Danish Off Shore Windpower Programme

International Advisory Panel of Experts on Marine Ecology (IAPEME)

Statement from meeting in September 2004

ABBREVIATIONS

Abbreviations:

ABC:	Statistical method
BACI:	Before/After Control/Impact
COWRIE:	Collaborative Offshore Wind Research Into the Environment
DIFRES:	Danish Fisheries Research
GIS:	Geographical Information System
NERI:	National Environmental Research Institute
PRIMER:	Plymouth Routines In Multivariate Ecological Research
TADS:	Thermal Animal Detection System
T-POD:	(towed) Porpoise Detector

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Prepared by:
IAPEME and Secretariat

Secretariat of IAPEME
Danish Forest and Nature Agency
Haraldsgade 53
DK-2100 Copenhagen Ø

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PREFACE

Due to the special status of the Danish off shore windpower programme a measurement and monitoring programme is conducted to investigate the effects on marine ecosystems before, during and after erections of wind farms. So far baseline studies have been made and monitoring has taken place during the construction phase of the farms at Rødsand and Horns Rev, respectively. The farms are now in operation and continued monitoring takes place at the moment.

In relation to the programme the Danish Energy Agency in November 2000 appointed five international experts to the International Advisory Panel of Experts on Marine Ecology – IAPEME.

The members are
Professor Rudi H. Drent, University of Groningen, NL
Professor Robert W. Furness, University of Glasgow, UK
Professor Klaus Lucke / Professor Ursula Siebert, University of Kiel, DE
Professor Antony Jensen, University of Southampton, UK
Assistant Professor Peter Grønkjær, Århus University, DK

The task of IAPEME is to comment on the environmental measurement and monitoring programme before, during and after erection of wind farms and assess the methods used in these programmes. Moreover it is the task of IAPEME on the basis of the documented results from the programme to comment on the impacts of the wind farms on birds, mammals, fish and benthos ecosystems as regards among other things noise, electric fields, disturbance and loss of habitats.

This report contains the statement from the fourth meeting of the International Advisory Panel of Experts on Marine Ecology, September 2004.

The Secretariat of IAPEME is placed in the Sea and Habitats Division, the Danish Forest and Nature Agency. Contact persons are Anne Grethe Ragborg and Karen Christensen.

Secretariat of IAPEME

1. GENERAL CONSIDERATIONS

Excellent progress has been made in the environmental monitoring programmes. There is no doubt that much of the research being carried out is world-leading science. We encourage the continuation of these programmes, and the comments we make in this report are of a relatively minor nature in the context of a very effective ongoing programme.

The panel recognises that many of its previous recommendations have been incorporated into the Environment Group's recommendations for environmental monitoring programmes. We feel that the changes that have been implemented have strengthened the overall programme, but we are aware that the basic philosophy of all of the monitoring is to use a BACI approach. By its very nature, a BACI design requires complete comparability of methods between the 'before' and the 'after' phases of the data collection. We therefore would wish at this stage to avoid recommending changes to the programme that would detract from this comparability. We also recognise the need, and legal requirement, to complete adequate assessment of the 'post-construction' situation in order to be able to take into account year to year variation in environmental conditions, and we strongly support the view that it is essential to collect data over several years to best account for the high variance typical of natural systems.

We were impressed by the success of the International Conference 'Offshore Wind Farms and the Environment' and the large numbers of people attending this meeting from a wide range of countries. We encourage attempts such as this to share expertise and avoid duplications of research. We especially encourage efforts to develop international collaborations to progress particular parts of the current programme beyond 2006 where important objectives are still to be met. The overwhelming interest shown by the neighbour states (more than one hundred participants, i.e. more than half) is a clear sign of the importance of the free exchange of ideas and techniques at this stage. Denmark has achieved a leading position not only in engineering and construction but also in ecological investigations in the demanding environment of the offshore environment, and thought should be given to the format of the final publications.

We would encourage the Environment Group to consider some further steps for getting the maximum benefit from the work carried out. We suggest that preference be given to producing a book to make the results available in a readily accessed form of interest to the scientific community and to a wider readership. This would require allocation of funds for book production, identification of an Editor, and arranging with contractors that preparation of a chapter for the book would be an integral part of the remaining research budget and programme. Contractors would require as much warning as possible of this if it were to be taken forward. We would envisage chapters being based on Final Reports, but obviously requiring a different format and therefore extra time for preparation. We also recommend that contractors are encouraged to publish main results in international scientific journals. This would give much wider dissemination of the programme. At present, wind farm research rarely reaches international journals as outputs are mainly in the form of reports that are not widely available. Again, contractors would require time

built in to their contract to achieve completion of scientific manuscripts, as this cannot be considered a trivial activity. But we feel that such outputs may be more useful than, for example, yet another annual report. It must be borne in mind that the credibility of the final product depends on publications in peer-reviewed scientific periodicals. A possible avenue worth exploring is to collect the papers in a special issue or supplement to the journal Wildlife Biology, a respected international organ with chief editorship in Denmark. In this case the collected scientific papers could function as a companion volume aimed at a more specialised readership than the book.

2. BIRDS

2.1 Recommendations:

- The bird work is generally progressing well, and programmes should be continued through 2005 to allow better assessment of annual variations, any habituation effects and influences of changes in food supply caused by the structures
- Since we have consistently identified the measurement of bird collision rate as a top priority, it is a matter of concern that it has not yet proved possible to develop systems that are cost-effective and statistically reliable. We recommend that consideration is given to possible international collaborations in the development of TADS and other novel approaches to detecting collisions, aiming to use possible sources of additional research funding from other countries (such as the UK COWRIE fund) or internationally. If possible such funding could ideally be used to continue this work at Nysted, where there is such good information on bird movements
- Continue radar observations of the directions of movement of birds and deflections of path caused by wind farms as part of the better estimation of risk through modelling. At Horns Rev a technical solution should be found to enable radar surveillance of the full arc, since the 'blank section' coincides with the sector of arriving (autumn) or departing flocks.
- Continue aerial counts at Horns Rev
- If possible, examine links between scoter distribution near Horns Rev wind farm and food availability, such as *Spisula* or sandeel by improving the links between bird distribution analysis and the sandeel/*Spisula* survey work, to tie in with diet analysis of scoters in that area (envisaged for 2004 and as we understand now poised for action)

2.2 Introduction

Wind farms might affect birds by increasing mortality rates through collisions, by disturbance of birds from feeding habitat, or by altering the amount of feeding habitat. Large wind farms may also produce a barrier effect, deflecting bird movements away from their intended tracks. Of these potential effects, collision risk is likely to have the greatest long-term impact on bird populations, so requires priority consideration. Birds may learn the hazards presented by marine wind farms, so that impacts may change over time as birds gain experience. This is particularly relevant when adult survival rates are high, as in seabirds and sea ducks, many of which may live for 20 years or more.

2.3 Collision risk

The development of a technological solution to observing collisions between birds and turbines has progressed, but has been constrained by the difficult environment in which the equipment must be used, and by cost. The Thermal Animal Detection System (TADS) has shown promise, but as we pointed out last year, a single camera is likely to record very few 'hits' even when optimally placed. Collision risk is likely to vary according to weather conditions, possibly being extremely low under normal conditions but much higher in foggy conditions, and we feel that it

will be worthwhile to continue with the deployment of the TADS for 2005 even though the chances of recording collisions will be low. Evidence from radar and direct observation suggests that birds generally perform rather well at avoiding turbines, but there is a real need to measure collision rates rather than depend on risk models that may provide rather inaccurate assessments of numbers of birds that may be killed. For example, the Scottish Natural Heritage collision model (based on rather limited data) estimates that red-throated divers may be killed in numbers that would be significant to population dynamics (due to their fast and direct flight and inability to turn quickly), whereas the empirical studies of movements suggest that red-throated divers never enter the wind farm as a result of strong avoidance behaviour so that collision rate may be very much lower than the SNH model estimates. It is now clear that it will not be possible within the present programme to achieve accurate measurement of bird collision rates, but progress in the development of technology to do so has been considerable. We feel that it is essential that technological development is continued. But that will require external funding. It would be optimal to gather the necessary resources from a variety of other national and international sources (perhaps from sources such as the UK COWRIE fund) with the aim of completing this work at Nysted, where there is already so much information on bird movements and where there are particularly large bird numbers, and where NERI has much accumulated experience.

We support the view that radar studies of bird movements should be continued in relation to assessment of the movement responses of birds to the presence of wind farms and in the assessment of collision risk.

We would encourage consideration of the possibility to make direct observations of the behaviour of birds within wind farms (probably more relevant at Nysted than at Horns Rev) from the viewing platforms available. This could provide a better understanding of how birds move and forage within the wind farm (especially species being attracted into wind farms such as cormorants), and how disturbance of birds within the farm might contribute to collision risk (which would complement the studies focusing more on the risk to birds approaching the farm from a distance).

2.4 Impacts on the habitat of birds

We recommend continuing aerial counts at Horns Rev, especially in view of the unexpected year to year changes in scoter distribution that presumably relate to food supply and not to any effect of wind farm, but which complicate analysis within a BACI design.

We note the numerical importance of the scoter population near Horns Rev, and we encourage studies to examine the possibility that scoter distribution in the areas near Horns Rev wind farm relates to diet, especially in spring. This could best be achieved by sampling scoter stomach contents and by forensic markers of diet such as fatty acids and stable isotopes, and by GIS comparisons between scoter spatial distribution and data on spatial distribution of sediment types, *Spisula* and sandeels.

We regard the follow-through on diet studies as a vital step in interpretation of the observed spatial pattern of foraging scoters. The avoidance of the wind park zone by scoters might be explained if there was a lack of suitable food, but the invertebrate survey data suggest that

suitable food organisms (e.g. *Spisula*) are present at moderate density. If the avoidance is due to the turbines and associated human activity, that is potentially a serious infringement of bird habitat at a critical time of year, especially in view of the intended extension of the wind park on Horns Rev as recently called for tender by the Danish authorities. The increased boat traffic and helicopter disturbance associated with the wind farm are believed to be contributory causes for avoidance by the birds and this point calls for quantification (weekends compared to weekdays etc).

3. MARINE MAMMALS

3.1 Recommendations:

- Continuation of the aerial counts of harbour seals at Nysted and adjacent areas
- Reduced effort regarding the seal video camera survey at Nysted – alternative improvement of the camera system for studying additional aspects
- Intensification of the the seal telemetry study at Horns Rev with substantial technical additions (double-tagging)
- Continuation of seal telemetry studies at Nysted has lower priority
- Continuation of studies on habitat use by harbour porpoises at both sites
- Continuation of surveys on harbour porpoise distribution at Horns Rev

3.2 Seals:

The aerial counts at the Nysted area have yielded valuable information on the stock size and distribution of the seals on the different sandbanks. Even though significant changes in the seasonal proportion of seals at Nysted could be documented, it remains unclear whether the chosen parameters are enough to draw a conclusion about the impact of the construction activities and the presence of the windfarm on the local Nysted population. For example it might provide more information in this regard to look closer at the pup production at the different sandbanks as this could be a more sensitive indicator of disturbances to the animals. In order to better identify the effect of general trends in the distribution of the seals with respect to the different sandbanks in the area the aerial counts should be continued during the remaining study period.

The video monitoring at the Nysted sandbank was most important during the construction phase of the windmills. However, conclusions on the overall effects of the construction activities should – based on the available information – still be drawn more carefully. It seems possible to reduce the effort in this study for the forthcoming seasons as such detailed information about the continuous use of this sandbank by the animals will presumably not increase the declarative strength of the information gathered by aerial surveys.
Only by increasing the optical resolution of the video camera system could additional information on the behaviour of the animals be collected. This information along with data on the individual distances of the animals under differing stress situation could provide valuable information about the effect of the windmills as well as other sources of disturbance. Alternatively photos taken during the aerial surveys should be investigated for differences in the distance between individuals in differing situation.

The likelihood to succesfully catch and equip seals with telemetry devices at Nysted without excessive disturbances seems to be very low. At the same time these efforts have proven to be more effective at Horns Rev. However, the number of animals tagged at both sites remains rather low to come to final conclusions about the impact of the construction and presence of the windmills. In order to evaluate these effects it is necessary to collect more detailed behavioural

data. The only applicable method for this purpose seems to be the combined use of satellite transmitters and data loggers that record activity pattern including diving. Others studies have shown that this method is applicable and yields detailed behavioural data. We therefore recommend to incorporated this into the design of the ongoing study at Horns Rev. The IAPEME welcomes the combined efforts between the University of Kiel and Danish colleagues in recent seal catches. In order to reap the benefits of this cooperation additional tags should be purchased for 2005 (new tags to accompany the satellite devices already in hand). Intensive collaboration in the data extraction and analysis will be required but the Kiel group is eager to help in this respect. Building on the success of the June 2004 meeting in Büsum, Germany we hope the Danish colleagues will convene a similar workshop to finalise data analysis and further discuss continuing improvement of methodology.

3.3 Porpoises:

The results from both the visual and the T-POD study resulted in contrary findings during the construction phase at both windfarm sites. In addition the acoustic and visual method revealed differences in the habitat use at windfarm area at Horns Rev during the construction phase. It remains unclear whether these differences are density dependent or potentially reflect a general difference in the use of the investigated habitat by the populations at both sites. In order to allow for a conclusion on the potential effects of the construction activities it would be useful to analyse the existing data in greater detail. Emphasis should be placed on information relating to encounter rates and waiting time during different weather conditions while construction was in progress. Any conclusion about the impact of the construction and presence of the windmills should also be drawn in relation to all available data on a bigger scale.

Both the T-POD information on the habitat use as well as the distribution of harbour porpoises at Nysted and Horns Rev are crucial for the analysis of the potential impact. The currently available data are not sufficient yet to finalize the evaluation process. In this context it seems essential to continue the ongoing acoustic and visual studies at both sites in 2005 and avoid any methodological changes during the remaining study period.

Specifically we feel there are still gaps in our approach (habitat use, criteria of habitat selection, food requirements, behaviour responses to the windpark and associated activities, basic acoustic data). In future there is a great need for more international collaboration in this labour intensive area.

4. FISH

4.1 Recommendations

- Continue sandeel survey at Horns Rev in 2005
- Perform acoustic survey to monitor pelagic and semi-pelagic species such as herring and sprat inside and outside the windfarm area at Horns Rev
- Carry out fishing with research gill nets and fyke nets directly on the cable trace to get conclusive evidence that the fish approach and cross the cable
- Carry out acoustic tagging of eels in order to verify the migration pattern of this species around the cable trace.
- Reduce the effort related to the use of directional pound-nets in order to accommodate the increased effort on gill netting and acoustic tracking.

4.2 Introduction

Studies of the effect of offshore windmills on the fish fauna conducted during the last reporting period have included the construction, post-construction and the initial operational phase. The fish related studies have focused on sandeels at Horns Rev and on the effect of the cable trace on the migrations of fish at Nysted. At both sites the species composition of fish fauna associated with the hard substrate have been analysed. Consequently, before-after comparisons are now available for the effect of the windfarm construction on sandeel abundance and distribution and to some extent also for the studies of the fish migration across the cable trace at Nysted.

The recommendation regarding studies of fish associated with the hard substrate is found in the “Benthos and Hard Substratum” section.

4.3 Horns Rev

A sandeel survey at Horns Rev has been carried out during the operational phase of the windfarm and complements a similar study from 2002. The design of the study was changed according to the suggestions from the IAPEME but these changes have not precluded the use of the BACI approach. The study shows a marked increase of sandeel in the impact area and the BACI analysis does not suggest that the presence and operation of the windfarm has had any negative effect on the sandeels in the area. Pronounced changes in the size and species composition from 2002 to 2004 were recorded both at the control and impact sites and, consequently, these changes are not believed to be related to the presence of the windfarm, but rather reflect the general recruitment pattern of sandeels (or failure thereof).

A similar sandeel survey should be performed in 2005 in order to evaluate the effect of an operational windfarm on the recruitment to the area, and to evaluate the temporal stability of the sandeel abundance pattern.

Sandeel abundance data should be analysed on a length (or age) specific basis in order to determine the influence of recruitment relative to other influences on the abundance. This may

also yield information of differences in mortality of sandeels in the control and impact area. An acoustic survey of pelagic and semi-pelagic species during summer or early autumn would be valuable to evaluate the effect of the windfarm on the presence of juvenile herring and sprat.

4.4 Nysted

The fish studies conducted in order to evaluate the effect of the cable trace on fish migration do not indicate that the cable represents an obstacle to migration. In general the results obtained in 2002 before the cable was put into use do not differ from the results from the operational phase in 2003.

However, the experiments are not conclusive and should in 2005 be extended with studies directly aimed at evaluating the behaviour of target species when approaching the cable. This should be performed by employing research gill nets and fyke nets directly on the cable and at a control site positioned at a short distance from the cable (ca. 50 m). The nets should be held in place using a methodology that does not necessitate the use of anchors. Small concrete weights placed on the sediment should be used instead to ensure that the cable is unaffected. Catches of fish in the nets directly above the cable will show that fish do approach and cross the cable, and the control site catches will yield further information on the abundance of fish at the cable trace compared to an unaffected site.

Further, acoustic tagging of, in first place, eels should be performed to evaluate the small scale (10-1000 m) migration pattern of this species and verify that eels cross the cable. The technology and experience with this approach is available at DIFRES, Silkeborg and at Fiskeriverket in Sweden. Such an investigation will yield conclusive evidence with regard to the effect of this type of cable on the migratory behaviour of eels and possibly other relevant species.

5. BENTHOS AND HARD SUBSTRATUM

5.1 Recommendations:

- The Horns Rev infaunal survey be continued in 2005
- The Horns Rev epifaunal and fish survey be continued in 2005
- The Nysted infaunal survey scheduled for 2005 is undertaken
- The Nysted epifaunal and fish survey is continued in 2005

In all cases the sample collection and data analyses should be reviewed in the light of the now reported techniques used by other groups in 2003. Modifications should be made to ensure comparability between projects, with the proviso that between year comparability is maintained. One of the themes coming out of the 2004 conference was the need to produce comparable, sharable data and it would be a shame if this was not seen to be a positive outcome of all the sampling work described in the final report.

Where similar data are being collected by different groups and an amalgamation of these data would provide information beneficial to the understanding of the impact of the wind farms these data MUST be shared and developed for the overall benefit of the project.

Use of the proposed acoustic fish monitoring system should be considered carefully and used only when it will make a real contribution to the information describing the biological community around the scour protection. The lack of species identification and the inability to follow animals into the scour protection are significant drawbacks to the technique. Fish presence around the scour protection may be better studied by divers and nets and/or acoustic telemetry than echosounder. The echosounder may be better suited to show sandeel activity and abundance within the windfarm site.

5.2 Infaunal Survey – Horns Rev

The infaunal survey is one in a series of surveys to highlight any changes in the sediments and infauna during construction and operation activities at this site in comparison to a baseline survey. Overall these surveys are sound and the work should continue in 2005 to provide a second year of data under an operational regime, to provide data that will follow changes in the fauna and sediment within the wind farm site and in the reference area. The report of the 2003 field sampling provides a good overview of the infauna and shows that changes are happening apparently independently of the wind farm activity. However consideration of the analytical techniques used is needed to ensure that the field samples yield as much useful information as possible.

The sampling methodology is appropriate for a survey of this nature in an obviously dynamic environment, focused on detecting large scale changes rather than identifying and explaining subtle alterations in the fauna and sediment.

The use of wet weight in biomass estimations is not as usable in analysis as dry weight would be, purely because wet weight estimates are subject to a greater element of error than dry weight. Dry weight estimates would be more representative and would facilitate comparison of the data with other relevant infauna datasets. Biomass data could be further analysed to allow the visualisation of an environmental stress level (using something like the ABC routine in PRIMER) between sites and temporal data could provide a valuable insight into infaunal community changes independently of the reference site. If the infaunal samples from 2003 and previous studies are still available it may be worth providing dry weight biomass and visualising an infaunal community stress indicator through time in the final report. Otherwise the 2004 field samples should report both wet and dry weights and consider the use of an analytical technique such as ABC.

One of the reasons for surveying the infauna is that they are sedentary, or of very limited mobility and so community structure reflects the environmental conditions experienced within the sediments as the fauna is unable to relocate. Mixing sediment surface dwelling epifauna (albeit dwelling on surface stones) and mobile fauna (such as hermit crabs) in with the infaunal data may dilute the clarity of the infaunal analysis. This needs serious consideration when preparing the 2004 field sampling analysis and final reports.

5.3 Epifaunal and fish survey

It is heartening to see an epifaunal community developing after the initial assumption, based on the winter sandblasting of the monitoring tower, that Horns Rev scour protection epifaunal communities would be minimal. The survey techniques used are developing a useful and informative data set relating to the epifauna and fish communities present on and around the scour protection. The level of data gathering and analysis is sufficient to show what is happening at the site and the survey should be continued in 2005. The level of effort that should be applied to expanding the fish data needs to be carefully considered for 2004 so that appropriate data are collected. The number of species and their use of the scour protection (both as habitat/shelter and as food source) would appear to be important in providing an initial assessment of the biological use of the scour protection. To do this video surveys and diver fish counts could provide qualitative data on presence/absence and use whilst research gillnets would provide stomach contents and size frequency data for some species. The benefit of adding acoustic techniques (echosounder and/or fish tag) to this approach needs to be assessed and the quality of data that would be generated in terms of fish species and size and interaction with the scour protection evaluated carefully for benefit to the scour protection dataset.

5.4 Nysted epifaunal and fish survey

In a similar fashion to the Horns Rev survey this work is very important as it describes the biological utilisation of the scour protection and concrete foundations in a unique environment. The ability to use such data in comparisons with other sites (as well as Horns Rev) in the future will be of value. The survey work should continue in 2005. Development of survey work to investigate the diet of cormorants roosting on the foundations should be undertaken, along with research gillnet deployment, to establish if the scour protection may be providing food for fish and whether those fish are in turn prey for the birds. The chance to use very similar techniques to those at Horns Rev should be taken. Consideration of the suitability of the proposed acoustic

methods to deliver the fish data required by the needs of the demonstration project should be carefully made, and use of other techniques, such as acoustic tagging of individual fish, assessed.

5.5 General comments

Consideration needs to be given to data sharing between survey groups within and between the two wind farm sites. In addition workers should ensure comparability within the work being conducted at both sites. For example, sediment samples are being taken within the Horn Rev wind farm by the benthic biologists and outside the farm by the sandeel survey. These data should be combined in the final report to provide an overview of the sediment changes over time, and so comparable data analysis is required. Data may be of use in modelling the areas most likely to contain *Spisula* and therefore play a role as feeding habitat for scoters.

Similarly the epifaunal surveys are using sampling protocols that differ in some regards; this may not be a problem for comparability but serious thought should be made by the biologists to ensure that datasets from each site can be compared effectively. Differences in sample gathering technique and data analysis could be modified from the 2003 methodology to ensure comparability with the 2004/5 sample collection and data analysis, with the proviso that the modifications are not so radical as to prevent comparison with 2003 data from that site.

Demonstration projects require scientific credibility if the results are to influence assessment of wind farms in the future. Serious consideration should be given to developing manuscripts, linked to the final reports in 2006, for publication in English language peer review journals, possibly linked to presentation at international conferences. This will require the temporal and spatial data and its analysis to be of high quality.

6. PRIORITIES

1. Continue studies of habitat loss for seabirds and marine mammals at both sites
2. Form an international consortium to perfect methodology for registration of bird collisions, also remembering public concern about impacts on songbirds
3. Deploy data loggers at Horns Rev to measure seal activity and to assist in the calibration of satellite tracks of seals
4. Continue infaunal surveys at both sites
5. Continue benthos and fish survey of scour protection areas of both sites
6. Continue sandeel/*Spisula* survey at Horns Rev
7. Gill net on cable trace to test for fish movement over cable at Nysted
8. Make provision for programme outputs such as a book and papers submitted to international scientific journals