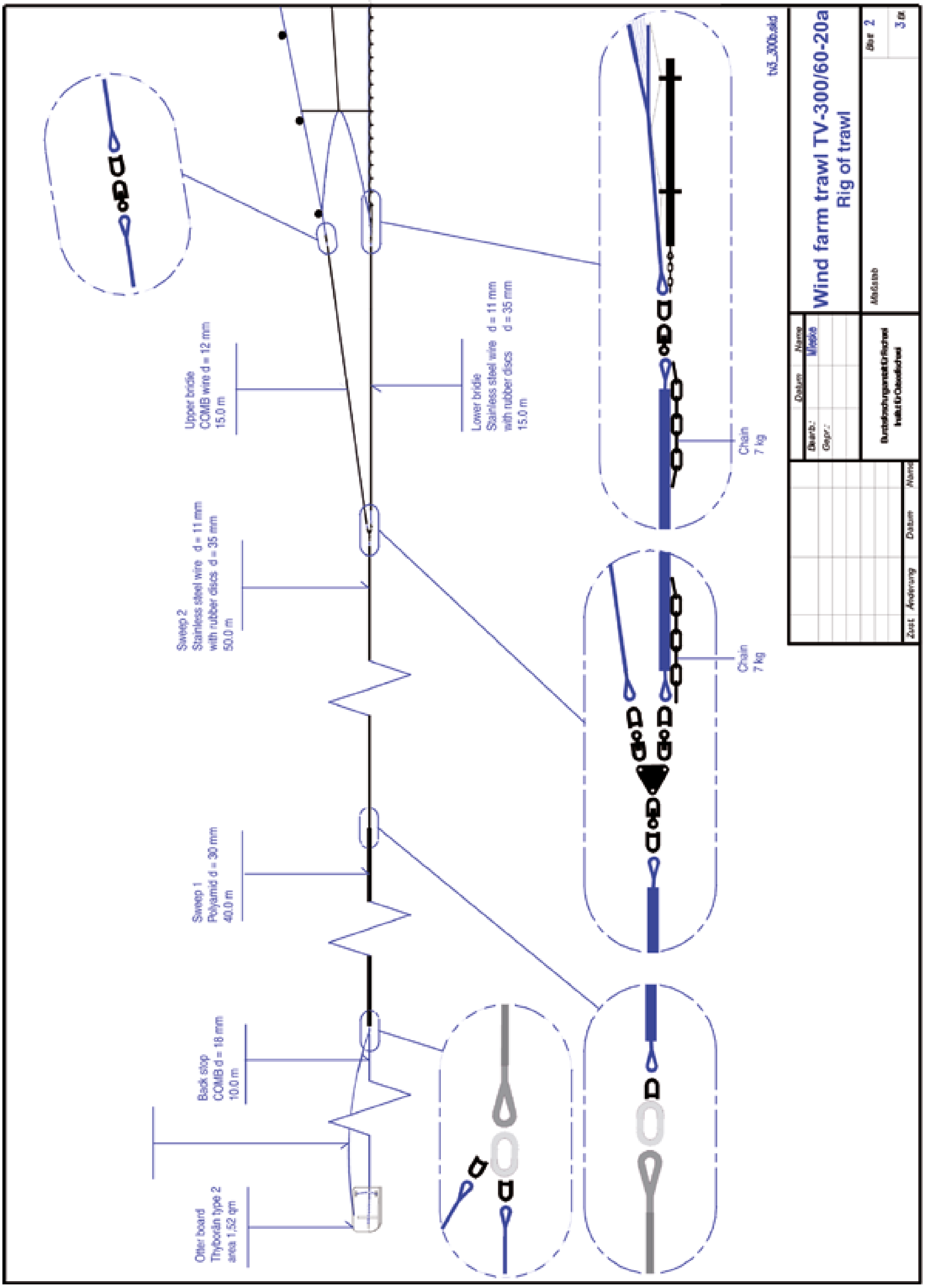


Figure 7: Wind farm trawl: Set of bridles.

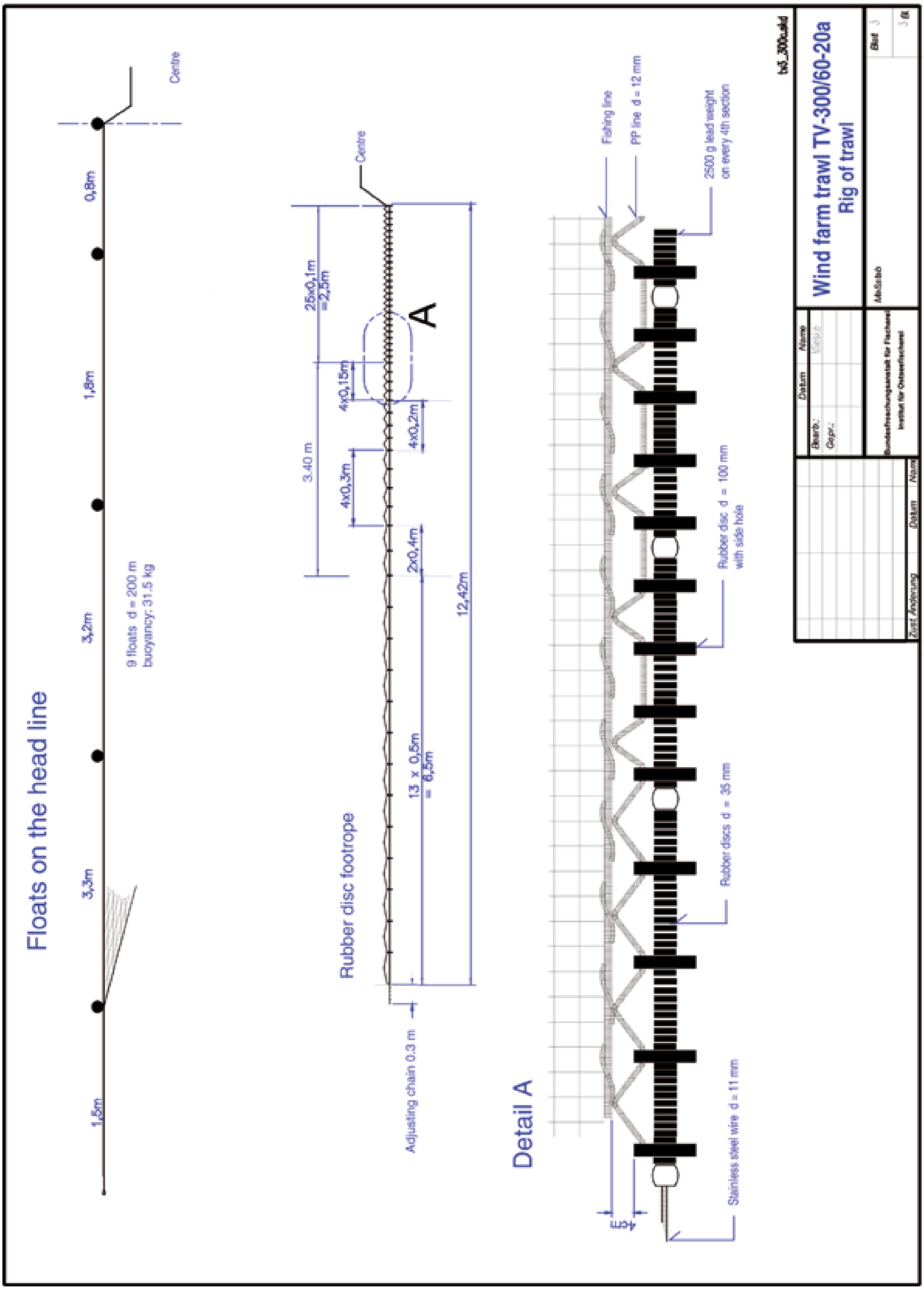


Figure 8: Wind farm trawl: head and foot ropes.

Process instruction for treatment of fishing hauls

Treatment of catches and sampling

Wherever possible, the entire catch must be treated. Determination of species is to be based on the lowest possible taxonomic classification. At least two of the following classification standards must be used:

- Muus & Nielsen (1999).
- Wheeler (1969).
- Wheeler (1978).
- Whitehead et al. (1986).

The Wheeler/Whitehead publications are no longer in print, but are available second-hand. Publications by Muus/Dahlström must not be used as they are taxonomically outdated and incomplete.

When transmitting data, uniform scientific and German species names must be applied. The validity of species names must be reconciled with the Catalog of Fishes (Eschmeyer 2012) under http://research.calacademy.org/research/ichthyology/catalog/fishcatmain.asp.

In the event of larger catches, which cannot be treated within a reasonable period of time, species or size categories of species that are available in sufficient numbers may be identified for taking representative sub-samples. Rare species or size categories must be separated from the catch. If a catch could not be fully treated, it must be accordingly marked in the data prior to transmission. The respective weight of the total catch, of the total catch of one species or size category and of the sub-samples per species or size category must always be documented.

Handling of problematic taxa

The members of some genera and families are difficult to classify down to species level. Usually, it is sufficient to refer to additional, general classification literature (see above). However, in individual cases, specialist literature/expert knowledge should be consulted. The classification level detail must be uniform for all required surveys.

Overview of problematic taxa:

Lampreys – Petromyzontiformes

The lamprey species occurring in marine habitats are the European river lamprey *(Lampetra fluviatilis)* and the sea lamprey *(Petromyzon marinus)*. Both species are named in Annex 4 of the FFH Habitats Directive and in the Red List (Freyhoff 2009) under conservation status 3 (endangered, *Lampetra fluviatilis*) and V (vulnerable, *Petromyzon marinus*). The species are easy to confuse. The most important distinguishing characteristic is the teeth of the mouthpart (Muus & Nielsen 1999).

Cartilaginous fish – Chondrichthyes
The basis is the identification key for cartilaginous fish of the North Atlantic (Ebert & Stehmann 2012).

Sharks – Selachii
Only few shark species regularly occur within the German EEZ. Considered established are the school shark *(Galeorhinus galeus)*, the spiny dogfish *(Squalus acanthias)*, the small-spotted catshark *(Scyliorhinus canicula)* and the starry smooth-hound *(Mustelus asterias)*. Some shark species may occur as rare guests, including the nursehound *(Scyliorhinus stellaris)* and the common smooth-hound *(Mustelus mustelus)* and others. Their classification should always be backed up by voucher specimen. According to new genetic studies, the common smooth-hound does not occur in the North Sea and neighbouring waters of the North-East Atlantic (Farrell et al. 2009).

Skates and whiptail stingrays – Rajidae and Dasyatidae
According to the latest revision of the family of skates, the former genus Raja is sub-divided into several genera, e. g. *Amblyraja, Dipturus, Leucoraja, Raja*. The species *Amblyraja radiata* (thorny skate), Dipturus batis (common or blue skate), *Leucoraja naevus* (cuckcoo ray), *Raja clavata* (thornback ray) and *Raja montagui* (spotted ray) are considered established in the German EEZ. From the family of stingrays, *Dasyatis pastinaca* (common stingray) occurs. In doubt, voucher specimen should be frozen and submitted to experts for verification of classification. Nota bene: The species Dipturus batis (common or blue skate) will presumably be divided into two new species (Griffiths et al. 2010, Iglesias et al. 2010): *Dipturus sp. cf. intermedia and Dipturus sp.cf. flossada*. Morphological distinguishing characteristics should be classified according to Iglesias et al. (2010).

Bony fish – Osteichthyes

Shads – Alosa spp.
Two species of the genus Alosa occur in the German North Sea EEZ: the allis shad (Alosa alosa) and the twait shad *(Alosa fallax)*. Both species are named in Annex 4 of the FFH Habitats Directive and in the Red List under conservation status 1 (critically endangered, Alosa alosa) and 3 (endangered, *Alosa fallax*) (Freyhoff 2009, Thiel et al. 2013). The species classification must take place solely on basis of the number of gill rakers. The distinguishing characteristic “number of dark spots on the sides of the body” as given in some identification keys is unsuitable for the correct assignation to either *A. fallax* or *A. alosa*. The genus *Alosa* is distinct from other herring fish by having a vertical notch in the middle of the upper jaw.

Herring, sprat, sardine – *Clupea harengus, Sprattus sprattus, Sardina pilchardus*
Juvenile individuals can be difficult to differentiate: the sardine is distinct from the herring and the sprat by the existence of prominent crests on the gill covers. Sprats and herrings can be safely differentiated by the position of their ventral fins relative to the dorsal fin (Wheeler 1976).

Sand lances or sand eels – Ammodytidae
From the family of *Ammodytidae*, the following four species are considered established in the German EEZ: *Ammodytes marinus* (Raitt’s sand eel), *Ammodytes tobianus* (lesser sand eel), *Hyperoplus lanceolatus* (greater sand eel) and *Hyperoplus immaculatus* (Corbin’s sand eel). A magnifying glass should be used for differentiating between *A. marinus* and *A. tobianus* in order to examine the scales of the tail. In the event of large catches of sand eels, the species classification of all individuals can be very time-consuming. In such cases, the species classification should take place by representative sub-samples and subsequent extrapolation to the total catch.

Dragonets – Callionymidae
Only the genus *(Callionymus)* occurs in the German EEZ. This includes the common dragonet *(Callionymus lyra)*, the spotted dragonet *(C. maculatus)* and the reticulated dragonet *(C. reticulatus)*. Species differentiation is more difficult in females than in males. *C. maculatus* and *C. reticulatus* are relatively small, therefore a magnifying glass should be used for identification, in particular as the thorns of the front gill cover must be examined in detail. In addition to the identification clues in Muus and Nielsen (1999), drawings of the front gill cover thorns should be consulted, e. g. in Louisy (2002) and Fricke (1986).

Gobies – Gobiidae
Four species are considered established in the German EEZ: the common goby *(Pomatoschistus microps)*, the painted goby *(P. pictus)*, the sand goby *(P. minutus)* and Lozano's goby *(P. lozanoi)*. The latter two species belong to the *P. minutus complex*. Exact species identification is often difficult under field conditions. However, safe identification of *P. microps* and *P. pictus* is possible in the laboratory by using a stereo microscope (binocular) and consulting Miller (1986). Hamerlynck (1990) should be consulted for differentiating the species *P. minutus* and *P. lozanoi*. To ensure the correctness of classification results, a random sample of classified material should be sent to experts for verification. In the event of large catches of gobies, the species classification of all individuals at sea can be very time-consuming. In such cases, the species classification should take place by representative sub-samples in the laboratory and subsequent extrapolation to the total catch. As the case may be, voucher specimen should be kept for the voucher collection.

Determination of length distribution

Length distribution must be recorded for all fish taxa. Length is defined as total length, measured between tip of the snout and tip of the tail. For herrings, sprats, sardines and anchovies, length is recorded in length classes of 0.5 cm, respectively rounded **down** to the next smallest 0.5 cm step ("0.5 cm below"). All other fish taxa are measured in full 1 cm length classes, respectively rounded **down** to the next smallest full centimetre ("1 cm below").

It is recommended to measure and weigh all *Elasmobranchii* (sharks and rays) separately by gender.

The exact representative length distribution is recorded for each catch category (species/genus). This can be the combined total catch of the catch category or a representative sub-sample. A representative sub-sample consists of at least 75 fish; in all cases it must be assessed whether the identified distribution corresponds to normal distribution. In cases where a true representative sub-sample cannot be chosen, the taxon in question must be separated into two or more size categories.

- *Example 1:* A catch category consists of 999 fish measuring 18–26 cm in length and of one fish measuring 40 cm. A sub-sample of 100 fish would result in either no or 10 fish of 40 cm length for this catch category. The correct method is to exclude this one fish from the sample and to measure it as a separate sample in the size category 1. A sub-sample is taken from the remaining 999 fish (here: size category 2), measured and extrapolated to the number (or weight) of the size category 2.

- *Example 2:* A catch category consists of 994 fish measuring 18–26 cm in length, 3 fish measuring 10–12 cm and 3 fish measuring 38–40 cm. A sub-sample of 100 fish can produce the values 0, 10, 20 and 30 for the smallest and largest size categories, that is, underrating or gross overrating of numbers. Therefore, here too, both length categories must be separated from the middle category and measured separately. The sub-sample must be derived from the middle length category and extrapolated to this category.

In the event of very large catches of one taxon (n > 1,000), the minimum number of the sub-sample should be doubled in order to ensure that length distribution is represented also with regards to extreme values.

3 Avifauna (Resting and migratory birds)

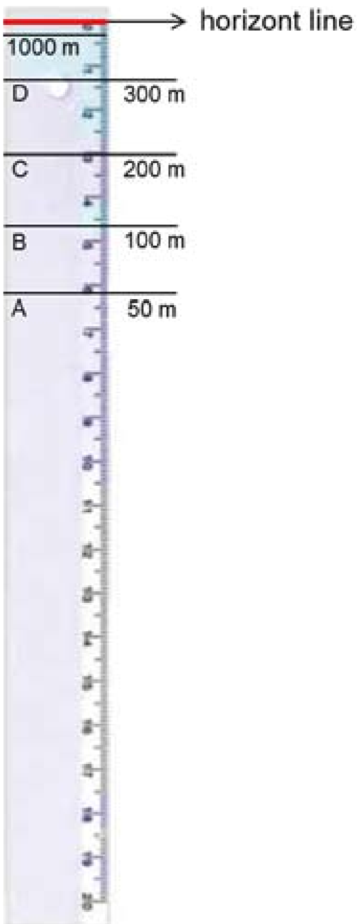
3.1 Resting birds

See table 3.1.1: Survey of foraging, moulting and resting birds.

Heinemann formula for estimating the transect width

Application

1. The ruler is held vertically. The arm is extended forwards. The ruler should be approximately at eye level.
2. The distance between ruler and the observer's eye is measured.
3. The observer's eye level above deck (standing) is measured.
4. The eye level height is added to the height of the deck above water (= eye level above water surface level).
5. The Heinemann formula is applied by using the values of the measured arm length, the eye level above water surface level and the transect band limits that need to be calculated (e. g. 50 m).
6. The calculation result is marked on the ruler (see drawing).
7. The zero line of the ruler is marked as horizon line.
8. For the improved estimate of larger distances (e. g. to ships or wind turbines) an additional distance of 1,000 m may be marked on the ruler.
9. For estimating transect band widths, the ruler with the marked horizon line is aligned with the true horizon line (standing, ruler held with arm extended forwards) and the transect band allocation is made.



Sections on the ruler =

$$\frac{A \times B\ (3838 \times B^{0.5} - C)}{B^2 + 3838 \times B^{0.5} \times C} \times 100$$

A = arm length
B = eye level height above water surface level
C = transect band limit

Table 1: Behavioural codes for identification of reactions of birds in the offshore region. The codes follow the ESAS standard (exceptions are marked with an asterisk *). The main codes highlighted in blue should be given highest priority (if possible, ALWAYS assign the corresponding behaviour).

Code	Behaviour	Kategorie
32	Feeds hatchling/juvenile at sea	Foraging
33	**Feeding, without detail**	**Foraging**
35	Scooping small food particles from the surface while swimming (e. g. pelicans, gannets)	Foraging
36	Kleptoparasitism during flight (to be used in combination with code 90 or 91 for the victim)	Foraging
39	Shallow flight above water while feet tread water surface (e. g. storm petrels)	Foraging
40	Scavenging	Foraging
41	Feeding on fishery waste	Foraging
42	Picking up small food particles from the water surface in flight	Foraging
43	Picking up small food particles from the water surface while sitting on the water	Foraging
44	Picking up larger food particles from the water surface while sitting on the water	Foraging
45	Deep plunging (e. g. gannets)	Foraging
46	Shallow plunging (e. g. terns, sea gulls)	Foraging
47	From flight, plunging into water in pursuit of potential prey (e. g. shearwaters)	Foraging
48	Diving for food	Foraging
49	**Active foraging**	**Foraging**
60	**Resting, sleeping**	**General behaviour**
61	Courtship	General behaviour
62	Courtship with “fish gift” for partner (e. g. terns)	General behaviour
63	Copulating	General behaviour
65	**With hatchlings**	**General behaviour**
66	Grooming, preening	General behaviour
68	Kleptoparasitism during swimming	General behaviour
69	**Circling (high)**	**General behaviour**
90	Attacked by kleptoparasite	Disturbance
91	Attacked by another bird (falling prey)	Disturbance
92	Attacked by a marine mammal (falling prey)	Disturbance
93	Escape dive	Disturbance
94*	Flying up (escape)	Disturbance
95	Injured	Disturbance
96	Entangled in a net or rope	Disturbance
97	Oil-fouled	Disturbance
98	Sick	Disturbance
99	Dead	Disturbance
113*	**Targeted flight**	**General behaviour**
115*	No escape reaction	General behaviour
116*	Embarrassment reaction when disturbed	Disturbance

Table 2: Association codes for identification of wind farm associated birds in the offshore region.

Code	Baustelle
200	Flying between foundations
201	Swimming between foundations
202	Associated with foundation (no tower) (sitting alongside/flying around it, foraging)
203	Sitting on foundation (no tower)
	Finished or partly finished offshore wind farm
210	Flying between wind turbines
211	Swimming between wind turbines
212	Associated with wind turbine (sitting directly alongside/flying around it, foraging)
213	Sitting on wind turbine base
214	Sitting on wind turbine nacelle
215	Colliding with wind turbine
216	Flight transit through rotor area (standing rotor)
217	Flight transit through rotor area (rotating rotor)
218	Disturbance by turbulences (wind wake)
	Transformer station
220	Associated with transformer station (sitting alongside/flying around it, foraging)
221	Sitting on transformer station
	Outside offshore wind farm
230	Flying in direction of offshore wind farm
231	Flying very close past the offshore wind farm (distance up to ca 500 m)
	Avoidance reactions
240	Horizontal swerving
241	Vertical swerving
242	Horizontal and vertical swerving (mainly for bird migration)
243	Flock disintegrating (mainly for bird migration)
244	Flying back (if a flock clearly/more or less clearly flew towards the wind farm and then back again) (mainly bird migration)
	General
250	No recognisable reaction associated with the wind farm

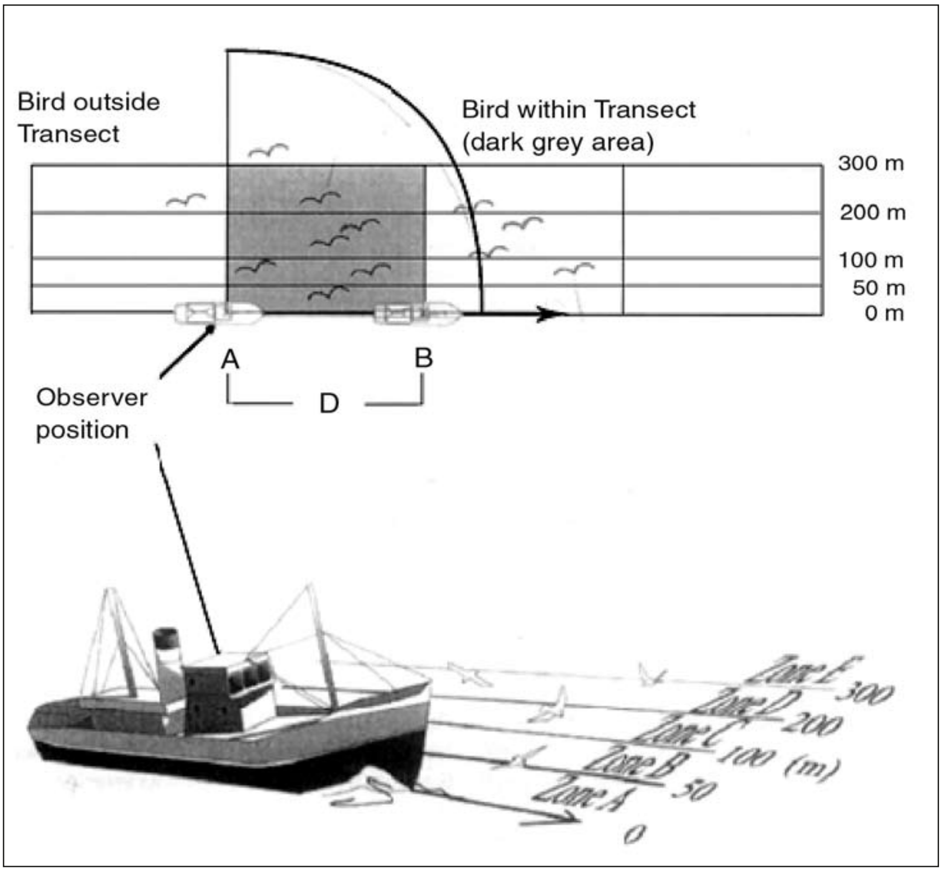


Figure 9: Principle of transect counting after Garthe et al. (2002). The ship is at position B, one or half a minute after having left position A (depending on cruising speed, and thus length of the snapshot area).

Table 3: Length of snapshot areas as a function of the ship's speed (after Garthe et al. 2002).

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

Template: SAS cover page
(according to FTZ Büsum, BSH version, Status: July 2013)

SHIP: .... BEOBACHTER/ IN: ....

DATE: ....

Number of SAS positions forms: .... PORT/STARBOARD SIDE: ....

METHODE:

All species: .... Transect width: …... m

Flight directions (absolut/relative): ....

SHIP TYPE: .... SPEED: .... Knoten

POSITION OF OBSERVER: Top deck ……………......................................
Navigation bridge wing....................................

OBSERVATION CONDITIONS:
SEA STATE: .... VISIBILTY: .... km

EXTRAS (yes/no):

Ruller for transect distinction: ....

Opeation WEA (on/off): ....

Registration of vessels: ....

Registration of fronts/foam line: ....

Behavioural observations (complete/no): ....

WEATHER:

....
....
....

SHIP POSITIONS:

....
....
....

REMARKS:

....
....
....
....

How to complete the SAS cover page (Status: July 2013)

Ship:	Name of ship.
Date:	Day / month / year
Number of observation forms	Total number of SAS observation forms completed per ship, day and (in case of double transects) ship side (port/starboard).
Observer:	Name of observers, at least two observers.
Side of count:	Port, starboard.
All species:	Please tick in case all species are recorded. Please indicate species, or groups of species, that have to be omitted.
Flight directions:	Absolute documentation of birds' flight direction (details see SAS Bird Count Form).
Transect width:	300 m.
Type of ship:	e. g. research vessel, ferry.
Location:	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, ask bridge personnel for information.
Observation conditions:	**Sea state:** Scale from 0–7 describing wave conditions (sea state) and thus the quality of observation conditions. Sea state changes must be recorded on the SAS Bird Count Form or on the SAS cover page under "Remarks". The scale is similar to documentation of wind force in Beaufort (Bft). 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. The survey has to be interrupted at sea state > 4. 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 7 Sea heaps up; white foam from breaking waves is blown in streaks along the direction of the wind **Visibility:** To be estimated in relation to sea marks and other ships etc. If visibility is ≥ 10 km, enter 10 in the column "visibility"; if it is lower, enter a number in kilometres. Changes in visibility should be noted on the SAS Bird Count Form.
Weather:	Information about the weather is particularly necessary in extreme conditions (that is, whenever observation accuracy might be affected; this applies in particular to precipitation, but also to dazzling light, to name an example).
Positions:	Parallel to the bird surveys, the ship positions have to be recorded regularly in order to be able to refer the observations to geographic positions. It is necessary to bring one's own GPS equipment and to record the position every minute.
Time:	UTC, corresponding to GMT (Greenwich Mean Time). UTC corresponds to German winter time less 1 hour, or German summer time less 2 hours.
Geogr. position:	In WGS 84 and in degrees, minutes, and hundredths of minutes (e. g. 54° 52.59') or as total decimal value (e. g. 54.8765° N).
Remarks:	Changes in ship's speed, stops, deployment and recovery of nets, inter alia, have to be recorded here. Also, changes in the wind direction and speed should be noted here.

Template: SAS Bird Count Form
(according to FTZ Büsum, BSH version, Status: July 2013)

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

Distance:
F = flying
A = sw., 0-50m
B = sw., 50-100m
C = sw., 100-200m
D = sw., 200-300m
0 = sw., A-D
E = sw., >300m
W = sw., false site

Transekt:
1 = outside
2 = inside

Flight directions:
1 = undirected
otherwise: all flight directions acc. to compass rose (10° - 360°)

Associated with:
12 = front
13 = foam line
14/ 1 / 16 = wood/ garbagel / oil
17 = Macroalgae, seaweed
18/ 21 = own / other ship
19 = ON own ship
26 = fishing vessel
22 = buoy; **27** = ice; **28** = land
29 = sand bar (**102** = on/ over; **103 = next to**)
50 = participating at feeding flock
100/ 101 = set net/ bow net

Behaviour:
30/ 31 = +fish/ -fish (e.g. alcid)
33 = feeding, no details
36 = pursuit flying (e.g. skua)
40 = scavenging
41 = feeding fishery waste
42 = dipping
43 = surface seizing
44 = surface pecking
45/ 46 = deep/ shallow plunging
48 = diving for food
49 = active foraging
60 = resting, sleeping
61/ 65 = courtship/ with hatchling
66 = preening
68 = cleptoparasitism during swiming
69 = (high) circling (gulls)
90 = attackted by cleptoparasit
93 = escape dive
94 = flying up (escape)
97/ 98/ 99 = oil-fouled/ sick/ dead
111 = NOT foraging
116 = embarassement reaction (disturbed)
113 = targeted flight

Time	Species	Age	Pumage/ Cal.years	Numer	Grp.	Dis-tance	Tran-sect	Flight dir.	Flight alt.	Assoc.	Behav.	Notes
➡		SS:			Visibility:							
			▪									

Prey: 10 = fish, **11** = small fish (beak length), **12** = medium fish (2-5x beak length), **13** = big fish, **21** = herring or sprat, **22** = sandeel, **24** = flatfish, **29** = pipefish, **30** = unident. small particle, **31** = unident. big object, **32** = jellyfish, **34** = worm (e.g. Nereis), **40** = unident. crustacean, **41** = swimming crab, **45** = unident. mussle, **50** = unident. carcass, **52** = dead whale, **53** = dead bird, **54** = garbage, **60** = unident. fishery waste
Flight alt.: 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

How to complete the SAS Bird Count Form (Status: July 2013)

General:	Please note 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 in the header on each page; changes of sea state and visibility should be noted under "Remarks" in the corresponding line (time).
Time:	The exact time (in hours and minutes, UTC!) has to be recorded for each bird observation. IMPORTANT: At the beginning of each transect, the hour and 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 the transect or counting, i.e. also during brief interruptions, the word STOP has to be noted together with the exact hour and 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. The abbreviations used must always be the same. Likewise, a particular abbreviation must not be used for different species.
Age:	**A** = adult, **IM** = immature/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** (cf. Annex 3 in Garthe et al. 2002) or A (for adult). *Fulmar:* **L** (for the typical, light-coloured North Sea birds or C (for all "coloured" individuals). Gender: **M** = male, F = female. *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:	Number of individuals.
Group:	Birds belonging to the same flock of birds should be recorded using identical numbers or curly brackets.
Distance:	Distance: Use letters for swimming birds: **A** = 0 to 50 m **B** = 50 to 100 m **C** = 100 to 200 m **D** = 200 to 300 m **E** = more than 300 m (= outside transect!). Flying birds always get the letter F, irrespective of their distance. Swimming birds in the transect, whose precise distance cannot be determined because 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 bands A, B, C or D. 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 buoys using radar, a commercially available range-finder or a ruler (according to Heinemann 1981) (see p. 53)!
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 recorded in degrees with a precision of 45° (N, NE, E, SE, S, SW, W, NW, taking into account the vessel's movement), using a compass rose, a shipboard compass or the compass of a GPS unit.

Association:	Here, any association with one's own ship or other ships as well as any association with other objects on/in the sea should be noted; details are given in the corresponding box on the Bird Count Form and on p. 55. The general rule is that individuals associated with one's own ship should always be recorded as not in transect and thus are not assigned a flight direction. (The exception being, if they only briefly deviate from a previously observed flight direction to have a look at one's own ship and then return to their original flight path.)
Behaviour:	This category, like "Association" is highly relevant to explain the distribution and abundance of individual bird species at sea. The behavioural categories to be distinguished are indicated in the corresponding box on the Bird Count Form and on p. 54. *Specifics:* Dead birds are given the behaviour code 99, yet in transect always 1 (e. g. A1). Birds plunging within the transect are given a 2 (even when they temporarily fly outside the transect).
Remarks:	This column is for additional details not covered by the other columns, for instance, when observation conditions change (sea state, visibility).

Table 4: Seasonal occurrence of seabirds in German waters (from Garthe et al. 2007 and unpublished. Data: FTZ Büsum, Status: 30.07.2013).

Art	Spring/Return	Summer/ Breeding period	Autumn/ Migration	Winter
Red/Black-throated Diver	01.03.–30.04.	01.05.–15.09.	16.09.–31.10.	01.11.–29.02.
Great crested grebe	01.03.–15.04.	16.04.–31.07.	01.08.–15.11.	16.11.–29.02.
Red-necked grebe	01.03.–30.04.	01.05.–31.07.	01.08.–15.11.	16.11.–29.02.
Horned grebe	01.03.–15.05.	16.05.–31.08.	01.09.–30.11.	01.12.–29.02.
Fulmar	16.03.–15.05.	16.05.–31.08.	01.09.–30.11.	01.12.–15.03.
Northern gannet	01.03.–30.04.	01.05.–31.08.	01.09.–31.10.	01.11.–29.02.
Cormorant	01.02.–31.03.	01.04.–31.07.	01.08.–31.10.	01.11.–31.01.
Common eider	01.03.–30.04.	01.05.–31.08.	01.09.–30.11.	01.12.–29.02.
Long-tailed duck	01.03.–30.04.	01.05.–30.09.	01.10.–30.11.	01.12.–29.02.
Black scoter	01.03.–31.05.	01.06.–30.09.	01.10.–30.11.	01.12.–29.02.
Velvet scoter	01.03.–31.05.	01.06.–31.08.	01.09.–30.11.	01.12.–29.02.
Red-breasted merganser	01.03.–30.04.	01.05.–31.08.	01.09.–30.11.	01.12.–29.02.
Little gull	01.03.–31.05.	01.06.–15.07.	16.07.–31.10.	01.11.–29.02.
Black-headed gull	01.03.–30.04.	01.05.–30.06.	01.07.–31.10.	01.11.–29.02.
Common gull	01.03.–15.05.	16.05.–15.07.	16.07.–31.10.	01.11.–29.02.
Lesser black-backed gull	16.03.–15.05.	16.05.–15.07.	16.07.–31.10.	01.11.–15.03.
Herring gull	01.03.–15.05.	16.05.–15.07.	16.07.–31.10.	01.11.–29.02.
Greater black-backed gull	01.03.–30.04.	01.05.–31.07.	01.08.–31.10.	01.11.–29.02.
Kittiwake	01.03.–15.05.	16.05.–31.07.	01.08.–31.10.	01.11.–29.02.
Sandwich tern	16.03.–15.05.	16.05.–15.07.	16.07.–15.10.	16.10.–15.03.
Common tern	01.04.–15.05.	16.05.–15.07.	16.07.–15.10.	16.10.–31.03.
Arctic tern	01.04.–15.05.	16.05.–15.07.	16.07.–15.10.	16.10.–31.03.
Common Guillemot	01.03.–15.04.	16.04.–15.07.	16.07.–30.09.	01.10.–29.02.
Razorbill	01.03.–15.04.	16.04.–30.06.	01.07.–30.09.	01.10.–29.02.
Black guillemot	01.03.–30.04.	01.05.–31.08.	01.09.–30.11.	01.12.–29.02.

3.2 Migratory birds

See table 3.2.1: Radar survey.

Minimum requirements of optical systems for survey of birds in the rotor area of offshore wind turbines

Recommendation

Optical systems are camera systems with automatic recording function, which can detect flying small birds day and night and the performance capability of which is verifiable. Image resolution should be at least 768 x 576 pixel (PAL) at a minimum of 15 images per second. The aperture angle must be such that the targeted species in the target distance can be depicted with a sufficient number of pixels. Continuous measurements must be carried out at least during the main migration periods in spring and autumn.

Process instruction for calculating distance correction for radar equipment (after Hüppop et al. 2002)

The distance correction method described in the following is just an example. Each radar unit has to be corrected individually and the formula below is by no means generally applicable.

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). 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 altitude distribution, the number of echoes recorded has to be corrected. Hüppop et al. (2002) decided not to apply an experimental approach to equipment calibration (e. g. by using a model plane). Instead, they tested an empirical approach using already 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) (e. g. 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 (a1 - 3), which constitute a good compromise between a good fit (assessed according to the Akaike Information Criterion) and easy handling of the model:

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

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. 9. Accordingly, the sum of all echoes for each 100 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 entirely 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 x 100 m field is too low. This distance correction has to be performed for each individual radar unit because of production-related differences and different equipment settings.

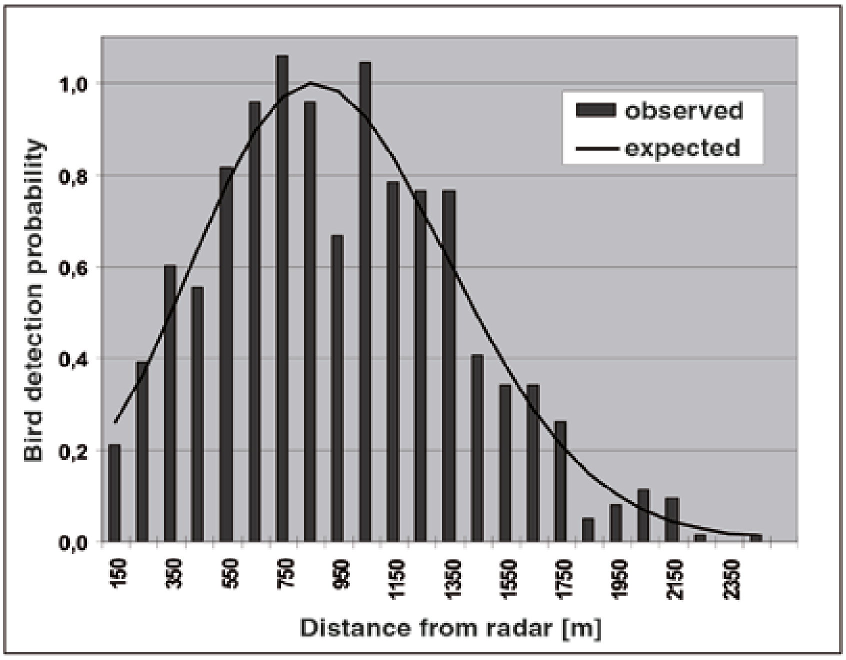


Figure 10: Bird detection probability as a function of distance at sea (n = 694) (unpublished, data: Institute for Avian Research “Vogelwarte Helgoland”).

See Table 3.2.2: Visual observations/recording of flight calls.

Process instruction for night-time automated survey of bird calls for identification of species in the offshore region

Call recording should be carried out with an omnidirectional microphone of high sensitivity and a very good signal-to-noise ratio. To minimise disturbance by wind and wave sounds and to increase the microphone’s life, it should be water-proofed by wrapping in thin plastic film and set up in a basket-type windscreen with fur cover; if possible, it should be suspended by rubber bands, thus mechanically decoupled from the mounting. If possible, the microphone system should be set up with free range in all directions (tip of microphone vertically upwards). At fixed locations, an alternative may be use of a directional microphone with known characteristics, since, as the case may be, mathematical correction of the recording range is possible only under stationary circumstances. For data recording, the microphone should be connected to a computer via a microphone pre-amplifier with phantom power for the microphone. As a rule, connection is via a corresponding sound card (internal, external or on the computer’s motherboard). After set up, the system should be regularly calibrated at least twice a year by playing previously recorded bird calls using speakers at various distances and low volume. The recording level must be set so that the calls are recorded by the microphone system while at the same time they can be heard by an experienced ornithologist.

The recordings should be saved as uncompressed WAV files (16 bit, mono); a sampling rate of 22 kHz is sufficient. The used recording software must be AROMA (Automatic Recording of Migrating Aves), a software for the automatic recording of bird calls based on the script language Tcl/Tk, which was developed by Dr Ommo Hüppop from the Institute for Avian Research “Vogelwarte Helgoland”. Based on the audio processing tool kit “Snack”, this software continuously examines the incoming audio signal to detect peaks, that is, sounds that steeply pitch above a previously set minimum frequency (maximum of 1,500 Hz; cf. Hill & Hüppop

2008) in a marked contrast to the ambient noise. Only the calls recognised on basis of these peaks will be automatically saved as audio files, whereas disturbance noise caused by wind and waves is largely ignored. Compared to recording technology that is triggered only by level (cf. Frommolt et al. 2012), the filtering function of this system reduces the data volume collected for evaluation to a manageable amount (Hill & Hüppop 2008). However, this is not a system for automatic call identification. Tests with different algorithms ultimately rendered no satisfactory results for the expected broad range of species. In about 10 years, for instance, FINO1 registered 112 species purely sound-based. Therefore, software for automatic identification of species must not be used.

The stored data should subsequently be listened to by qualified personnel for identification down to species level, if possible. To this end, a closed headphone system must be used, while at the same time, to simplify analysis, the spectrum of the audio files should be illustrated in sufficient resolution by means of suitable software
(e. g. RAVEN http://www.birds.cornell.edu/brp/raven/ravenoverview.html). In times of strong bird call activity, several files per minute might be generated. Individual birds or flocks are saved on several consecutive files, if the intervals between detected calls are longer than 1.5 s or the maximum file size of 5 s has been reached (both this is pre-set in AROMA and should not be changed). Each call-positive file is documented as one data set together with the time of recording and the detected species. If more than one species can be identified per file, several data sets are created accordingly. Calls (or songs) of individuals or flocks that evidently happen to rest at the recording site – recognisable by the temporal accumulation of birds calling obviously in always the same distance – are marked according to file. Even so, the data sets should be further identified with the remark “rest” and recorded. Quantification is consciously abstained from, since it must be assumed that the system features a varying range depending on the weather, bird species and many other factors. General migration intensity is recorded by radar at night-time, yet only call recording provides the additional insight into the involved species, in spite of all the limitations of the procedure. Even without direct quantitative reference, the analysis of data in the relative unit “call-positive files/h” provides sufficient information to identify certain call concentrations. The presentation of results should be by species per migration night and hour under due registration of duration of night.

Regarding further discussion of the method, the data thus obtained and the evaluation options see Hüppop et al. (2012). They processed the calls with the help of only a few experts and expressed them quantitatively in estimated individuals/h. Since the number of future revisers and their qualitative comparability is not known, we abstain here from estimation of individuals/h (requiring a high degree of experience) in favour of the simpler unit “call-positive files/h”. To ensure quality, a randomised sample of 5% of call-positive files should be evaluated by a second reviser. In the event of significant deviations, the revisers should receive corresponding training or be replaced.

More information on the method and potential applications of the AROMA software are available upon request to:

Institute for Avian Research “Vogelwarte Helgoland”
Dr Ommo Hüppop
An der Vogelwarte 21
26386 Wilhelmshaven
Germany
e-mail: ommo.hueppop@ifv-vogelwarte.de

4 Marine mammals

See table 4.2: Survey of habitat use.

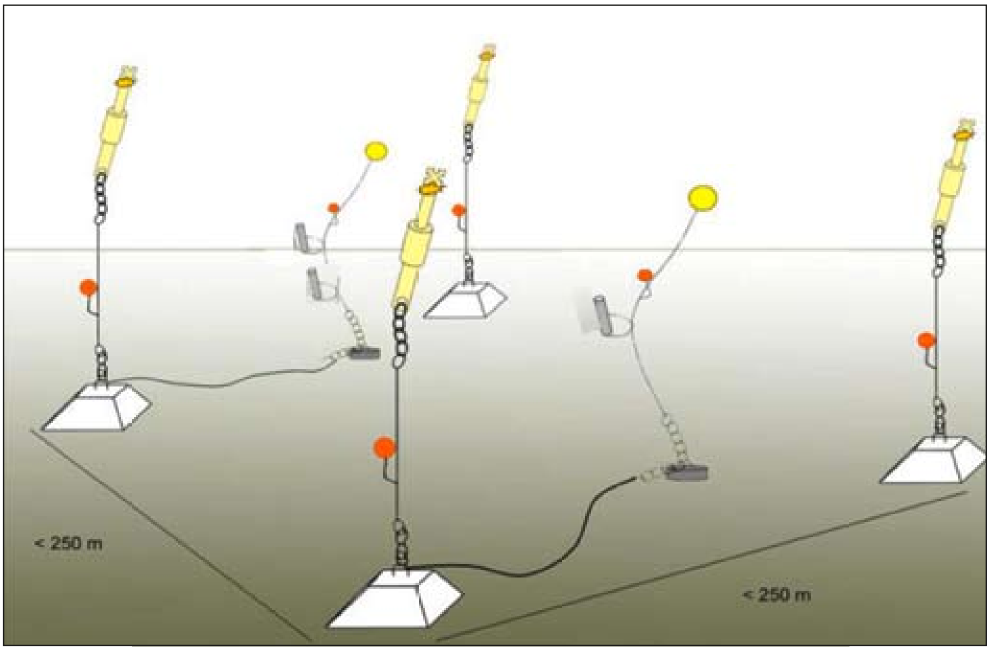


Figure 11: Sketch of the anchoring system of a POD station comprised of 3 individual PODs (Design: C. Honnef/M. Gauger).

Process instruction for statistical analysis of the C-POD data collected within the framework of the StUK monitoring.

Variables and selection criteria

The following section describes the procedure for the currently prevailing measuring system C-POD including the software C-POD.exe used for classification. Should other, equivalent measuring systems be issued, comparability of the variables and detection probabilities must be ensured.

For analysing the origins of the click trains (in C-POD.exe), the measuring system C-POD provides the variables NBHF (narrow band high frequency), Other cet and Sonar. The statistical data evaluation should use the variable NBHF, which in the North and Baltic Seas is largely attributed to harbour porpoises *(Phocoena phocoena)*.

For the variable TrClass (train class = quality parameter determining the degree of probability which which classified click trains actually may be attributed to harbour porpoises), only the values Hi (high probability that the click train should be attributed to a harbour porpoise) and Mod (sufficient probability that the click train should be attributed to a harbour porpoise) should be selected. A “detection” has occurred, when a click train falls into one of these two classes.

The chosen parameters should be DPM (detection-positive minutes) and DP10M (detection-positive 10-minute intervals). The accuracy may be varied to describe harbour porpoise activity before, during and after pile driving events. Based on experience, a resolution by hours (e. g. DPM h^{-1}) is helpful here. The parameter DP10M d^{-1}, which is a good measure for phenological descriptions, is too inaccurate for registering the influence of pile driving activities on harbour porpoises.

Another value to be calculated is "waiting time", defined as a time interval (minutes) between two harbour porpoise detections. Because of the chronologically possible autocorrelation between two detections, at least 10 minutes without detection must pass. Such related harbour porpoise-positive 10-minute periods are called "encounter" and gaps are called "waiting time". Thus, the defined minimum value for "waiting time" is 10 minutes (definition in Carstensen et al. 2006 and Tougaard et al. 2009).

For integrating the pile driving activities into the statistical modelling, the pile driving data per pile should be available as machine-readable ASCII file derived from the piledriver's measurement sensors. These files must provide clear identification of the pile, the date and time per single impact (documentation of time system) and the impact energy (kJ). If the pile driving data is not available in such detail, at least the total impact energy, total number of impacts as well as beginning and end (at least correct to 10 minutes) of the pile driving event must be included in the evaluation. To include in statistical modelling the waterborne noise measured at the C-POD's measuring position, the median value (50% percentile) of the single event level (SEL_{50}) should be available for each pile and measuring position in order to provide a measure for the volume [dB re 1 $\mu Pa^2 s$] for the mainly used impact energy.

Influence of pile driving on harbour porpoise activity and harbour porpoise activity recovery times

To analyse the influence of pile driving on harbour porpoise activity, generalised additive models (GAM, Wood 2006) or generalised linear models (McCullagh & Nelder 1989) should be used due to the condition of the data (as a rule, not normally distributed data, over dispersion, heterogeneity of variance, temporal and spatial autocorrelation). Where necessary, these models can easily be extended to generalised additive mixed models (GAMM, Lin & Zhang 1999) or generalised linear mixed models (GLMM) by inclusion of random factors. For these methods it is a priori not known over which functional form one or several explanatory variables impact on the dependent variable. Moreover, in addition to the parametric forms of generalised linear models (GLM), a GAM allows for the use of non-linear so-called *smoothing terms* to characterise the connection between the dependent *(response)* and the explanatory (predictor) variable. Here, all parameters are included in a purely additive manner, as is the case also in the traditional linear models.

The analyses can be carried out script-based in the R software (current version 2.15.2, R Development Core Team 2012), which holds available several different GAM and GLM packages. Since there is no exactly delineated definition for what exactly is a GAM, these models can be very variable. The deriving diversity of models is reflected in the various implementations: "mgcv" (current version 1.7-22, Wood 2006) and "gam" (current version 1.06.2, Hastie & Tibshirani 1990). Other uses include "VGAM" (current version 0.9-0, Yee 2012) and "gamlss" (current version 4.2-0, Rigby & Stasinopoulos 2005). For GLM, the packages "lme4" (Bates et al. 2012), "nlme" (Pinheiro et al. 2012) and "MCMCglm" (Hadfield 2010) and others are important.

Statistical models are subject to ongoing further and new development, which can result in new or advanced methods being similarly efficient and adequate in answering the given issues as are the ones described here. In so far, this method is to be understood as providing a basis, which may be extended to take into account recent developments.

For carrying out the modelling, comprehensive data exploration (described in Zuur et al. 2010) and model validation (Wood et al. 2006, Zuur et al. 2009, 2010, 2012a,b) are required to check, whether the model assumptions regarding the basic distribution of data and correlations are supported by residual variance distribution. Model validation examines aberrations, homogeneity of variance, normal distribution of residuals, zero inflation, correlated predictor variables, interactions and the assumption of independence of data (Zuur et al. 2010). Model validation results in suitable models correctly describing the data. Predetermination to use GAMM or GLMM is not reasonable. Conversely, mixed models are absolutely necessary, since the question as such is simple: how to harbour porpoises *(response)* react to pile driving of foundations *(predictor)*. However, this process is influenced by seasonal and geographic distribution of harbour porpoises and differences in the measuring equipment, which ideally are taken into account in the model as *random effects*. Model validation must take into account also spatial and temporal autocorrelation effects. Temporal autocorrelation can, for instance, be accommodated in "mgcv" by introduction of an autocorrelation structure; spatial autocorrelation should be checked by variograms (Zuur et al. 2010).

To achieve the highest possible temporal resolution of harbour porpoise activity in relation to the pile driving events (hours with pile driving events = hour "0"), evaluation takes into account either the harbour porpoise-positive minutes per hour (DPM h^{-1}) or, alternatively, the harbour porpoise-positive 10-minute periods per hour (DP10M h^{-1}). Using the influence of *predictor* variables, the impact of pile driving activities can be described both spatially (e. g. distance to the pile driving site) and temporally (e. g. hour relative to the pile driving event). The correlation of spatial and temporal effects is complex and may be characterised, for example, by introducing an interaction term (*predictor space x predictor* time or as a tensor product). Moreover, the model may include also temporal parameters (time of day, month, year) and, depending on the data set, other parameters, for instance, those describing the pile driving event more closely (e. g. duration, average energy used kJ h^{-1}, measured noise immission at site of C-POD measurement). The p-values obtained by modelling are not to be equalled with traditional statistics, which is why p-values that are close to the alpha level of 5% must be critically examined. As a rule, evaluation is carried out by an ANOVA or log-likelihood test.

If the calibration data are available in evaluable form, they preferably should be included in the model. The inclusion of the POD-ID as a *random factor* can, under certain circumstances (fast change of measurement equipment and homogeneous utilisation of a preferably small equipment pool across the project stations), lead to improvement of the model results. However, this is not an equipment-specific characteristic and can therefore be subject to strong influences from seasonal and geographical distribution of harbour porpoises: accordingly, it is a collective factor. The error distribution is dependent on data inspection and model validation. Potentially suitable distributions may be Poisson, Binominial and negative Binominial distributions, their derivatives for compensation of overdispersion (quasi-) as well as zero-inflated distributions (Zero Inflated or Altered Binomial (ZIB, ZAB), Zero Inflated or Altered Poisson (ZIP, ZAP) and Zero Inflated or Altered Negative Binomial (ZINB, ZANB)).

Recovery times (waiting time)

As an alternative to a GAM with "harbour porpoise activity" (DPM h-1) as dependent variable, the influence of pile driving activities on harbour porpoise recovery times may be analysed. In this approach, the waiting times between individual harbour porpoise events ("encounters") are taken as measure for re-utilisation of the area in reference to the pile driving activities. The waiting times after end of a pile driving event are numbered (categorial variable) and compared to uninfluenced waiting times. Since it is highly probable that the end of pile driving activities coincides with a longer rather than with a shorter waiting time ("Bus Paradox": Ito et.

al. 2003, Tougaard et al. 2009), the first waiting time after end of pile driving activities must be compared to a random sample of the uninfluenced waiting times; the randomized sample size (n) must be identical. This has to be effected by randomised selection of dates/times and related waiting times from time intervals that are uninfluenced by pile driving and feature similar seasonal patterns or from longer intermissions in the pile driving activity, during which a natural distribution of harbour porpoises that is uninfluenced by pile driving may be assumed (Tougaard et al. 2009). The Bus Paradox is not eliminated by randomised selection of numbered waiting times in the randomised sample, but exclusively by randomised selection of a point in time and selection of the waiting time associated with that point in time. In this case, waiting times should be used only once (selection without putting back/"Jackknife"). All other reviewed waiting times after pile driving are independent of the "Bus Paradox" and are compared with the total number of uninfluenced waiting times.

Non-parametric standard test procedures (e. g. Mann-Whitney U-Test) lend themselves as mean value comparisons between individual groups (e. g. first "waiting time" after pile driving vs uninfluenced "waiting time", separated into distance classes). Further analyses allowing for the investigation of influence of other parameters may be carried out by using a generalised linear model (GLM), which can be extended to a mixed model (GLMM) by addition of random factors (e. g. POD station).

5 Bats

See Table 5.1: Survey of bat migration activity in the offshore area.

Process instruction for survey of bat migration activity in the offshore area of the Baltic Sea.

Scope of application

The process instruction should be seen as a guideline for the qualitative survey of bat occurrence and for the relative estimate of bat activity in the assessment area during bat migration times. In the Baltic Sea region, bat migration is expected, depending on the species, in the period from mid-April to mid-June and mid-August to end of October (e. g. Ahlén 1997, Seebens et al. 2013).

So far, the knowledge base for correct offshore monitoring of bats is limited. This process instruction is a first step towards standardised survey. It will be evaluated and reviewed with further development of the StUK.

The survey of bat fauna is carried out in the style of the night-time call survey of migratory birds (cf. Table 3.2.2) and comprises the acoustic recording of echolocation calls. The probability of recording these calls depends on the species-specific call “volume” and on the technical characteristics of the used acoustic detectors (frequency-dependent sensitivity, directional characteristic) (e. g. Adams et al. 2012). Most species or species groups can be identified on the basis of their call characteristics (species spectrum). The number of bat call sequences provides information regarding their relative activity.

Equipment for recording/analysis of bat calls

The survey system presented below follows the Avisoft system. If other survey systems are used in the context of offshore surveys, it must be ensured that they comply with the minimum requirements and equipment standards presented here.

The survey system must fulfil the following minimum requirements. It must be noted that only detector systems with a high sensitivity range of 16–25 kHz are permissible:

Bat detection system:
- Bat call recording per second
- Real time recording
- Minimum sampling rate 300 kHz
- External microphone port
- Calibration possible
- Option for bat call filter

Microphones:
- External ultrasound microphones (e. g. Knowles FG Electret Ultrasound or CM16/ CMPA)
- Shielded microphone cable with shielded 5-pin XLR connector
- Waterproof microphone cover (e. g. plastic tube)
- Signal generator for testing functionality and for regular calibration
- Microphone heating (Note: microphone heating has the advantage of reducing condensation and thus salinisation of the microphone)

Laptop/external hard drive:
- Sufficient storage capacity
- It must be taken into consideration that the various detection systems work with different operating systems (e. g. Avisoft with Windows, Batcorder with Macintosh).

Analysis equipment for bat call identification:
- Sound analysis software (e. g. Avisoft SAS-Lab Pro, Pettersson BatSound)

The following system provides an example for recording of bat calls in the offshore area:

Sample configuration:
- Detector: Avisoft UltraSoundGate 416h
- 3 x P 48 Electret Ultrasound Microphone (Avisoft Bioacoustics/Knowles FG) with microphone heating in anti-exposure casing
- Shielded microphone cable with shielded 5-pin XLR connector
- Avisoft Bioacoustics piezo-electric signal generator (a piezo-electric signal generator allows for automatic control signals of pre-defined frequency and volume to be emitted at any time in order to check the microphone's efficiency)
- Laptop and external solid state hard drives
- Avisoft SAS-Lab Pro.

Bat call survey

General procedure:

Call activity recording takes place in fixed anchor position parallel to night-time migratory bird call recording in the periods mid-April to May and mid-August to October in windless nights (up to 3 Bft). Principally, bat call recording takes place from sunset to 2 hours after sunrise (civil twilight). *Continuous call activity recording must be ensured!*

Basically, three external ultrasound microphones are installed, following the standards as given below. The installed detector system automatically records bat calls. The data is stored, read after each trip and brought to the office for analysis.

Bats that are sighted or land on the ship during the bird migration survey (see table 3.2.2) are recorded accordingly (if possible, down to species level). Anchor position and weather information are copied from the bird migration survey data.

Installation of survey equipment:

The survey equipment (computer, detector system) is set up protected from the weather. The microphones that are installed externally on the ship are connected to the detector system by microphone cables and fastened in a manner protecting them from the weather (wind/waves/rain) (Suggestion: the microphone may be inserted in, for example, a PUR tube, which extends beyond the microphone by about 2 cm. The tube ends should be sealed with waterproof tape/silicon sealant to protect also the plug connections).

Depending on conditions on the ship, three microphones should be installed at a maximum height of 5 m above the water surface (e. g. on the survey ship's rail). Ideally, the microphones should not be installed near the ship's generator and radar. One microphone each should be installed on the port and starboard side of the ship. A third microphone points to the stern, angled downwards at 45° and, where necessary, should be equipped with a reflector panel.

Calibration of the bat detector:

All available detector systems allow for a broad range of calibrations; it is therefore difficult to provide general calibration standards. Generally, it must be ensured that the entire species spectrum potentially occurring in the assessment area is captured. By way of example, the Avisoft system calibrations are presented in the following:

in the offshore area, standardised specifications apply to calibration of bat detectors of the Avisoft system, which (slightly altered) shall provide a guideline for bat surveys in the offshore area (BMU project “Reduktion des Kollisionsrisikos von Fledermäusen an Onshore-Windenergieanlagen (RENEBAT II)”, FKZ: 0327638C, Period: 01.09.2011–31.08.2013). If survey systems other than the Avisoft system are used in the context of offshore surveys, it must be ensured that they correspond to the requirements and calibrations as specified here (cf. Fig. 2).

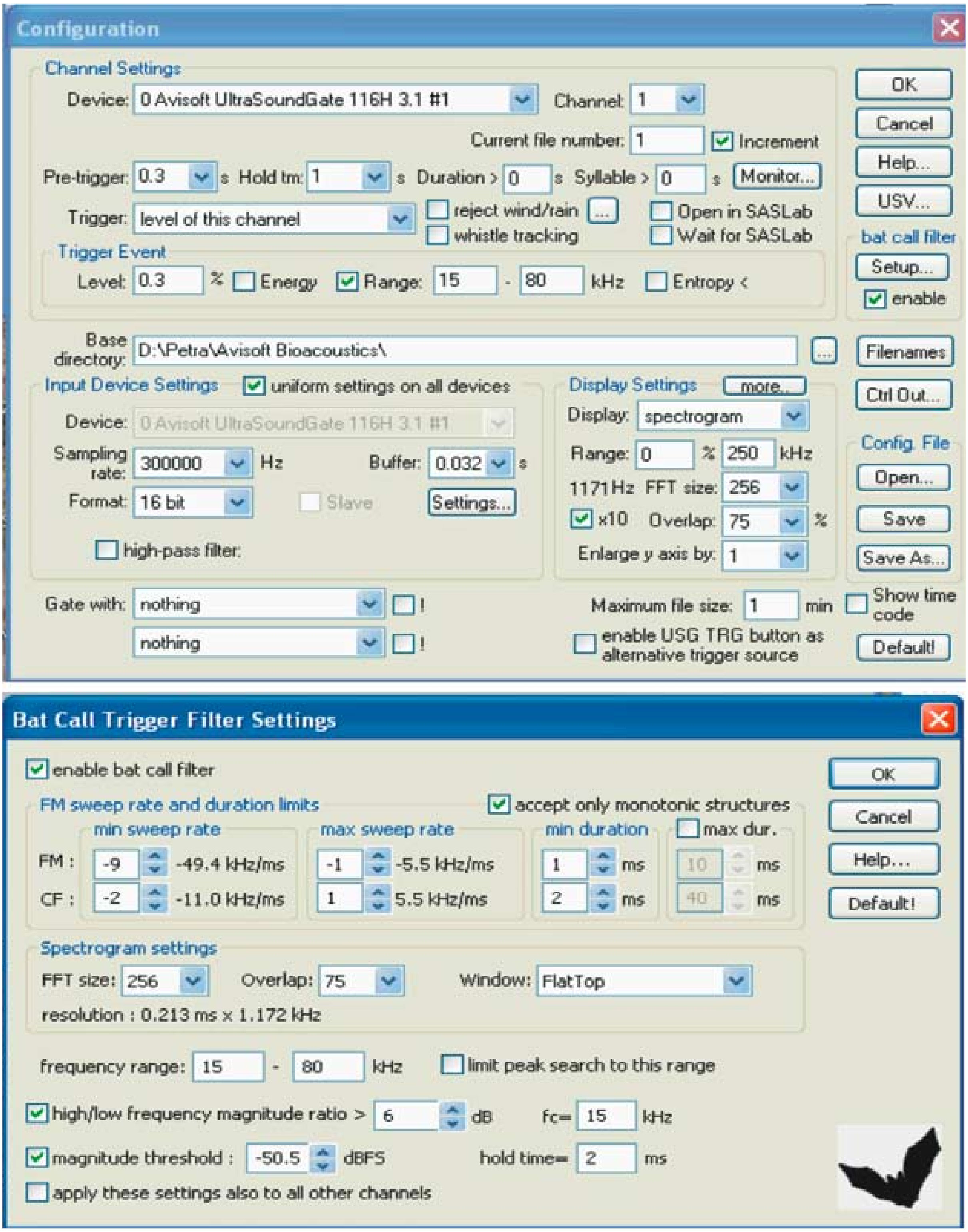


Figure 12: Guidelines for calibration of the Avisoft detector for survey of bat call activity in the offshore area. (Attention: maximum file size = 1 min.).

Identification and processing of bat calls

Identification of bat species:

Generally, the latest literature should be used for identification purposes (e. g. Skiba 2009, Barataud 2012, Russ 2012). The call characteristics of bats is highly dependent on the flight behaviour of the animals. The interpretation of bat call recordings and the identification of species should therefore be carried out by persons with long-standing experience in the bio-acoustic analysis of bat calls.

All recorded data must be *manually* assessed and identified. A large number of automatic systems for bat call identification is available. Automatic survey systems can feature an identification error rate that is too high and therefore are not permissible for the survey required here.

Calls that cannot be identified at the species level should be recorded as follows:

- *spec.:* identification of genus (e. g. *Myotis spec.*)
- *Pnat/Ppip* for Nathusius's pipistrelle/Common pipistrelle
- *Ppip/Ppyg* for Common pipistrelle/Soprano pipistrelle
- *Nyctaloid:* identification possible only down to group comprising the species of the genera *Nyctalus*, Eptesicus and Vespertilio, the species of which cannot be safely identified under certain flight conditions.

Identification and evaluation of activity:

Similar to the night-time survey of migratory birds, the observation numbers for population surveys of bats must not be regarded as absolute abundance, since it is impossible to identify individuals. The data is rendered as "activity density". All bat observations are therefore to be evaluated as a relative measure.

The number of recorded call sequences constitutes the activity. If two different call sequences by one species are identified at the same time within one recording, this shall be registered as two activities:

1 call sequence by one species = 1 activity
2 call sequences by one species at the same time = 2 activities

The data evaluation must contain:

- Seasonal distribution of species-specific activity (cf. Fig. 13)
- Blending of activity data with collected weather data (cf. Fig. 14).

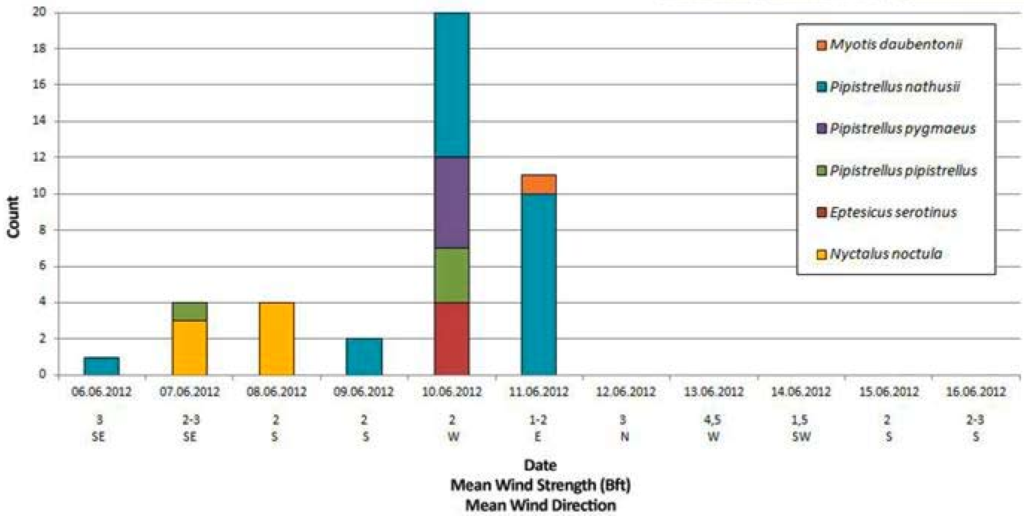


Figure 13: Evaluation of bat activity over the course of the survey period.

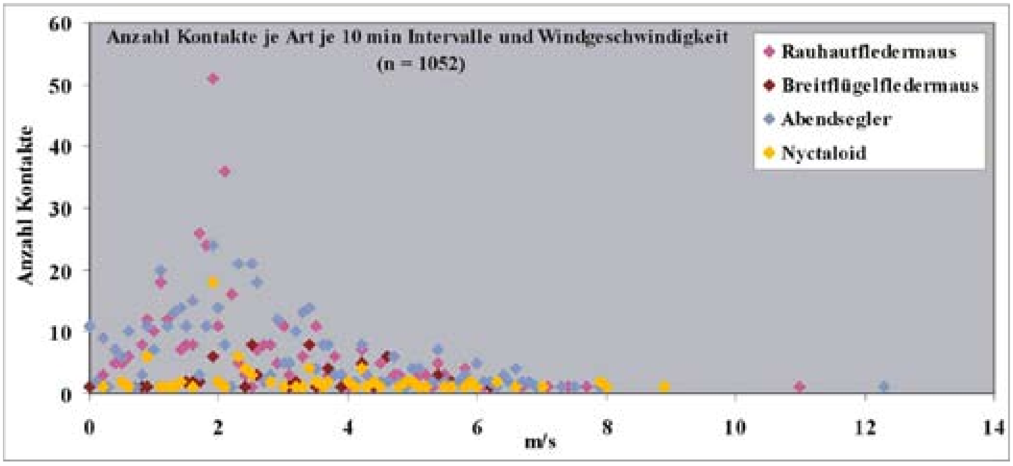


Figure 14: Blending of wind data with bat activity.

Quality assurance

The equipment must be maintained in manner to ensure failure-free operation:

- Maintenance and calibration of microphones and detector system must be carried out once per survey year by the manufacturer If necessary, repairs are carried out by the manufacturer's service department
- Example calibration for the Avisoft system under: http://www.avisoft.com/Inbetriebnahme%20und%20Kalibrierung%20des%20WEA-Fledermausmonitoring-Systems.pdf
- The minutes or reports documenting maintenance and repair work are collected in the "equipment log".

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Abbreviations and acronyms

AEWA	Agreement on the Conservation of African-Eurasian Migratory Waterbirds
AIS	Automatic Identification System
ANOVA	Analysis of Variance
EEZ	Exclusive Economic Zone
BACI	Before-After-Control-Impact
BfN	German Federal Agency for Nature Conservation
BGBl	German Federal Law Gazette
BNatSchG	German Federal Nature Conservation Act
BSH	German Federal Maritime and Hydrographic Agency
ESAS	European Seabirds at Sea
FFH Directive	(Flora-Fauna) Habitats Directive
FINO	Forschungsplattformen in Nord- und Ostsee (German research platforms in the North and Baltic Sea)
GIS	Geographic Information System
GLM	Generalized Linear Model
GLMM	Generalized Linear Mixed Model
GPS	Global Positioning System
HELCOM	Helsinki Commission (Baltic Marine Environment Protection Commission)
N	Survey sample size
OSPAR	OSPAR Commission (Convention for the Protection of the Marine Environment of the North-East Atlantic)
OWP	Offshore wind park
PA braided line	Polyamide braided line
PE braided line	Polyethylene braided line
PP braided line	Polypropylene braided line
Sal	Salinity
SAS	Seabirds at Sea
SeeAnlV	German Marine Facilities Ordinance
SPEC	Species of European Conservation Concern
SS	Sea State
SSS	Side scan sonar
StUK	Standard for Environmental Impact Assessments
SEA	Strategic Environmental Assessment
T	Temperature
TS	Transformer station
UTC	Universal Time Coordinated
EIA	Environmental Impact Assessment
BD	EU Birds Directive
WEA	Wind turbine
WGS 84	World Geodetic System 1984
WSA	German Water and Shipping Authority

Links

Agreement on the Conservation of African-Eurasian Migratory Waterbirds
www.unep-aewa.org/documents/index.htm

ACCOBAMS
www.accobams.org

ASCOBANS
www.ascobans.org

Birdlife International
www.birdlife.org/index.html

Bonn Convention
http://www.cms.int/documents/convtxt/cms_convtxt_english.pdf

BSH Standards
/www.bsh.de/de/Produkte/Buecher/Standard/index.jsp

Bund/Länder-Messprogramm
www.blmp-online.de/

German Federal Nature Conservation Act
http://dejure.org/gesetze/BNatSchG

Environmental Impacts of Offshore Renewable Energy Developments for the Exchange of Information (on behalf of OSPAR)
www.environmentalexchange.info

FFH Habitats Directive
http://europa.eu/legislation_summaries/environment/nature_and_biodiversity/l28076_en.htm

Helsinki Commission
www.helcom.fi/

Helsinki Convention
www.helcom.fi/Convention/en_GB/convention/

Offshore-Wind
www.offshore-wind.de

Ecological concomitant research for the first German offshore wind farm alpha ventus
www.bsh.de/de/Meeresnutzung/Wirtschaft/Windparks/StUKplus/stukplustext.jsp

Ecological monitoring according to StUK3
www.bsh.de/de/Meeresnutzung/Wirtschaft/Windparks/StUK3/index.jsp

Oslo-Paris Commission
www.ospar.org/

OSPAR Convention
www.ospar.org/content/content.asp?menu=01481200000000_000000_000000

Programme „Distance“ (Distance correction for radar devices)
www.ruwpa.st-and.ac.uk/distance/

Seabirds at Sea - Germany
www.uni-kiel.de/ftzwest/ag4/projekte/birds/sas.shtml

Seabirds at Sea - Europe
www.jncc.gov.uk/page-1547

German Marine Facilities Ordinance
www.bsh.de/de/Meeresnutzung/Wirtschaft/Windparks/index.jsp

EU Birds Directive
http://europa.eu/legislation_summaries/other/l28046_en.htm

OSPAR-Übereinkommen
www.ospar.org/content/content.asp?menu=01481200000000_000000_000000

Programm „Distance“ (Distanzkorrektur für Radargeräte)
www.ruwpa.st-and.ac.uk/distance/

Seabirds at Sea – Deutschland
www.uni-kiel.de/ftzwest/ag4/projekte/birds/sas.shtml

Seabirds at Sea – Europe
www.jncc.gov.uk/page-1547

Seeanlagenverordnung
www.bsh.de/de/Meeresnutzung/Wirtschaft/Windparks/index.jsp

Vogelschutzrichtlinie
http://europa.eu/legislation_summaries/other/l28046_en.htm