The Wozep Monitoring and Research Programme

An evaluation in light of research results and policy developments

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Contents

1	**Introduction**		**4**
2	**Evaluation**		**7**
	2.1	Birds: displacement from habitat	7
		2.1.1 Summary of research and key results	7
		2.1.2 Implications for Monitoring and Evaluation Programme	7
		2.1.3 Specific relevance for 'Vervolg Routekaart' and 'after Vervolg Routekaart'	8
	2.2	Birds: collision risk	8
		2.2.1 Summary of research and key results	8
		2.2.2 Implications for Monitoring and Evaluation Programme	8
		2.2.3 Specific relevance for 'Vervolg Routekaart' and 'after Vervolg Routekaart'	9
	2.3	Bats	9
		2.3.1 Summary of research and key results	9
		2.3.2 Implications for Monitoring and Evaluation Programme	10
		2.3.3 Specific relevance for 'Vervolg Routekaart' and 'after Vervolg Routekaart'	10
	2.4	Marine mammals	10
		2.4.1 Summary of research and key results	10
		2.4.2 Implications for Monitoring and Evaluation Programme	11
		2.4.3 Specific relevance for 'Vervolg Routekaart' and 'after Vervolg Routekaart'	11
	2.5	Fish	12
		2.5.1 Summary of research and key results	12
		2.5.2 Implications for Monitoring and Evaluation Programme	12
		2.5.3 Specific relevance for 'Vervolg Routekaart' and 'after Vervolg Routekaart'	12
	2.6	Benthos	12
		2.6.1 Summary of research and key results	12
		2.6.2 Implications for Monitoring and Evaluation Programme	13
		2.6.3 Specific relevance for 'Vervolg Routekaart' and 'after Vervolg Routekaart'	13
3	**Quality Assurance**		**14**
References			**15**
Justification			**17**

1 Introduction

The Wozep Monitoring and Evaluation Programme (Anonymous, 2016) was developed in order to enhance understanding of the ecological effects of offshore wind farms. Such understanding is needed in order to fulfil the larger Wozep goals:

- Reduce (scientific) uncertainties concerning knowledge gaps and assumptions from the Framework Ecology and Cumulation (KEC), Environmental Impact Assessment (EIA) and Appropriate Assessment (AA).
- Reduce uncertainties concerning knowledge gaps and assumptions regarding long term impacts and upscaling of OWFs (in relation to OWF plans that may follow up on the roll-out of the Energy Agreement).
- Determine effectiveness of mitigation measures (in the context of the 40% cost reduction in the Energy Agreement).

While the monitoring and evaluation plan outlines research activities for a longer period, it also aims to maintain a certain flexibility. This is in order to anticipate and/or adapt to changes in policy, but also to allow the results of planned research to affect the priorities and planning of future work.

This evaluation does just that. It evaluates the implications of the research which has been carried out so far for the plans in the Wozep Monitoring and Evaluation Programme. Furthermore, a 'Vervolg Routekaart' is being developed which will lay out plans for the further development of offshore windfarms (OWFs) in the Dutch North Sea for the period 2023-2030. Policy documents for further developments after that (2030-2050) are also in development. In this report, I will refer to these latter documents as 'after Vervolg Routekaart' . A second goal of this evaluation is to assess the consequences of the research results in light of the further growth of OWFs, as part of 'Vervolg Routekaart' and 'after Vervolg Routekaart'.

Specific documents considered in this evaluation are:

- Aarts, Geert, Jenny Cremer, Roger Kirkwood, Jan Tjalling van der Wal, Jason Matthiopoulos & Sophie Brasseur, 2016. Spatial distribution and habitat preference of harbour seals (Phoca vitulina) in the Dutch North Sea. Wageningen University & Research centre, Wageningen Marine Research, Wageningen Marine Research report C118/16, http://dx.doi.org/10.18174/400306. 43 pp.;

- Binnerts, B., de Jong, C., Ainslie, M., Nijhof, M., Müller, R., Jansen, E., 2016. Validation of the Aquarius models for prediction of marine pile driving sound. TNO report number TNO 2016 R11338.

- Dirksen, S. Review of methods and techniques for field validation of collision rates and avoidance amongst birds and bats at offshore wind turbines. 2017. Sjoerd Dirksen Ecology report number SjDE 17-01.

- Glorius, S.T., O. Bos & C. Chen, 2017. Aanbevelingen voor de voortzetting van het benthos onderzoek in de windparken PAWP en OWEZ; Op basis van een poweranalyse en literatuurreview. Wageningen Marine Research rapport C042/17

- Gyimesi, A, Evans, T.J., Linnebjerg, J.F., Collier, M.P., Rijn, R.C., 2017. Review and analysis of tracking data to delineate flight characteristics and migration routes of birds over the Southern North Sea. Bureau Waardenburg Report nr. 16-139.

- Jak, R. & S.T. Glorius, 2017. Marcobenthos in offshore wind farms; A review of research, results, and relevance for future developments. Wageningen, Wageningen Marine Research (University & Research centre), Wageningen Marine Research report C043/17

- Kastelein, R., Helder-Hoek, L., Jennings, N. 2016. Seasonal changes in food consumption, respiration rate and body condition of a male harbor porpoise (Phocoena phocoena). SEAMARCO report 2016-12.

- Lagerveld, Sander, René Janssen, Jasper Manshanden, Anne-Jifke Haarsma, Simon de Vries, Robin Brabant & Michaela Scholl, 2017a. Telemetry for migratory bats – a feasibility study; Wageningen, Wageningen Marine Research (University & Research Centre), Wageningen Marine Research report C011/17. 47 pp.

- Lagerveld, Sander, Gert Kooistra, Gerwoud Otten, Lydia Meesters, Jasper Manshanden, Dick de Haan, Daan Gerla, Hans Verhoef & Michaela Scholl , 2017b. Bat flight analysis around wind turbines – a feasibility study; Wageningen, Wageningen Marine Research (University & Research Centre), Wageningen Marine Research report C026/17. 40 p.

- Lagerveld, S., H.J.G.A. Limpens, M.J. Schillemans & M. Scholl 2017. Bat 1: Estimate of bat populations at the southern North Sea. Supporting note to ZDV report no. 2016.031 Migrating bats at the southern North Sea. Wageningen, Wageningen Marine Research (University & Research Centre), Wageningen Marine Research report no. C014.17/Dutch Mammal Society report no. 2017.08. 14 pp.

- Leopold, M.F., 2016. Seabirds? What seabirds? An exploratory study into the origin of seabirds visiting the SE North Sea and their survival bottlenecks. Den Helder, Wageningen Marine Research (University & Research centre), Wageningen Marine Research report C046/17.

- Limpens, H.J.G.A., S. Lagerveld, I. Ahlén, D. Anxionnat, T. Aughney, H.J. Baagøe, , L. Bach, P. Bach, J.P.C. Boshamer, K. Boughey, T. Le Campion, M. Christensen, J.J.A. Dekker, T. Douma, M.-J. Dubourg-Savage, J. Durinck, M. Elmeros, A.-J. Haarsma, J. Haddow, D. Hargreaves, J. Hurst, E.A. Jansen, T.W. Johansen, J. de Jong, D. Jouan, J. van der Kooij, E.-M. Kyheroinen, F. Mathews T.C. Michaelsen, J.D. Møller, G. Pētersons, N. Roche, L. Rodrigues, J. Russ, Q. Smits , S. Swift, E.T. Fjederholt, P. Twisk, B. Vandendriesche & M.J. Schillemans, 2017. Migrating bats at the southern North Sea - Approach to an estimation of migration populations of bats at southern North Sea. Rapport 2016.031. Zoogdiervereniging (Dutch Mammal Society), Nijmegen/ Wageningen Marine Research

- Snoek, R., de Swart, R., Didderen, K., Lengkeek, W., Teunis, M., 2016. Potential effects of electromagnetic fields in the Dutch North Sea Phase 1: Desk Study. WaterProof Marine Consultancy & Research BV. and Bureau Waardenburg BV, WP2016_1031

- van den Heuvel-Greve, M.J., L. IJsseldijk, C. Kwadijk, M. Kotterman, 2016. Contaminants in harbour porpoises beached along the Dutch coast; A first overview of contaminants in all age classes. Wageningen, Wageningen Marine Research (University & Research centre), Wageningen Marine Research report (Concept)

- IJsseldijk, L.L., Gröne, A., 2016. Investigation into hearing damage and life history of Dutch stranded harbour porpoises. Utrecht university, Faculty of Veterinary Medicine, Department of Pathobiology.

In addition to these publications, we will review the results of two other activities ('vogel 1' and 'vogel 2') projects, which have not yet led to concrete final reports, but are relevant nonetheless.

For clarity, these research results are separated into the same chapters used in the Wozep Monitoring and Research Programme ‘17-’21 (MRP 17-21): birds: displacement from habitat, birds: collision risk, bats, marine mammals, fish and benthos. Each subject is evaluated in 3 categories. First, a general summary of the research and key results is provided. The selection of highlighted results is not meant as a complete overview, because that is not the aim of this document. Only those results are mentioned which are relevant in the following evaluation paragraphs. The first of these evaluates the implications of research in this subject for the Wozep programme, while the second paragraph discusses implications in relation to longer-term OWF development, under ‘Vervolg Routekaart’and ‘after Vervolg Routekaart’. In this latter paragraph, only specific implications for the long-term are discussed, which have no implications for the work under the Wozep programme. Of course, all implications for the Wozep programme, are also important in relation to ‘Vervolg Routekaart’ and ’after Vervolg Routekaart’.

2 Evaluation

2.1 Birds: displacement from habitat

2.1.1 Summary of research and key results

Three studies were planned, :

1. A pilot project where the feasibility of direct counts and behavioural observation of common guillemots (*Uria aalge*) from an offshore wind turbine platform, has been postponed due to time constrains and adverse weather conditions. All preparatory work was carried out, so that there are fewer legal/technical obstacles in the future.

2. A project focused on the distribution, origin and behaviour on the Dutch Continental Shelf (DCS) of the top 10 seabirds that are perceived to be most at risk from Dutch offshore wind development.

3. An international workshop to combine and analyse data collected in various wind farms across Europe on avoidance behaviour of common guillemots. The objective was to derive the degree of avoidance, and how it relates to the location and technical specifications (number and size of turbines, configuration) of wind farms. The first phase, carried out in 2016, was to explore the availability of data and the willingness to share this data for such an analysis. This exploration resulted in the actual workshop taking place in April 2017. Statistical analysis and manuscript drafting is currently under way, and a second meeting is expected to be necessary to finalize the analyses and draft paper.

2.1.2 Implications for Monitoring and Evaluation Programme

Numbering here follows that in the previous paragraph

1. The field work which was postponed, should still be carried out. It provides a potential way to directly study, the behaviour of common guillemots in and around wind farms. If direct observation is possible, it could provide a very cost-effective way to obtain detailed behavioural information which can otherwise only be obtained from tagging studies. All logistical hurdles have already been overcome, so that the expectation is that the pilot can be carried out in the 2017-2018 winter season.

2. The results (Leopold, 2017) provide an overview of resources (data and knowledge) and as such provide the first exploratory building blocks for future seabird displacement and collision studies. The study hence fulfils its stated aims in the MRP 17-21. A concrete consequence of this work is that sandwich tern, which is not indicated as a species sensitive to habitat loss in the KEC, is now listed as a top 5 species based on the proximity of its breeding colonies to (planned) OWFs.

3. The results from the international data collation and analysis on the avoidance behaviour of common guillemots provides an important starting point for the population-level assessment of the effects of offshore wind farms on common guillemots (such as reduced survival and/or reproduction), and a blueprint for how such an analysis may be conducted for other species. Because the analysis includes the effect of configuration/specifications of turbines, it can also be used to highlight potential mitigating measures.

2.1.3 Specific relevance for 'Vervolg Routekaart' and 'after Vervolg Routekaart'

For the OWF development foreseen under the 'Vervolg Routekaart', OWF placement will occur in those areas which have already been appointed under the 'Structuurvisie'. However, for the period after 2030 additional areas will be appointed. These areas will most likely be located further offshore. This would present a novel situation where a new group of species (such as Northern Fulmar (*Fulmarus glacialis*), Puffin (*Fratercula arctica*), Little Auk (*Alle alle*), White-billed Diver (*Gavia adamsii*) become species of higher concern than they currently are (Leopold, 2017).

Of the other two studies, the common guillemot data collation (3 in the paragraph above) may give insight into the time scale on which habituation of guillemots to wind farms occurs. This is of particular interest under the 'Vervolg Routekaart', because with such large-scale developments habituation becomes even more relevant.

2.2 Birds: collision risk

2.2.1 Summary of research and key results

A review was undertaken of methods and techniques for field validation of collision rates and avoidance of birds and bats at offshore wind turbines (Dirksen, 2017). Collision detection systems are important to determine the number of bird (and/or bat) victims from wind turbines, while flux measurements are used to put the number of victims in perspective, so that a collision risk for birds/bats passing through can be established. However, flux measurements can also be used to enable mitigation based on switching off turbines during high local fluxes of birds and/or bats. While the main focus of Dirksen (2017) is on the former (quantifying collisions), the results have relevance for the latter point (mitigation) as well.

The study on the distribution, origin and behaviour on the Dutch Continental Shelf (DCS) of the top 10 seabirds that are perceived to be most at risk from Dutch offshore wind development (Leopold, 2017) is also highly relevant for bird collisions in relation to the 'Vervolg Routekaart', even though it was commissioned within the framework of habitat loss. For 6 out of the 10 species studied, the main risk comes from collisions rather than displacement

Furthermore, a review and analysis of tracking data (Gyimesi et al, 2017) was conducted to delineate flight characteristics and migration routes of birds over the Southern North Sea. This led to reduced estimates of collision figures for Bewick's swan (60% lower) and Brent goose (6% lower). For great black-backed gulls, the result was mixed, with a 10% reduction based on one set of data, but an increased number for another data set. For great skuas, the data obtained was considered so unrepresentative that no further calculations were made.

Gyimesi et al (2017) further showed that many studies on GPS tagging on the relevant species are currently under way. The data from these studies is not yet available, but should be in the coming years. Furthermore, this report makes a plea to expand the study of collision using GPS transmitters to a wider array of species, namely waders, land birds and seabirds which should be caught within or near existing wind farms.

2.2.2 Implications for Monitoring and Evaluation Programme

The information summarized in the review on flux and collision measurement systems highlights that there is a large diversity of systems available, each with its own strong and weak points. The overview provides RWS with the necessary information to make an informed decision about which (if any) combination of flux and collision detection systems to invest in, and prevents RWS from investing in developing something which already exists elsewhere.

In order to prevent collisions of seasonally migrating species which are present in high numbers during relatively short time intervals and/or only at specific weather conditions, predictive models for the abundance of such birds can be developed. Using these models, turbines can potentially be stopped in anticipation of peaks in the presence of vulnerable species. Such predictive methods require radar observations and meteorological data from constructed OWFs. Dirksen (2017) can provide guidance in choosing flux measurement systems to collect data in support of such models This is also relevant for migrating bats.

The updates of the numbers of collision victims based on new data in Gyimesi et al (2017) mostly show that there is a lot of variation in the data, which leads to uncertainties in current estimates. Therefore, the value of additional data collection is highlighted. The advice to widen the scope of the work in terms of species is very valid, but before (expensive) GPS tagging studies are conducted, a reconsideration of the most important species to study should be made. This reconsideration should not only focus on what is technically possible, or which species 'seem vulnerable', but also on to what extent each study contributes to obtaining policy-relevant results, and at what cost. This may lead to different choices then would be made on purely ecological grounds.

2.2.3 Specific relevance for 'Vervolg Routekaart' and 'after Vervolg Routekaart'

The importance to understand and the capacity to mitigate effects of OWF bird collisions becomes even more pressing as the projected development of OWF is scaled up further.

Further implementation of OWF (beyond 2030) will most likely involve OWF development in hitherto unconsidered locations (for example on the Dogger Bank and other offshore areas).

The need for new data collection on collision estimates and collision risk which is relevant for the MRP 17-21, is of course equally (if not more) relevant in relation to OWF development beyond 2023.

The focus in the current research is restricted to the species which are in the 'top 10' for being at risk, based on earlier work for the KEC. In the current situation, this covers the species for which the KEC (Anonymous, 2016) calculates the highest PBR estimates, and which are consequently assumed to bemost at risk. With further development of OWF beyond 2023, the list of species at high risk is likely to grow so that the range of relevant species will also grow. This is partly because after 2030 new areas will be appointed for OWF, but also because increasing cumulation of the various OWF developments in already appointed areas may mean that a longer list of species will be projected to suffer significant population effects.

2.3 Bats

2.3.1 Summary of research and key results

A substantial research effort has been made into the effects of offshore wind on bats. Limpens et al (2017) focused on determining the geographical origin and relevant (sub)population size of Nathusius' pipistrelle (*Pipistrellus nathusii)* which migrates over the Southern North Sea. The study estimates that roughly between 100 – 1,000,000 (with an intermediate of 40,000) individuals of the Nathusius' pipistrelle migrate over the southern North Sea. This is a very rough estimate, and the large interval (4 orders of magnitude) is mostly because it is based on a compilation of expert opinion, in which different uncertainties cumulated. This uncertainty is larger than what the authors expected a priori.

Two other studies were conducted. Lagerveld et al (2017b) developed methods to record individual bat behaviour (3D flight path) around wind turbines, using a combination of thermal imaging cameras and 12 bat detectors. This project has developed promising technology, but will need a substantial investment on two fronts: software needs to be developed for automated 3D-tracking of bats when they enter the surveyed airspace, and the installation must be constructed to be offshore-proof. Lagerveld et al (2017a) focused on bat radiotelemetry, as a tool to determine migratory pathways and large-scale dispersive/migratory behaviour at sea. A substantial improvement on existing methods was reached, using a largely automated setup for data acquisition and processing.

2.3.2 Implications for Monitoring and Evaluation Programme

The large uncertainty in the assessment of the relevant population size cannot be further reduced by using the same expert consultation methods. The biggest problem is lack of data in other (mostly Eastern-European) countries. To determine the number of bats that migrate over the North Sea, alternative approaches will have to be used. These should consist of direct measurements of numbers of bats arriving on the coast and numbers of bats actually migrating over the Southern North Sea, plus an estimate of the collision risk for those individuals that do migrate. This information, combined with general life history rates of the species (from literature) could be used to conduct an estimate of the population-level effect of OWF development, even in absence of a population estimate.

Given the costs and uncertainty regarding the development of the thermal imaging camera technology, it seems wise to take a 'small step' approach to its further development, where each step is a limited investment, and is followed by an evaluation to consider what, if any, the next steps should be. It is advised that the focus of further research should be on radiotelemetry and bat detectors. Using this combination, it will be possible to determine the importance of migration, but it will be very difficult to assess collision risk. This is directly limiting for the applicability of the results of Wozep bats. One possibility is to use the thermal camera system on land, and extrapolate mortality rates from land to offshore turbines. This would be substantially cheaper than to develop an offshore-proof system. However, even the costs of this application extend beyond the capacity of Wozep. Hence, it is recommended that alternative funds are looked for in order to facilitate this development.

2.3.3 Specific relevance for 'Vervolg Routekaart' and 'after Vervolg Routekaart'

Because of the current lack of knowledge regarding the population-level importance of migration across the North Sea, specific relevance for 'Vervolg Routekaart' and further (beyond 2030) cannot be distinguished from general relevance to the MRP 17-21.

Mitigation techniques?

2.4 Marine mammals

2.4.1 Summary of research and key results

Five studies were conducted in 2016.

Binnerts et al (2016) gives an overview of the strengths and weaknesses of 3 variations of the Aquarius propagation model and gives recommendations for the improvement of these models. The most promising improvement of these models, as recommended by the authors, would be a better representation of the effects of sediment and wind.

Aarts et al (2016) show that harbour seal distribution in the Dutch North Sea is concentrated near the haul-out sites in the Wadden Sea and Southern Delta areas, with areas further offshore visited less frequently. This is partly a 'concentration effect' because all seals that use haul-out sites are concentrated in relatively small areas, and the paths between these and the foraging areas therefore have an extremely high abundance. However, this should not be taken to imply that other areas are unimportant: the paths are necessary, but not sufficient for the seals' survival, as they provide access to feeding locations, but not the food itself.

The report on harbour porpoise energetics (Kastelein et al, 2016) provides important data on the named variables. This provides a baseline understanding of harbour porpoise energetics, which is needed to contrast with further studies into the effects of fasting or noise exposure on energetics under different conditions (i.e. juvenile/fully grown individuals, water temperature).

Van den Heuvel-Greve et al (2016) show that stranded harbour porpoises suffer from high levels of contaminants. The levels found can affect both the reproduction process and the immune system of harbour porpoises, even in the very early life stages.

2.4.2 Implications for Monitoring and Evaluation Programme

Having an adequate representation of the propagation of pile driving noise (and how it changes as it propagates) is crucial for determining population-level effects on marine mammals. The current report compares measurements and model output. The 'mismatch' between these two is a measure of the uncertainty regarding exposure of animals at certain distances (but note that exposure does not equal impact, which depends on frequency weighing and other factors). The strengths and weaknesses of the models in Binnerts et al (2016) are of a technical nature (related to their accuracy and computational efficiency). To what extent these differences between the models (and their proposed improvements) are relevant for the projected population-level effects on affected biota remains unclear. It is recommended that this should be prioritized in further work. Such work should focus on the spatial arrangement of functional habitats (e.g. foraging areas, migration routes, etc.), and the combination of sound exposure and frequency weighing (frequency-dependent hearing sensitivity).

In determining the effect of pile driving on seals, it is important not only to look at the 'footprint' of the piling on the seal distribution map, but to consider the barrier effect of pile driving to migration between haul-out and feeding sites.

The report on harbour porpoise energetics (Kastelein et al., 2016) provides data for further analysis. This data can be used to parameterize a (simple) energy budget model of harbour porpoises, which can then be used to predict effects of starvation. A future experimental study on starvation can then be used to validate and refine the energy budget model. This appears to be in line with current plans.

The high levels of contaminants in harbour porpoise, in the range where harmful physiological effects are possible, is a highly relevant finding. Porpoises have a high metabolism and need to eat frequently. When noise from pile driving induces long periods of flight behaviour during which animals do not feed, this can lead to emaciation, and emaciation can lead to poisoning when fat reserves (blubber) are used which contain high levels of toxic contaminants. The levels of contaminants found in stranded porpoises are sufficiently high that this effect should be incorporated in the work on weight fluctuations following periods of starvation in porpoises, which is planned in the Wozep Monitoring and Evaluation Programme.

A study on hearing damage in porpoises stranded along the Dutch coast showed that out of 10 specimen which were fresh enough to analyse the ears for signs of damage, 3 individuals had probable damage, of which one was potentially related to sound exposure, although other causes could not be excluded.

2.4.3 Specific relevance for 'Vervolg Routekaart' and 'after Vervolg Routekaart'

The sound propagation study (Binnerts et al, 2016), the harbour porpoise feeding and respiration study (Kastelein et al, 2016), the contaminant study (Van den Heuvel-Greve et al, 2017) and the hearing damage study (IJsseldijk & Gröne) have no specific consequences for the 'Vervolg Routekaart' and 'after Vervolg Routekaart' (not different from the current 'routekaart').

Harbour seal abundance can be very high near shore, especially near the Wadden Sea and Southern Delta areas. Based on overlap with harbour seals, it is hence preferable to find new space for OWFs further away from the coast.
Is verdere mitigatie van geluidsproductie mogelijk via nieuwe innovatieve technieken als Blue Piling?

2.5 Fish

2.5.1 Summary of research and key results

Work on fish was limited to a study reviewing the potential effects of electromagnetic fields (EMFs; Snoek et al, 2016) on marine animals. The conclusions were that EMFs, generated by the cables (to be) used on the DCS, can most likely be perceived by some of the species living there. Furthermore, it is concluded that it is unclear, but not unlikely, that these EMFs also affect (for example, behaviour and feeding success of) the individuals of sensitive species when they encounter them. EMFs are local phenomena, around electric cables. However, there are many cables associated with the planned Dutch OWFs, which scales up the potential effects.

2.5.2 Implications for Monitoring and Evaluation Programme

Given the large uncertainty, it is most logical to take a step-wise approach. The next two steps should be to 1. measure EMF strength around cables currently present on the DCS, which are relevant for those used in the future, and/or collaborate with owners of existing OWFs to obtain existing data. 2. use these measurements to create small-scale lab experiments where sensitive species (for example elasmobranchs) are exposed to these fields. The objective would be to measure if the animals can detect the fields, and if so, what their (behavioural) response is.
If these experiments would show potential effects of EMFs on sensitive species, it is important to start considering potential mitigation measures. It may be that these measures can be implemented at relatively little cost. Only if mitigation turns out to be expensive or impossible, further studies into the effects (focusing on population-level effects) should be conducted.

2.5.3 Specific relevance for 'Vervolg Routekaart' and 'after Vervolg Routekaart'

There is no specific relevance of the EMF work to 'Vervolg Routekaart' and 'after Vervolg Routekaart'.

Nice to know: Hoe staat het met de visfauna tussen de palen in OWEZ en PWAP 12/13 jaar na sluiting van het gebied voor bodemberoerende visserij? Vanuit perspectief windparken minder interessant. Vanuit perspectief effect van gesloten gebeid voor visserij wel. Samenwerking met VIBEG?

2.6 Benthos

2.6.1 Summary of research and key results

A literature survey of realized and planned wind farms (Jak et al, 2017) showed that there is a trend towards deeper and more offshore waters. If this trend continues, the existing studies on the effect of OWF on soft sediments will lose relevance, as they are all conducted in relatively nearshore, shallow areas. The review also showed that these effects, if at all, occur on the long term. After 5 years, effects are still small and subtle. However, it is not unlikely that 5 years is simply too short. On hard substrate, a clear and stable vertical zonation is observed along the turbines, independent of the location of the OWF. However, the succession (species replacing one another) going on is not finished, and therefore 'final' biodiversity on the OWF-related hard substrate cannot yet be assessed.

A reconsideration of the hard- and soft substrate sampling in the Dutch wind farms PAWP and OWEZ (Glorius et al, 2017), now 10 and 12 years after installation, concluded that a re-sampling of these areas would be very valuable. However, the boxcore monitoring of the soft substrate was deemed inefficient and was advised against. Monitoring of the soft substrate was carried out, but only in PAWP. Results are not yet available.

2.6.2 Implications for Monitoring and Evaluation Programme

The recommendations to resample PAWP and OWEZ was followed, but only in PAWP and its reference areas. The survey design was adapted to maximize contrast between fished (reference) and unfished (OWF) samples. This will yield a unique data set in terms of 'time after closure'. It is recommended to use not only a species- but also a body size and a biological traits approach in the analysis of this data.

2.6.3 Specific relevance for 'Vervolg Routekaart' and 'after Vervolg Routekaart'

When OWFs are to be built on more offshore and deeper locations, Jak et al (2017) has shown that the existing work on soft substrate effects become less relevant, because they are from nearshore, shallow locations. Such a movement offshore is expected under 'after Vervolg Routekaart'.

Nice to know: Positief effect. Hoe heeft de benthosgemeenschap en visgemeenschap nabij de palen van OWEZ en PAWP zich ontwikkeld na 12/13 jaar.

3 Quality Assurance

Wageningen Marine Research utilises an ISO 9001:2008 certified quality management system (certificate number: 187378-2015-AQ-NLD-RvA). This certificate is valid until 15 September 2018. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V.

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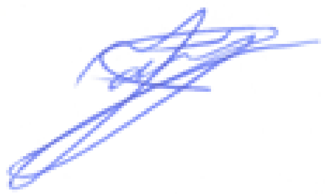
Justification

Report C084/17
Project Number: 4315100056

The scientific quality of this report has been peer reviewed by a member of the Management Team of Wageningen Marine Research.

Approved: Drs. Jakob Asjes
Manager Integration

Signature:



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