East Anglia
Offshore Wind

VATTENFALL

SCOTTISHPOWER RENEWABLES

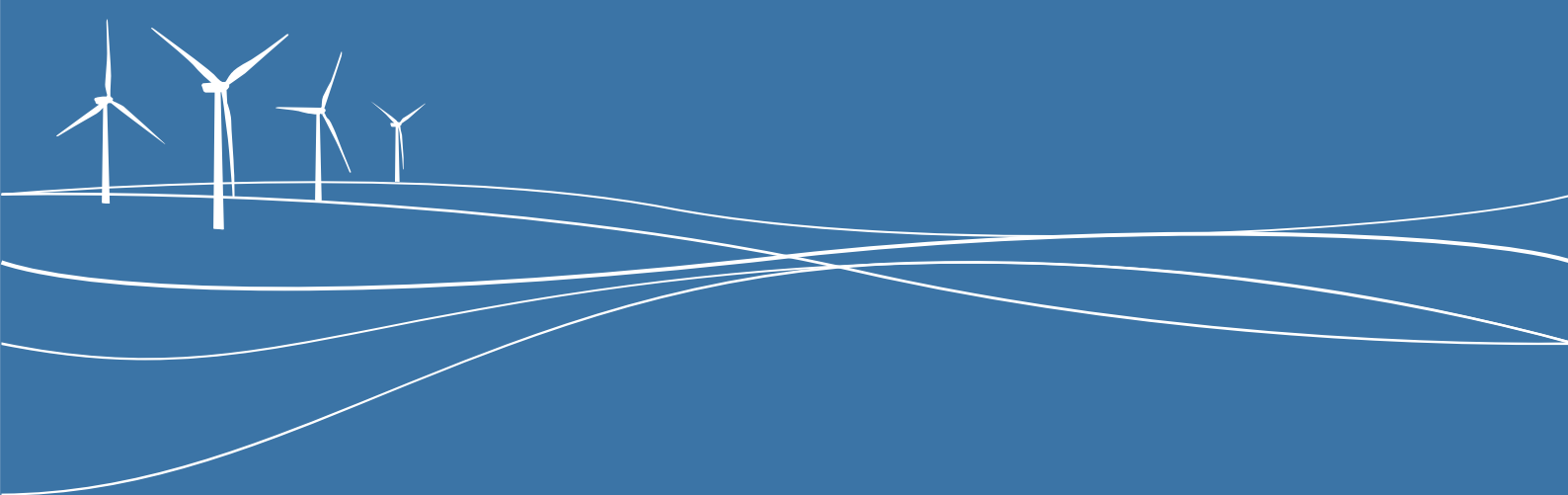
East Anglia THREE

Appendix 10.1

Benthic Ecology Evidence Plan

Environmental Statement
Volume 3
Document Reference – 6.3.10 (1)

Author – Royal HaskoningDHV
East Anglia THREE Limited
Date – November 2015
Revision History – Revision A



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10.1 BENTHIC ECOLOGY EVIDENCE PLAN

10.1.1 Introduction

1. This Appendix contains a number of documents which form the Evidence Plan for Benthic Ecology, these are:

   - The Evidence Plan method statement; a document which was used to inform the first benthic ecology Expert Topic Group (ETG) evidence plan meeting. This was distributed to all members of the ETG on the 3rd of September 2013 prior to the group's first meeting held on the 10th of September 2013. Section 10.1.2
   - The minutes from the first benthic ecology ETG Evidence Plan meeting held on September 10th 2013. These were agreed with all members of the group. Section 10.1.3
   - Clarification of impact assessment methodology and approach to cumulative impacts. This was requested by the group at the first meeting and was distributed to members following the meeting. Section 10.1.4
   - Emailed agreement to the outcomes of ETG first meeting. Section 10.1.5
   - Emailed agreement to Postpone ETG Meeting 2. Section 10.1.6
   - The minutes from the second benthic ecology ETG Evidence Plan meeting held on the 8th July 2014. These were agreed with all members of the group. Section 10.1.7
   - A further set off comments were submitted by Natural England following the ETG 2 meeting these are also provided in this appendix. Section 10.1.8

2. It should be noted that these documents are as close to their original form as possible and have not been updated as projects have developed. Therefore the timelines and parameters given in section 10.1.2, the Method Statement are now out of date. Furthermore, the documents within this appendix refer to the proposed East Anglia FOUR project, which at the time of writing was being progressed in parallel with the proposed East Anglia THREE project; it should be noted that this is no longer the case and East Anglia FOUR is no longer part of the cumulative impact assessment as the project details are not known.

10.1.2 Benthic Ecology Method statement

East Anglia
Offshore Wind

VATTENFALL

SCOTTISHPOWER RENEWABLES

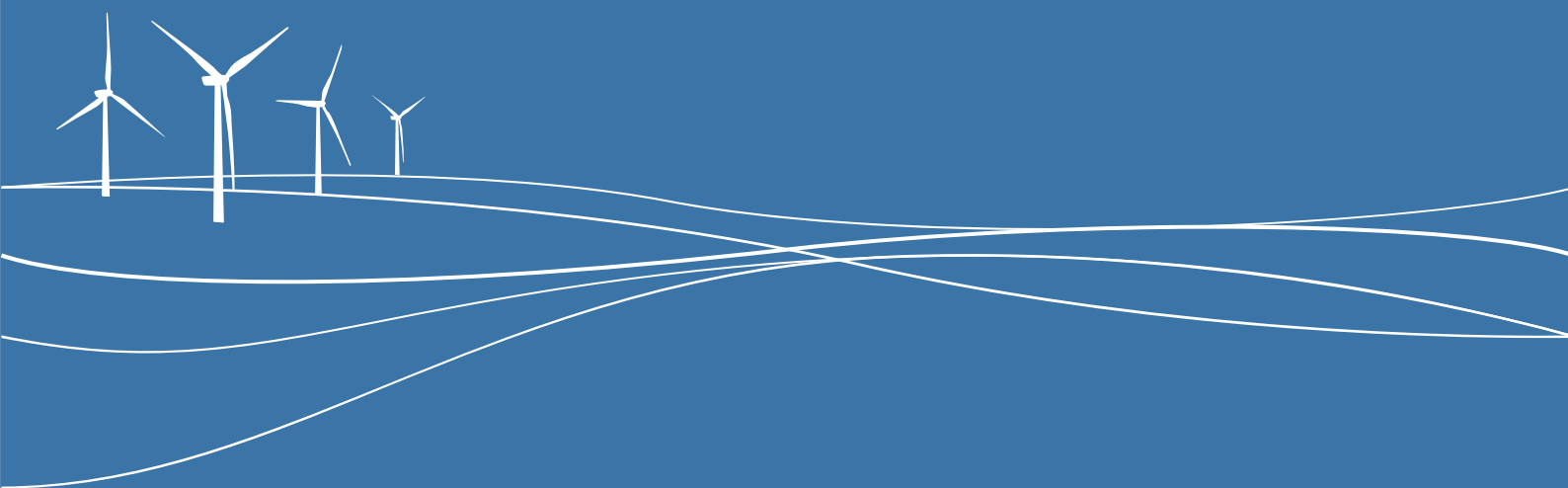
East Anglia THREE and East Anglia FOUR

Evidence Plan

Benthic Ecology Method statement

Benthic Ecology Expert Topic Group
Preliminary meeting: September 2013

Author – Royal HaskoningDHV
East Anglia Offshore Wind Limited
Date – August 2014
Revision History – Revision C



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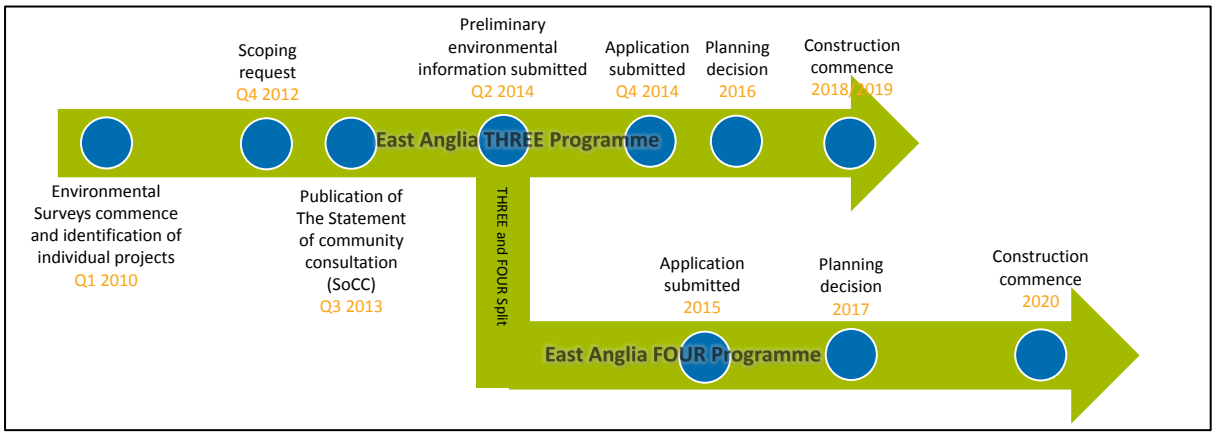
1 INTRODUCTION

1. This note is designed to provide the reader with a background to the status of the benthic ecology Environmental Impact Assessment (EIA) for East Anglia THREE and FOUR offshore windfarms

1.1 Background

2. A time line leading up to DCO submission for both East Anglia THREE and East Anglia FOUR is displayed below. It is the intention that the PEI (which will be a draft Environmental Statement (ES)) for both projects will submitted in May 2014 after which point effort will be focused on completing the final East Anglia THREE ES for submission in November 2014. The Final submission date for East Anglia FOUR is likely to be in Q2 of 2015.



1.2 Project Description

3. The location of East Anglia THREE and East Anglia FOUR windfarms are presented Figure 1 below and various parameters for each windfarm are provided in Table 1 below.

Table 1. Indicative offshore project characteristics

Parameter	East Anglia THREE	East Anglia FOUR
Capacity	1,200MW	1,200MW
Number of turbines	120-240 units	120-240 units
Windfarm area (offshore)	370km^2	359km^2
Distance from windfarm to shore (midpoint of site to port at Lowestoft)	79km	91km
Maximum offshore cable corridor length	140km	160km
Maximum offshore cable corridor area	550km^2	550km^2
Number of export cables (HVDC)	Up to 4	Up to 4
[1]Proposed turbine capacity	5-10MW	5-10MW
Turbine rotor diameter	Up to 200m	Up to 200m
Hub height	Up to 145m (LAT)	Up to 145m (LAT)
Tip height	Up to 245m (LAT)	Up to 245m (LAT)
Minimum clearance above sea level	22m (MHWS)	22m (MHWS)
Indicative minimum separation between turbines	In row spacing 750m	In row spacing 750m
	Inter-row spacing 750m	Inter-row spacing 750m
Average water depth over windfarm site	Typically 35-45m	Typically 25-40m

[1] Note that it is envisaged that more than one turbine type and manufacturer will be employed, up to a maximum of three turbine models for East Anglia THREE and East Anglia FOUR.

2 THE EAST ANGLIA ZONE

1. A Zonal Environmental Appraisal (ZEA) commenced in 2010 with the purpose of identifying the location of individual windfarms within the zone. During the ZEA benthic survey campaign 643 benthic grabs samples were analysed and 428 taxa were identified, with an average of 70 individuals and 16 taxa recorded per sample. Of these grabs, 48 were taken within East Anglia THREE and 49 were taken within East Anglia FOUR.

2. Annelids (worms) were the most abundant taxa present (contributing to 58% of the species) and were the most diverse group, making the largest contribution to the taxonomic richness (41%) across the zone. Echinoderms (brittlestars, starfish and sea urchins) made the largest contribution to biomass (as ash-free dry weight (AFDW) in grams) in the benthic samples (37%) followed by annelids (32%) (EAOW, 2012b).

3. Within the top ten taxa recorded, the most abundant across the zone were the Ross worm *Sabellaria spinulosa* (Figure 2), brittlestars (ophiurodea) and the white furrow shell *Abra alba*. Together these accounted for nearly 40% of the total abundance. Abundance overall across the Zone was low with the majority of samples containing less than 210 individuals. Only 22 samples contained 701 or more individuals. The majority of samples supporting the high numbers of individuals were located in the western side of the zone (East Anglia THREE and FOUR are located in the east of the Zone, see Figure 1 below).

3 EAST ANGLIA THREE AND EAST ANGLIA FOUR

3.1 Windfarm sites

3.1.1 Infauna

4. Multivariate analysis of the benthic infaunal data collected as part of the ZEA was carried out using the PRIMER V6 software package, this analysis identified ten faunal groups across the Zone, and only three of these groups (E, H and J) were found within East Anglia THREE and East Anglia FOUR (EAOW, 2012b). The main characterising taxa were:

- Group E: Brittlestars (ophuroidea), ribbon worms (nemertea) and the bristleworm *Spiophanes bombyx*;
- Group H: S. bombyx, the catworm *Nephtys cirrosa*, necklace shell *Polinices (Euspira) pulchellus* and the bristleworm *Scoloplos armiger*; and
- Group J: *N. cirrosa, S. bombyx* and nemertea.

5. These groups are all closely related and indeed, all 10 infaunal groups across the Zone were similar (EAOW, 2012a), with overlap of characterising fauna in many of the faunal groups. The infauna across East Anglia THREE and East Anglia FOUR was dominated by Group H with species richness, biomass and abundance generally uniform across the site and typical for the levels seen across the Zone. There is a cluster of higher biomass and species richness towards the northwest corner of the East Anglia THREE site, which may be related to the presence of high numbers of *S. spinulosa* (although this is not thought to constitute biogenic reef). There is also a cluster of higher biomass and species richness towards the northeast corner of the East Anglia FOUR site. This is attributed to the fact that one sample station in this area had large numbers of the polychaete worms *Aonides oxycephala* and *Mediomastus fragilis* and another station contained relatively large species such as the sea potato *Echinocardium cordatum*.

3.1.2 Epifauna

6. A total of 78 epibenthic trawl samples were taken during the survey of the East Anglia Zone, four trawls were conducted within East Anglia THREE and six were taken across East Anglia FOUR. The zone surveys identified 95 taxa, with an average of 956 individuals and 24 taxa per sample. Epifaunal abundance ranged from 110 to 15,252 individuals per trawl, with the majority of trawls supporting less than 565 individuals. The north west of the zone had the largest abundances of epifauna per trawl, with the east of the zone and East Anglia THREE and FOUR having

comparatively low epifaunal populations. The distribution of taxonomic richness across the zone and East Anglia THREE and FOUR was highly variable with no clear geographical patterns.

7. Multivariate analysis of the epifaunal data was carried out using the PRIMER V6 software package, this analysis identified four faunal groups across the East Anglia Zone, the group which dominates across East Anglia THREE and FOUR is characterised by the brittlestars *Ophiura ophiura* and *O. albida*, the brown shrimp *Crangon allmanni*, gobies Gobiidae and sole *Solea solea*.

3.2 Cable Route

3.2.1 Subtidal

8. The benthic survey of the East Anglia ONE cable corridor which is shared with East Anglia THREE and East Anglia FOUR (Figure 1 below) identified 270 taxa from 39 grab samples. The average number of individuals and taxa were 93 and 20 respectively. The relative abundances were made up of annelids (47%), crustaceans (11%) and echinoderms (5%). The top ten most abundant taxa contributed to 55% of the overall abundance in the samples taken. The four most abundant taxa included *S. spinulosa,* mussels (mostly *Mytilus edulis*), *A. alba* and the acorn barnacle *Balanus crenatus*. The presence of the acorn barnacle and mussels which require hard substrate in large numbers indicates that the substrate of the cable corridor is different from that of East Anglia THREE and East Anglia FOUR. Other abundant species were the polychaetes *Sphaerosyllis bulbosa* and *S. bombyx*.

9. The majority of grab samples had fewer than 80 individuals, with 5 stations having over 250 individuals and one having over 600. The stations with the highest abundances were located at the western end of the EA ONE cable corridor.

10. Multivariate analysis of the East Anglia ONE cable corridor benthic infaunal data identified seven faunal groups. The analysis showed a similarity of 15% between all faunal groups. This illustrates that there is overlap in many of the characterising fauna in many of the faunal groups. The main characterising taxa were:

- Group A *S. bombyx*, *N. cirrosa* and the bristleworm Ophelia borealis;
- Group B *S. spinulosa* and mussels;
- Group C the polychaete worm *Pseudonotomastus southerni*, mussels and the spionid worm *Aonides paucibranchiata*;
- Group D *S. bombyx*, and the bivalves *Nucula nucleus* and *N. nitidosa*;

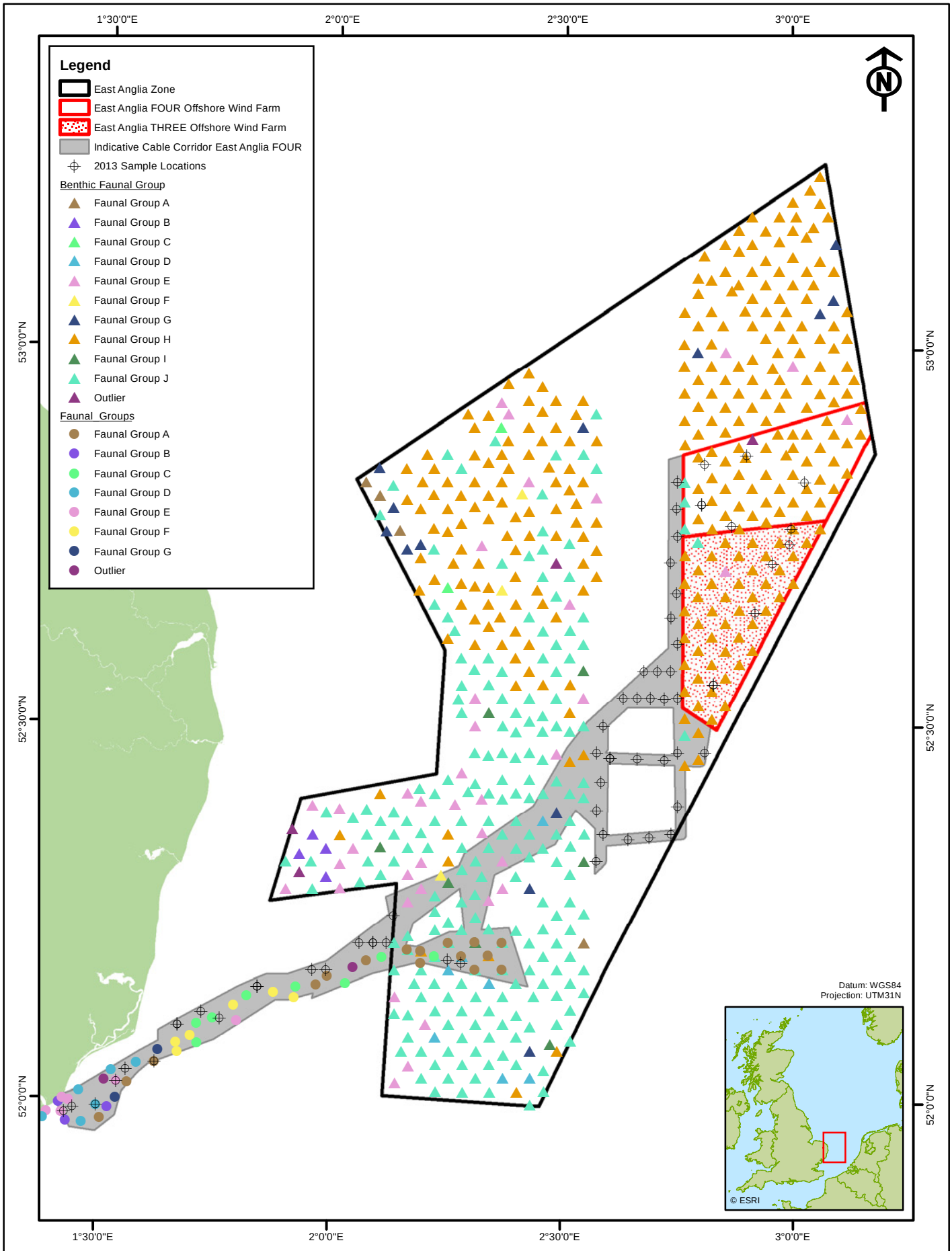
- Group E *S. spinulosa* and mussels;
- Group F Bristleworm *Mediomastus fragilis*, nemertea and tubeworm *Pomatoceros lamarcki*; and
- Group G Mussels

11. Group A species roughly match the characterising species from the Zone surveys which cover eastern end of the cable corridor (the majority of which are Group J - *N. cirrosa*, *S. bombyx* and nemerteans). Comparisons between the distribution of abundance and taxonomic richness across the cable corridor indicate that the offshore cable corridor has a low overall diversity when compared to East Anglia THREE and East Anglia FOUR.

12. Overall, the infaunal groups described for the site and cable corridor are what would be expected for the substrate type, i.e. coarse sand and gravel (Figure 1 below) supporting low diversity and low abundances. The survey results are a good fit with previous studies (Heip and Craeymeersch 1995, the East Coast Regional Environmental Characterisation (REC) (Limpenny et al, 2011) and habitat groups identified by UKSeaMap 2010 (JNCC, 2013).

3.2.2 Intertidal

13. Intertidal habitat at the landfall is predominantly shingle, which runs from the mid to low shoreline. At the southern end of the landfall site the shingle runs into larger cobbles and rock higher up the shore. At the landfall the shingle is unvegetated, with vegetated shingle approximately 300m from where the cables will come ashore.



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East Anglia Offshore Wind
Benthic Community Groups (Grab samples)

Original A4 Plot Scale 1:750,000

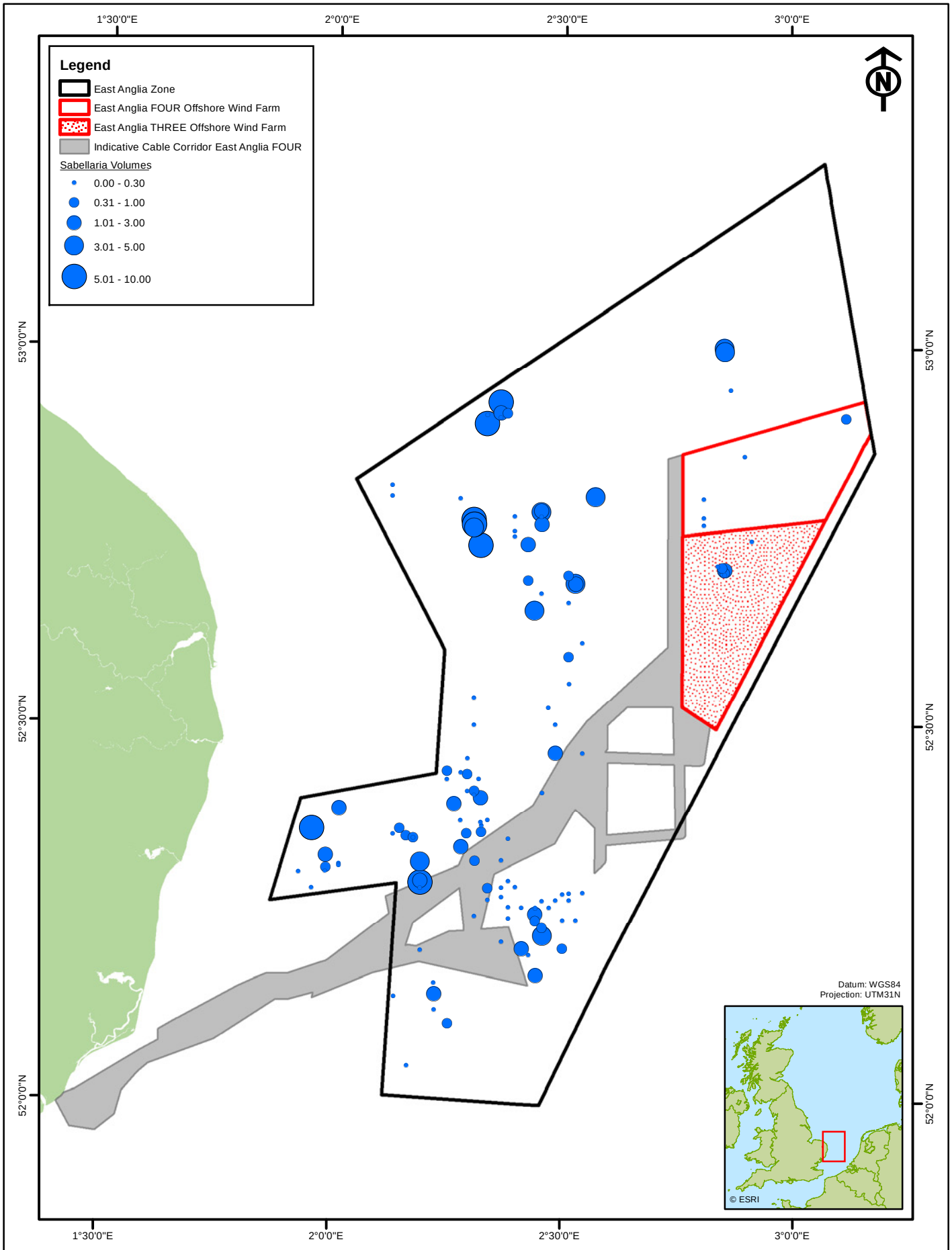
0 5 10 km 0 2 4 6 nm

Rev	Date	By	Comment
A	15/10/12	FK	First Issue.

Layout	Date	Rev	Dwg No.
N/A	15/10/2012	A	

Figure 1

Ref: Z5_Zone_v03_100914rs, Z5_Project_v10_100914rs, EAOW1_CabCoAoI_v06_110811lm_UTM31N, EAOW1_CabCo_v06_110626rs_UTM31N



SCOTTISHPOWER RENEWABLES VATTENFALL

East Anglia Offshore Wind

Sabellaria Abundance

Original A4 Plot Scale 1:750,000

0 5 10 km 0 2 4 6 nm

Rev	Date	By	Comment
A	15/10/12	FK	First Issue.

Layout	Date	Rev	Dwg No.
N/A	15/10/2012	A	

Figure 2

Ref: Z5_Zone_v03_100914rs, Z5_Project_v10_100914rs, EAOW1_CabCoAoI_v06_110811lm_UTM31N, EAOW1_CabCo_v06_110626rs_UTM31N

4 APPROACH TO ASSESSMENT

14. Given the scale of survey conducted to date and the largely homogeneous nature of the benthos, it is intended that data gathered for the Zone and for East Anglia ONE will be used to characterise the benthos for the purposes of the EIA for East Anglia THREE and East Anglia FOUR.

15. It has been agreed by Cefas and the MMO (see Appendix 1) that given the level of debate there is in the scientific and regulator community regarding the usefulness of biotope mapping, particularly at the regional scale; this may not be the most appropriate method of presenting the benthic data.

16. APEM Ltd (2012) undertook an exercise to review data gathered at East Anglia THREE and FOUR to determine if this was sufficient to characterise the benthos or whether further survey was required (see Appendix 2). This study concluded that for the windfarm site the existing data were sufficient and that for the areas of cable route not covered by previous survey a further 36 benthic grab stations needed to be sampled (The power analysis report is appended to this note). This approach was discussed with and approved by Cefas/JNCC (see Appendix 3). To be certain of comprehensive coverage of East Anglia THREE and East Anglia FOUR windfarm sites the 2013 survey (See Table 2 above) included five grab samples in each of the windfarm sites and 48 stations within the cable route (Figure 1 below).

17. In addition a further 11 video trawls were completed across the two windfarm sites and 41 within the cable route. Furthermore three beam trawls (2m) were completed within each windfarm site and six within the cable route (Table 2).

Table 2 Summary of Benthic surveys within East Anglia THREE and FOUR and the Cable route

Data Souce	East Anglia THREE	East Anglia FOUR	Combined Cable Route
Grabs	49 from the zonal campaign; 5 from recent surveys (Spring 2013)	49 campaign; 5 from recent surveys (Spring 2013)	39 from the zonal campaign; 39 taken from EA ONE and 48 from recent surveys (Spring 2013)
Video trawls	5 from recent surveys (Spring 2013)	6 from recent surveys (Spring 2013)	41 from recent surveys (Spring 2013)
Benthic Trawls	4 from the zonal campaign and 3 from recent surveys	6 from the zonal campaign and 3 from recent surveys	
Contaminated sediment samples	10% of all grabs	10% of all grabs	10% of all grabs analysed for contaminants

18. The site-specific geophysical data which have been collected in 2012 for East Anglia THREE and FOUR was also reviewed prior to the commencement of survey work to inform the 2013 benthic survey. Guidance from Limpenny et al. (2010) was used to identify and evaluating the presence of *S. spinulosa* reefs.

19. The assessment of the potential impacts upon the benthos will be cross-referenced where relevant to the assessments of physical processes and water and sediment quality.

20. **It is expected that the suitability of the data collected by EAOW for characterisation of the benthos in the EIA will be agreed in ETG meeting 1.**

4.1 Potential Impacts

21. A range of potential impacts on benthic ecology may occur during the construction, operation and decommissioning of East Anglia THREE and FOUR, with these being described in the following section. Sensitivities of the benthic communities have been judged for each of these impacts on the basis of expert judgement and reference to the work of the Marine Life Information network (MarLIN, eg see Budd, 2006 and 2007; Hill and Wilson 2008; Rayment, 2008; and Ager, 2009).

22. **It is expected that the list of potential impacts and methodologies for assessment used in the EIA will be agreed in ETG meeting 1.**

23. **It is expected that the initial impact assessment will be discussed and agreed (as far as possible) in ETG meeting 2.**

24. **It is expected that the impact assessment and any mitigation required will be discussed and agreed (as far as possible) in ETG meeting 3.**

4.1.1 Potential impacts during construction

4.1.1.1 Physical disturbance:

25. There is potential for direct physical disturbance of the seabed during foundation and cable installation from jack-up vessel legs, piling seabed preparation (dredging) and cable installation. Areas affected by jack-up operations and cable installation will be relatively small and seabed recovery is expected quickly following cessation of installation activities given tolerance and recoverability of the communities present.

4.1.1.1.1 Proposed method for assessment:

- The ZEA provides known size of area of each habitat type across the zone which can also be augmented by the 2013 survey data and applied to the specific windfarm sites.
- Calculations will be made of the area of temporary disturbance using a worst case for the operations identified above
- The magnitude of the impact will be quantified by calculating the maximum area of disturbance as a percentage of each habitat within East Anglia THREE and EAST Anglia FOUR that would be lost if the entire windfarm were to be built within each habitat (worst case scenario).

  It should be noted that this is an unrealistic worst case scenario and that this will lead to exaggerated percentage take figures, however this is the logical way of ensuring that the absolute worst case scenario is considered.

- This will then be put into the context of the wider zone.
- Assessment of the sensitivities will be guided by the assessments available on MarLIN.

  Currently Saballeria across the zone is concentrated in the west of zone (Figure 2) away from East Anglia THREE and East Anglia FOUR. However due to the temporary spatial nature of Sabellaria reef, unknown final foundation locations and the lead in time for construction, it is proposed that detailed mapping of potential Sabellaria reef across the windfarm sites is not appropriate. A commitment to conduct pre-construction surveys and to microsite turbines to avoid impacts to Sabellaria reef is proposed as a more appropriate method for minimising impacts to this Annex I habitat. This approach is in line with the SoCG agreed for East Anglia ONE.

4.1.1.2 Smothering:

26. Sediment disturbance and deposition from construction activities, such as cable and foundation installation could have an adverse and indirect impact on the benthic communities, through increased turbidity or as a result of smothering by sediment released during the construction process. However, given the substrate at the site and dynamic conditions, it is likely that the communities are habituated to smothering from natural events and are tolerant of smothering and evidence suggests that this is indeed the case given the dominant species and communities detailed above.

4.1.1.2.1 Proposed method for assessment:

- The information generated by the physical processes chapters will be used to determine the magnitude of smothering both in terms of the area impacted and the thickness of deposited material.

- Assessment of the sensitivities will be guided by the assessments available on MarLIN.

4.1.1.3 Re-mobilisation of contaminated sediments:

27. Sediment disturbance could lead to the mobilisation of contaminants that could be harmful to the benthos. Work undertaken for East Anglia ONE suggests that there is little contamination in the sediments offshore and for the windfarm areas it is considered unlikely this impact will be significant.

4.1.1.3.1 Proposed method for assessment:

- The magnitude of the impact will be assessed based on the levels of contamination within the sites and export cable routes and the maximum amount of sediment disturbance that will occur during construction.

- Contamination levels of the sediment will be derived from existing data (for example the National Marine Monitoring Programme (NMMP) Cefas 2001) and results of sampling carried out by EAOW. Contaminant sampling carried out by EAOW includes:
    - East Anglia ONE sampling (which found no evidence of anthropogenic impacts in the Warren Springs disused disposal ground (which covers East Anglia ONE and part of the cable route)); and
    - East Anglia 2013 contaminated sediment sampling within sites East Anglia THREE and East Anglia FOUR and along the cable route.
- Assessment of the sensitivities will be guided by the assessments available on MarLIN.

4.1.1.4 Underwater noise and vibration:

28. Research into the effects of underwater noise upon benthos is on-going. However it is likely that there is habituation to noise created by the existing shipping which occurs in the area. There may be reactions from some benthic species to episodic noise such as that from pile driving (Lovell et al, 2005, Heinisch and Weise, 1987). Any impact is likely to be localised and temporary (i.e. occurring only during piling).

4.1.1.4.1 Proposed method for assessment:

- The qualification of the magnitude of this impact will be guided by both the results of noise assessments and the findings of the ES chapter that will assess the impacts of underwater noise (Chapter 9 Underwater noise, vibration and EMF).

- The sensitivity of relevant species will be guided by available literature such as the studies mentioned above and by the assessments of sensitivity to noise available on MarLIN.

4.1.1.5 Loss of habitat:

29. The installation of turbine foundations will result in a small temporary loss of habitat during the construction phase. This will have a small footprint and it is not anticipated that it would be considered significant in the context of similar available habitat in the wider area. The exception would be if this loss was of Annex I habitat, however none are known to exist within East Anglia THREE and East Anglia FOUR at present.

4.1.1.5.1 Proposed method for assessment:

- Loss of habitat during construction will only assess the impacts of temporary habitat loss whereas impacts during operation will assess permanent loss of habitat (see below).

- Information generated as part of the coastal processes assessment and calculations based on the design parameters will be used to quantify the magnitude of the impact, these will include:
  - The area in which the cable plough operates
  - Area around foundations
  - Area around scour and cable protection.

  It is proposed that habitat loss during construction is assessed along with the physical disturbance impact

- Assessment of the sensitivities will be guided by the assessments available on MarLIN.

4.1.2 Potential impacts during operation

4.1.2.1 Loss of habitat:

30. There may be some loss of habitat over time associated with scour around foundations. This will have a small footprint and it is not anticipated that it would be considered significant in the context of similar available habitat in the wider area.

4.1.2.1.1 Proposed method for assessment:

- The ZEA provides known size of area of each habitat type across the zone which can also be augmented by the 2013 survey data and applied to the specific sites.

- Calculations of the entire footprint of the project will be made using a worst case scenario for:

- Foundations (Turbine, collector station, convertor station and met mast).
- Scour protection
- Cable protection (including cable crossings)

- The magnitude of the impact will be quantified by calculating the footprint as a percentage of each habitat within East Anglia THREE and EAST Anglia FOUR that would be lost if the entire windfarm were to be built within each habitat (worst case scenario).

  It should be noted that this is an unrealistic worst case scenario and that this will lead to exaggerated percentage take figures, however this is the logical way of ensuring that the absolute worst case scenario is considered.

- This will then be put into the context of the wider zone.

- Assessment of the sensitivities will be guided by the assessments available on MarLIN

4.1.2.2 Physical disturbance:

31. There is potential for physical disturbance of the seabed from jack-up vessel legs during planned maintenance or, in the case or a cable failure, excavation of cables. In addition small localised disturbance may occur as a result of changes in physical processes instigated by the positioning of structures on the seabed. In general, the impacts from planned maintenance and changes in coastal processes should be temporary, localised and small scale and overall there would be less impact than during construction.

4.1.2.2.1 Proposed method for assessment:

- The ZEA provides known size of area of each habitat type across the zone which can also be augmented by the 2013 survey data and applied to the specific sites.

- Calculations will be made of the area of disturbance using realistic worst case scenarios taking into account:
  - Jack up legs (although they may not be used)
  - Cable installation (including sediment plumes and side casting)
- The information generated by the physical processes chapters will be used to determine the magnitude physical disturbance through changes to the physical processes.

- The magnitude of the impact will be quantified by calculating the maximum area of disturbance as a percentage of each habitat within East Anglia THREE and EAST

Anglia FOUR that would be lost if the entire windfarm were to be built within each habitat (worst case scenario).

- This will then be put into the context of the wider zone.

4.1.2.3 Smothering:

32. Small volumes of sediment could be re-suspended during maintenance activities; the volumes will be lower than for construction. Changes in coastal processes in the area caused by the deployment of the windfarm may also lead to increased sediment deposition on the seabed. It is not expected that there would be significant smothering effects during operation.

4.1.2.3.1 Proposed method for assessment:

- The information generated by the physical processes chapters will be used to determine the magnitude of smothering both in terms of the area impacted and the thickness of deposited material.

- Assessment of the sensitivities will be guided by the assessments available on MarLIN.

4.1.2.4 Re-mobilisation of contaminated sediments:

33. Given the likely levels of sediment contamination and the low levels of sediment disturbance that will occur during operation, this impact is likely to have a very low magnitude.

4.1.2.4.1 Proposed method for assessment:

- • The magnitude of the impact will be assessed based on the levels of contamination within the sites and the maximum amount of sediment disturbance that will occur during operation.

- Contamination levels of the sediment will be derived from existing data (for example the National Marine Monitoring Programme (NMMP) Cefas 2001) and results of sampling carried out by EAOW. Contaminant sampling carried out by EAOW includes:
  - East Anglia ONE cable route sampling (in the Warren Springs disused disposal ground (which covers East Anglia ONE and part of the cable route)) and
  - East Anglia 2013 contaminated sediment sampling within sites East Anglia THREE and East Anglia FOUR and along the cable route.
- Assessment of the sensitivities will be guided by the assessments available on MarLIN.

4.1.2.5 Colonisation of foundations and cable protection:

34. The sub-sea structures (foundations and scour protection and cable protection) are expected to be colonised by a range of species leading to a localised increase in biodiversity. The presence of the structures will also provide habitat for mobile species and for example serve as a refuge for fish. Although potentially viewed as a positive effect, this represents a change from the baseline ecology and may also increase the potential for colonisation by non-native species. Overall, the area available for colonisation would be low and to date there is no evidence of a clear 'reef effect' (OES, 2009, Lindeboom et al, 2011) or significant changes of the seabed beyond the vicinity of the structures themselves.

4.1.2.5.1 Proposed method for assessment:

- The assessment of this impact will be mostly qualitative
- The magnitude of the impact will be assessed by calculating total available area for colonisation and reviewing available literature (for example studies of short term effects of Dutch windfarms (Lindeboom et al. 2011) the monitoring programme at Kentish flats (OES,2009) and studies at the Danish Hrons Rev windfarm (Bioconsult, 2006)) to determine which species are likely to colonise the structures.
- The sensitivity will be assessed by using existing studies to qualify how the surrounding habitats and species may be affected by the induction of new habitat types and subsequent colonisation by foreign species.

4.1.3 Potential impacts during decommissioning

35. The potential impacts arising during the decommissioning phase are envisaged to be similar to those described for the construction phase.

4.1.3.1.1 Proposed method for assessment:

36. The methods used for assessing the impacts during decommissioning will be very similar to those used during the construction phase. The operations involved will be slightly different, however it is anticipated that the magnitude of the impacts will generally be less. Each of the impacts considered for the construction phase will also be assessed in the operation phase.

4.1.4 Potential cumulative impacts

4.1.4.1 Windfarms:

37. Interactions between the East Anglia windfarms and with other offshore windfarms are not expected, given the localised and small scale nature of the impacts on the benthos and the distance to the other planned or proposed windfarm projects in the East Anglia Zone and other windfarms in the region. Although there would be an

aggregated direct and permanent loss of habitat during the operational phase of the windfarms it is anticipated that, given the recoverability of the species found in East Anglia THREE and East Anglia FOUR and across the wider southern North Sea, cumulative impacts would not be considered significant.

38. During the construction phase there is potential for the situation to arise where a number of export cables were to be under construction concurrently, in this scenario there is potential for cumulative impacts to arise however these are not expected to be significant. Also during both the construction phase and the operation phase there is potential for the cable protection at cable crossing points to act cumulatively to create a number of Impacts. The cables from East Anglia ONE, East Anglia THREE and East Anglia FOUR will cross the cables from the Greater Gabbard and Galloper offshore windfarms. Depending on the method by which these cable crossings are protected there is potential for cumulative impacts including:

- Construction
  - Physical disturbance; and
  - Habitat loss.
- Operation
  - The colonisation of a reef type structure; and
  - Habitat loss (as a result of changes in physical processes.

4.1.5 Other activities:

39. The distance of other activities from East Anglia THREE and FOUR, combined with the common and widespread nature of species and habitats within the East Anglia Zone and export cable corridor, means that significant cumulative impacts are not anticipated.

4.1.6 Transboundary impacts

40. Similarly to the general case with cumulative impacts, the localised and small scale nature of the impacts on the benthos and the distance to the other planned and proposed windfarm projects means that significant transboundary impacts are unlikely.

5 EVIDENCE PLAN PROGRAMME AND STRATEGY

Date	Event
10th September 2013	Benthic ETG meeting 1 Project Introduction Evidence Plan Process Baseline Methods Cumulative Assessment Statement of Common Ground (SoCG)
October/ November 2013	**Project design available**
November /December 2013	HRA screening
February 2014	Benthic ETG meeting 2 Draft PEI workshop Impact assessment Thresholds, significance SoCG
April 2014	HRA draft report EA 3 & EA4
May 2014	**PEI submission (draft ES) EA 3 & EA4**
August 2014	HRA final report EA 3
Summer 2014	Benthic ETG meeting 3 PEI feedback DCO conditions Mitigation and monitoring SoCG
November 2014	**DCO application EA 3**
Spring 2015	**DCO application EA 4**

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APPENDIX 1: EAOW BENTHIC SURVEY AND ANALYSIS CONSULTATION MEETING 1ST MARCH 2011

Meeting minutes

Environmental Resources Management

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Wallbrook Court
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Facsimile
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Subject/Ref	
Venue	Holiday Inn, Ipswich
Date of Meeting	1st March 2011
Present	Alan Gibson (MMO), Rebecca Walker (Cefas), Paul Whomersley (Cefas), Helen Thompson (EAOW), Rick Campbell (EAOW), Martin Whyte (EAOW), Muffy Seiderer (MESL) and Victoria Allen (ERM) *Please note that Alan Gibson and Rick Campbell were not present for the full duration of the meeting.*
Distribution	All
Date	2nd March 2011

ACTION

1. **Welcome and Introductions**

2. **Project Update**

Helen Thompson provided an update on the progress of offshore survey activity associated with the project, including the completion of the benthic survey, and pointed out that the ZEA and EIA is now moving from the survey phase into the assessment phase.

An outline of consultation with stakeholders to date and meetings due to take place over the coming months was also provided.

3. **Presentation by Muffy Seiderer and discussion**

Muffy from MESL gave an informative presentation on the benthic survey methodology, initial findings and the proposed methodology for analysis and reporting of the data.

It was stressed that the information provided was not based on the results of the analysis but was inferred from field notes and seabed imagery and so conclusions should not be drawn until the results of all the data analysis are available.

It was suggested by Muffy and agreed by all that given the level of debate there is in the scientific and regulator community regarding the usefulness of biotope mapping, particularly at the regional scale; this may not be the most appropriate method of presenting the benthic data. It was agreed that further discussion with JNCC is warranted. The next meeting with the JNCC is scheduled for the 25th March, when MESL will give their presentation again. RW to find out if Andy Kenny from Cefas is available to dial in to/attend the discussion, and provide his experience from aggregates extraction projects, in particular the RECs and REAs.

RW to confirm Andy Kenny's attendance (or that he will dial in) to the meeting with JNCC/NE on 23/03/11.

VA to arrange call with MESL and the EAOW team to discuss the biotope issues and to brainstorm for topics to discuss at the benthic meeting with JNCC/NE on the 25th March. Suggested date for call is 3pm on 17th March.	VA to arrange EAOW/ERM/MES call on the 17/03/11 to discuss benthic meeting with JNCC on 25/03/11.
It was agreed that the use of a 'GeoPDF' or similar software is the most efficient way of presenting a data set of this magnitude. A user can switch on and off particular layers of interest, view the geophysical outputs and drop down camera images behind each station and query the associated metadata.	
It was pointed out that the IPC have requested that all information be presented in hard copy. HT to present the GeoPDF to the IPC to check that presenting the information in that way is compliant with their requests.	HT to confirm with IPC that presenting benthic data via GeoPDF is acceptable.
All to check whether or not they will be able to download the toolbar required to read a GeoPDF.	All to check IT permissions for downloading GeoPDF toolbar.

4. AOB

Preliminary Environmental Information (PEI) – there is little guidance from the IPC on what this report should include. However there is currently draft IPC/Defra guidance to the MMO on what to expect from the developers in terms of PEI, so it is expected that guidance to developers will be available soon.	
HT to send a letter to the regulators (following receipt of guidance) which will provide an outline to everyone of what the PEI report will include.	HT to circulate letter to regulators outlining what the PEI report will include.
RC pointed out that one PEI report will be produced for the onshore, cable and offshore elements of the project.	
The scoping phase of the cable work will take place towards the end of April. It is proposed that the benthic survey Terms of Reference for the cable work will be presented as part of the scoping report.	
HT asked Cefas how the issue of the sediment contaminants within EA One should closed out given that sampling has taken place there and no evidence of historical contamination within the sediment was found. RW replied that a 2 page letter sent to MMO/Cefas outlining the results of the samples analysis including a note from ABP on the dispersive nature of the water currents within	VA to draft letter on contaminants analysis by 8/03/11 and seek input

the region, would be the most appropriate method to do this. VA to draft this letter by 8th March.	from ABP.
The Rochdale workshop is currently schedule for the 2nd week in May. The aim of this is to present the engineering and commercial reasons behind the initial attempt to decide on the Rochdale envelope. Cefas, MMO, IPC, JNCC, NE, RSPB and Brown and May to attend.	
MS to meet with the engineering team as part of a wider engineering/environmental workshop on the 10th March in London at Vattenfall's offices, to discuss the benthic survey and present the initial data in GeoPDF format.	MS to attend engineering meeting in London 10/03/11.
It was suggested that the next meeting with the MMO/Cefas to discuss the initial results of the fish survey may take place on the 11th April. RW to confirm availability of Jim Ellis or Ainsley (Buckley?) from Cefas to attend.	RW to confirm availability of Jim Ellis or Ainsley (Buckley?) to attend fish meeting on 11/04/11.

APPENDIX 2: EAST ANGLIA BENTHIC AND EPIBENTHIC SURVEY STATISTICAL ANALYSIS

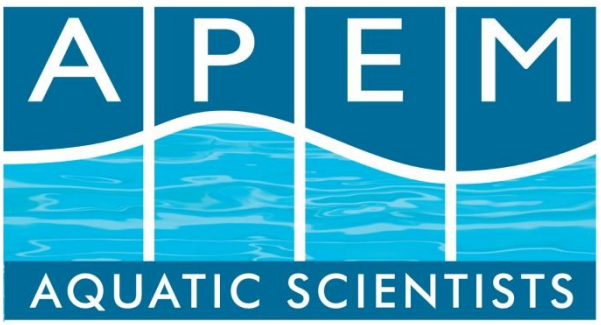
Scottish Power Renewables

East Anglia Benthic and Epibenthic Survey Statistical Analysis

FINAL REPORT

June 2012

APEM REF: 412124



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PROJECT No: **412124**

DATE OF ISSUE: **June 2012**

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CONTENTS

1 INTRODUCTION

Scottish Power Renewables (SPR), in partnership with Vattenfall Wind Power, (VWP), has been awarded the rights to develop up to 7,200MW of wind driven electrical power off the East Anglian coast, within an area known as the East Anglia Zone. Together these companies have formed the joint venture East Anglia Offshore Wind (EAOW) Ltd.

The current round of development within the EAOW Zone focuses on East Anglia THREE and FOUR and the associated cable corridor, shown in Figure 1-1. A large benthic and epibenthic characterisation survey of the whole Zone was carried out between September 2010 and January 2011 by Marine Ecological Surveys Ltd (MESL, 2011), during which surveys were conducted across the extent of East Anglia THREE and FOUR, as well as sections of the cable corridor.

APEM were commissioned by EAOW to assess whether further sampling was required to inform the ecological baseline for the development of East Anglia THREE and FOUR and the cable corridor, or whether data from the 2010 surveys were sufficient to provide a statistically robust spatial characterisation of the benthic and epibenthic ecology of the site.

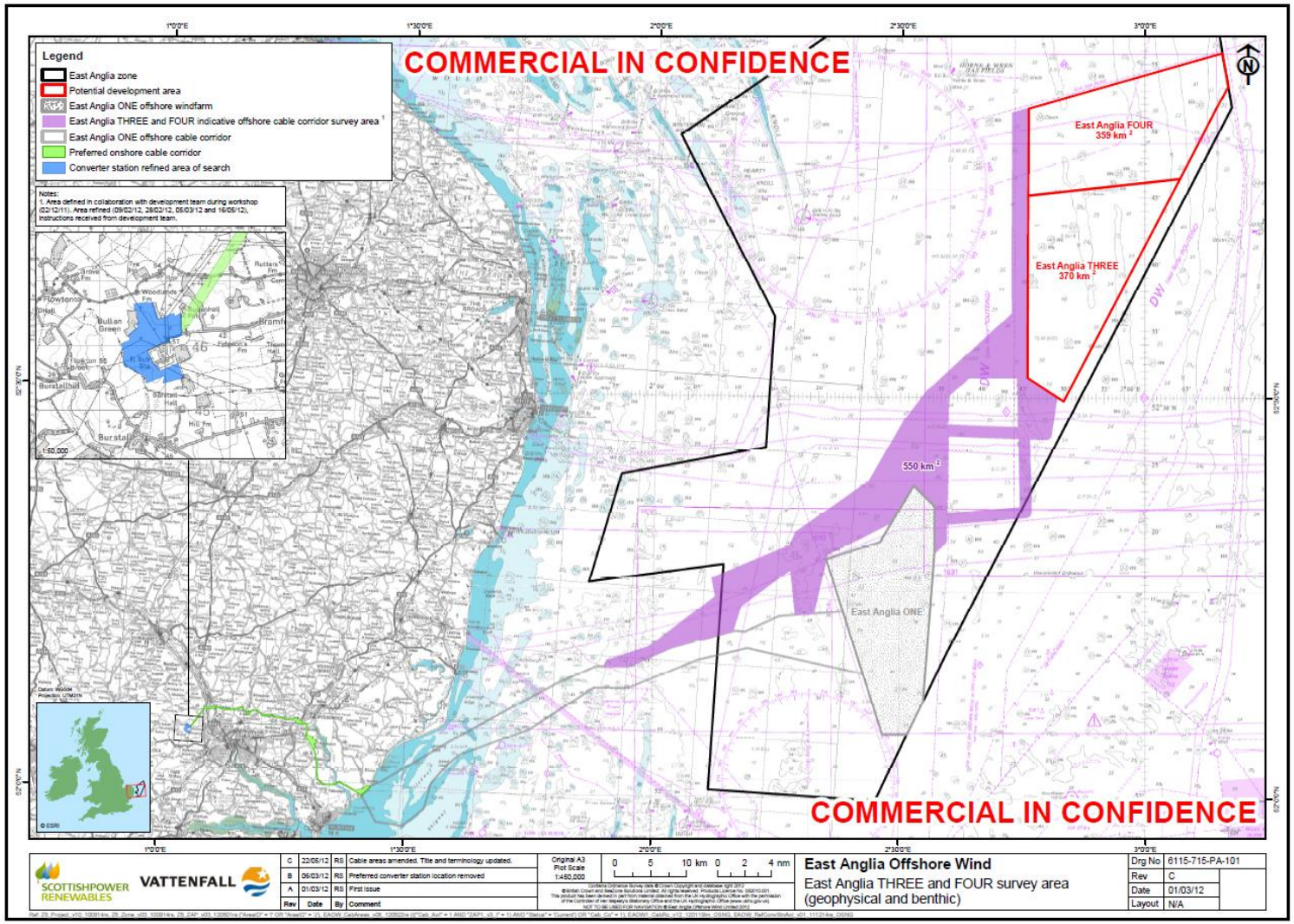


Figure 1-1 Location of East Anglia THREE and FOUR and associated cable corridor (shaded in blue)

2 POWER ANALYSIS

Biological systems are inherently variable. Variability in the spatial and temporal distribution of species within an ecosystem means that it is often difficult to separate natural variability in a measured parameter (often referred to as 'noise') from any causative effect. For example, it is difficult to ascertain whether a difference in the abundance of species observed in two populations is a result of chance, or a result of some significant underlying difference between the two populations. An important aspect in the design of any monitoring survey programme is to minimise the degree to which the natural variability within the measured data affects the statistical analysis and interpretation of the data.

There is the potential to make two kinds of error in the interpretation of statistical models. Type I errors (indicated by α) are made when the null hypothesis (H_0) is rejected when it is in fact true. Type I errors are also referred to as the significance level, or p-value. Type II errors (indicated by β) occur when H_0 is accepted when it is false (Table 2.1). Statistical Power is a measure of confidence that a statistical analysis will give us the "true" answer by limiting the risk of committing a Type II error.

Power is therefore simply 1 – β. It can be carried out *a priori*, using information gained from a pilot study or the literature to inform on the number of samples required to allow for robust statistical analyses (e.g. pre and post construction studies), or *post hoc*, to assess whether results from analysis are valid (Quinn and Keough, 2004).

Table 2.1. Summary of Type I and Type II errors

		Truth for population	
		H_0 is true	**H_0 is false**
Decision based on sample	**Accept H_0**	Correct (True positive)	Type II (False negative, β)
	Reject H_0	Type I (False positive, α)	Correct (True negative)

The two types of error are inversely relational and an increasing effort to reduce β increases the risk of encountering Type 1 error. It is therefore common practice for a compromise level for Power to be set at 0.8 (Crawley, 2011).

The formal representation of Power analysis is:

Eqn. 1.

$$Power \propto \frac{es\ \alpha \sqrt{n}}{\sigma}$$

Where:

- ***σ***– Standard deviation. A measure of deviation within dataset. The greater the standard deviation in a data set, the greater the degree of variation of data

values about the mean and the more difficult it is to measure statistical differences between populations (e.g. pre- and post-development, between geographic locations, etc).

- ***es*** – Effect size.
- ***α*** – Required significance level, or *p*-value. The desired p level is to be set at 0.05 (or 95% probability).
- ***n*** – The sample size

Any one term from Eqn. 1 can be solved when all other terms are known.

2.1 Standard Deviation

Standard deviations for epibenthic and benthic community mean values for this power analysis have been calculated from the 2010/2011 Zonal Characterisation Survey data (MESL 2011). Data with higher standard deviations (δ) have a greater degree of variability. These data require a higher degree of sampling effort (i.e. a higher number of samples, *n*) to detect a significant effect of a given size than data with low variation values.

2.2 Effect Size

Effect size is the level of change we are able to detect. It is calculated thus:

Eqn. 2 (Coe, 2002)

$$es = \frac{mean\ of\ survey\ A - mean\ of\ survey\ B}{\sigma}$$

and can be summarised as standardised mean difference.

In this study we are attempting to understand if a suitable number of samples have been taken as part of the Zonal Characterisation Survey to correctly detect a response to development of East Anglia THREE and FOUR and the Cable corridor in subsequent post-construction surveys. The effect size required that is representative of a true shift in the benthic and epibenthic communities however, is unknown. This is a common issue with many Power Analyses and to satisfactorily deal with this Cohen (1988) proposed the use of effect sizes of 0.8, 0.5 and 0.2 to represent a high, medium and small effect size. These effect sizes reflect degrees of change based on standard deviations (e.g. 0.2 = two standard deviations from the mean of survey A). This study has also investigated the use of a range of *es* (see Section 4.2).

Power Analysis calculations were based on calculations of Shannon Diversity and Simpson's Index at each survey site for benthic and epibenthic fauna. For ease of interpretation, this study will present *es* as percentage change. Although this is not common practice for power analysis it has been possible to convert *es* to an Estimated Detectable Percentage Change (EDPC) by partially solving Eqn. 2. Data from the Zonal Characterisation Survey were assessed and the standard deviation within

different survey areas was calculated. This information was used to calculate the EDPC values for a range of effect sizes.

As only one survey has been carried out the standard deviation used is derived solely from survey A (MESL, 2011, method derived from Coe, 2002). Therefore,

Eqn. 3

$$EDPC = \frac{\sigma(survey\ A)es}{mean(survey\ A)} \text{ x } \frac{100}{1}$$

2.3 Detection Level

Although no industry standard *es* or EDCP has been made available for marine benthic and epibenthic communities, when undertaking ornithological Impact Assessments for windfarm developments an ability to detect a halving or doubling of population size (*i.e.* 50% change) is used as the threshold level for determining the accuracy of a survey. This approach was used to assess the accuracy of bird counts during initial ornithological investigations for the London Array (APEM, 2010). The 50% level of population change is also commonly used when designing surveys for fish species of conservation interest in UK rivers (Bohlin *et al.*, 1990), (e.g. Lamprey, APEM, 2011a), as well as other species of high commercial/recreational value (e.g. brown trout, APEM, 2003). The Power analysis approach is taken from survey design methodology proposed by Elliott (1993) for quadrat (*i.e.* spatially constrained) sampling for pond invertebrates.

We therefore propose that an EDCP level of greater or less than 50% is a valid ecological level at which to conduct benthic and epibenthic surveys. A unique aspect to this project however, is the use of diversity metrics to estimate the variance required for power analysis to detect changes to benthic and epibenthic marine communities. This is necessary given the complex community structure of benthic and epibenthic marine ecosystems. As discussed, the 50% EDCP threshold is used as a benchmark level of detectable change in population sizes of bird and fish species. Therefore a 50% change in diversity, as measured by Shannon or Simpson, does not necessarily indicate a 50% change in the total invertebrate abundance. Similarly it may not indicate a 50% loss of the number of taxa present. In essence, a 50% effect will show a change to the specific index value which is based on complex alterations to the community composition and patterns of dominance within the community in question, i.e. a combination of change to species number and abundance. This is because increases in abundance and the number of taxa are not linearly related to increases in Shannon or Simpson. The relationship between population number and changes to that population is however, linear. Furthermore, index values are usually functionally constrained by maximum values, 0-approximately 1 for Simpson and 0 – 3.4 for Simpson (these upper limits can be breached on occasion) while, within sensible limits, population numbers are not. Changes in population number and changes to community diversity metric values cannot therefore be directly compared as they respond differently to change. Consequently, although we have presented this analysis based on this 50%

threshold, it should be recognised that this is not a simple halving of the community in question.

2.4 Sample Number.

The Estimated Sample Number (ESN) required to reach a Power = 0.8 (the ESN) can be estimated where *es* and σ are known.

3 METHOD

As the full extents of East Anglia THREE and FOUR were surveyed for benthic and epibenthic surveys during the Zonal Characterisation Survey (MESL, 2011), GIS was used to identify which of the stations sampled fell within those areas. Subsequently we derived Shannon (H') and Simpson (S) diversity indices for East Anglia THREE and FOUR followed by overall mean and standard deviations of these indices to allow conversion of *es* to EDPC (see Section 2.2) and undertake power analysis. This analysis allowed us to determine whether further sampling effort was required to characterise the benthic and epibenthic assemblages present.

As certain sections of the cable corridor are located within the navigational channel at the centre of the Zone, a full suite of stations encompassing the entire corridor was not available. Based on the overall density of stations/km^2 (0.13km^2 for benthic stations and 0.01km^2 for epibenthic stations) carried out in the 2010 survey (MESL 2011), it was therefore estimated that 71 benthic stations and 6 epibenthic stations would have had to be surveyed to provide complete coverage of the corridor.

To derive means and standard deviations for the cable corridor, 71 and 6 sites respectively were chosen at random and the Shannon (H') and Simpson (S) diversity indices calculated. These indices incorporate information on the number and abundance of species and the relative abundance of species in an assemblage (termed evenness). These measures are routinely employed to characterise ecological communities. These indices were used to derive the necessary descriptive statistics for the cable corridor. We felt a randomised approach to derive the necessary information was valid as the entire Zone was characterised by high levels of homogeneity, both in terms of ecological communities and substrate (MESL, 2011). This approach using randomly assigned, but relevant, data is also described in Quinn and Keough (2004).

Power analyses tailored towards t-tests were carried out using R (www.R.project,org), based on the proposed null hypothesis that there will be no difference in community diversity between the communities sampled during the 2010 survey (MESL 2011) and potential survey(s) carried out post-development.

4 RESULTS

4.1 Descriptive Statistics

The descriptive statistics (Table 4.1) demonstrate the low levels of variance in ecological diversity within the relevant areas, and is supportive of the Zonal Characterisation results (MESL, 2011). Table 4.1 demonstrates the relatively higher variance in Shannon diversity index when compared with the Simpson index. This may result in a higher ESN for Shannon to reach the critical Power threshold (0.8) when compared with Simpson. The table also shows the number of stations surveyed in 2010/2011 present within East Anglia THREE and FOUR, and the sample number used for cable corridor assessments.

Table 4.1. Descriptive statistics for Power analysis and es conversion

Study	Metric	Area	*n*	mean	σ
Benthic	Shannon	EA FOUR	49	2.19	0.34
	Shannon	EA THREE	48	2.06	0.4
	Shannon	Cable	71	2.15	0.5
	Simpson	EA FOUR	49	0.84	0.11
	Simpson	EA THREE	48	0.8	0.14
	Simpson	Cable	71	0.85	0.13
Epibenthic	Shannon	EA FOUR	6	1.69	0.34
	Shannon	EA THREE	4	1.56	0.31
	Shannon	Cable	6	1.6	0.11
	Simpson	EA FOUR	6	0.74	0.12
	Simpson	EA THREE	4	0.68	0.12
	Simpson	Cable	6	0.71	0.07

4.2 Effect Size

Table 4.2 shows the percentage changes (as Estimated Detectable Percentage Change, EDPC) in Shannon Diversity (H') and Simpson's Index (S) values that represent a range of effect sizes (*es*). The results show that this relationship is variable between Areas and between diversity index measured. The *es* values commonly adopted in ecological investigations (i.e. 0.2, 0.5 and 0.8, Cohen 1988) all represent changes in diversity index values of less than 20% (Table 4.2). The EDPC values at these effect sizes are all lower than would be considered required as part of an Impact Assessment, on the basis that a 50% change in a diversity index would be accepted by the statutory authority.

Table 4.2. The relationship between Effect Size and Estimated Detectable Percentage Change for each area and metric. Green boxes indicate percentage change values for target detectable effect sizes of 0.2, 0.5 and 0.8 (small, medium and large, respectively). Orange boxes represent breaches of the 50% change level.

Effect Size	BENTHIC						EPIBENTHIC					
	Shannon EA FOUR	Shannon EA THREE	Simpson EA FOUR	Simpson EA THREE	Shannon Cable	Simpson Cable	Shannon EA FOUR	Shannon EA THREE	Simpson EA FOUR	Simpson EA THREE	Shannon Cable	Simpson Cable
	% change	% change	% change	% change	% change	% change	% change	% change	% change	% change	% change	% change
0.1	1.55	1.94	1.31	1.75	2.33	1.53	2.01	1.99	1.62	1.76	0.69	0.99
0.2	3.11	3.88	2.62	3.50	4.65	3.06	4.02	3.97	3.24	3.53	1.38	1.97
0.3	4.66	5.83	3.93	5.25	6.98	4.59	6.04	5.96	4.86	5.29	2.06	2.96
0.4	6.21	7.77	5.24	7.00	9.30	6.12	8.05	7.95	6.49	7.06	2.75	3.94
0.5	7.76	9.71	6.55	8.75	11.63	7.65	10.06	9.94	8.11	8.82	3.44	4.93
0.6	9.32	11.65	7.86	10.50	13.95	9.18	12.07	11.92	9.73	10.59	4.13	5.92
0.7	10.87	13.59	9.17	12.25	16.28	10.71	14.08	13.91	11.35	12.35	4.81	6.90
0.8	12.42	15.53	10.48	14.00	18.60	12.24	16.09	15.90	12.97	14.12	5.50	7.89
0.9	13.97	17.48	11.79	15.75	20.93	13.76	18.11	17.88	14.59	15.88	6.19	8.87
1	15.53	19.42	13.10	17.50	23.26	15.29	20.12	19.87	16.22	17.65	6.88	9.86
1.5	23.29	29.13	19.64	26.25	34.88	22.94	30.18	29.81	24.32	26.47	10.31	14.79
2	31.05	38.83	26.19	35.00	46.51	30.59	40.24	39.74	32.43	35.29	13.75	19.72
2.5	38.81	48.54	32.74	43.75	58.14	38.24	50.30	49.68	40.54	44.12	17.19	24.65
3	46.58	58.25	39.29	52.50	69.77	45.88	60.36	59.62	48.65	52.94	20.63	29.58
3.5	54.34	67.96	45.83	61.25	81.40	53.53	70.41	69.55	56.76	61.76	24.06	34.51

4.3 Benthic Power Analysis

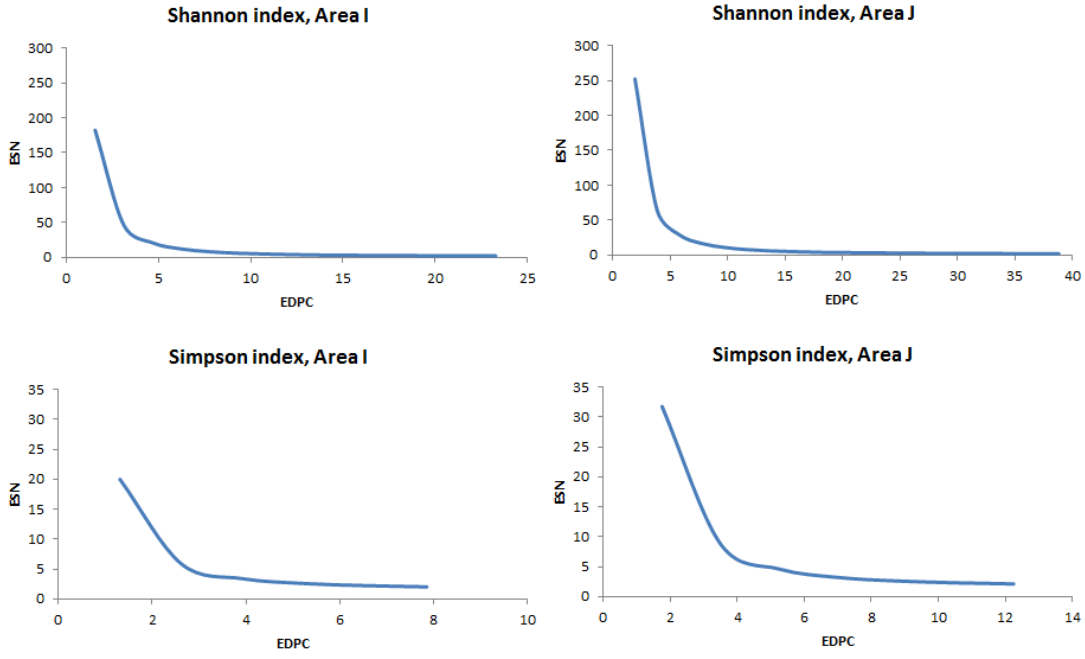
4.3.1 East Anglia THREE and FOUR.

Table 4.3 presents the Power inherent from the 2010 surveys (MESL 2011) for benthic surveys from East Anglia THREE and FOUR.

Table 4.3. Results from power analysis for East Anglia THREE and FOUR.

Effect Size	EA FOUR (n = 49)		EA THREE (n = 48)	
	Power H'	Power S	Power H'	Power S
0.2	0.82	1	0.67	0.99
0.5	0.99	1	0.99	1
0.8	1	1	1	1

The results show that only one test, for Shannon (H') at an effect size of 0.2 (East Anglia THREE), fails to reach the required Power level (0.8). At an *es* of 0.8[1] = 15% detectable change (Table 4.2) for the Shannon metric in East Anglia THREE however, the 0.8 level (effect size) is more than adequate to detect change at less than the required 50% level. This is true for all benthic surveys from East Anglia THREE and FOUR and therefore we can state that the sample numbers are sufficient, and that an *es* of 0.8 as a benchmark is also suitable for determining whether the number of sites sampled in 2010 was suitable to characterise the site and allow a future detection of change.



[1] Please note; 0.8 is the critical threshold for **statistical Power**, and care should be taken to avoid confusion between this value and the **effect size** of 0.8

Figure 4.1. Relationship between estimated sample number and percentage change in metric for benthic data.

Figure 4.1 further illustrates this point, demonstrating that the survey effort undertaken in East Anglia THREE and FOUR can detect change well below the 50% level for each metric and Area. This is evident from the decay and stop in the line at an ESN of approximately 2 before reaching an EDPC of 50% (as it is based on the variability of data between samples, Power analysis cannot predict a sample size less than 2).

4.3.2 Cable Corridor

Table 4.4 presents the Power inherent from the 2010 surveys (MESL 2011) for benthic surveys from the cable corridor.

Table 4.4 Results from Power analysis for Cable Corridor

Effect Size	2011 density (n = 71)	
	Power H'	**Power S**
0.2	0.66 (99)	1
0.5	0.99	1
0.8	1	1

As with the Shannon metric from East Anglia THREE, the Power of a comparison using Shannon at an effect size of 0.2 is lower than a Power of 0.8. The 0.8 *es* however, equates to an estimated detection level of 18% (Table 4.2). As the 0.8 *es* for Simpson is also well below the 50% threshold (see Table 4.2), we can state that a survey effort of 71 stations is sufficient to characterise the site and allow a future detection of change. Figure 4.2, below, further highlights that a survey effort based on 71 sites within the cable area can detect change well below the 50% level for each metric and area.

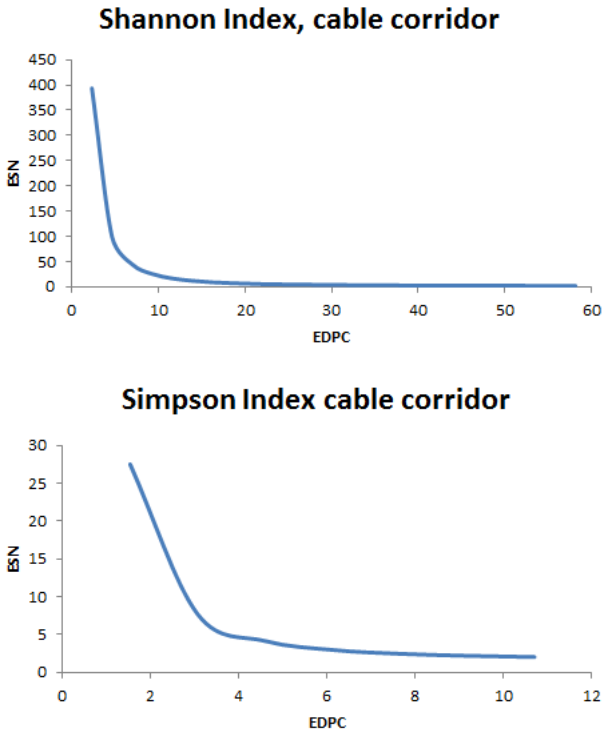


Figure 4.2. Relationship between sample size (*y*) and percentage change detection for the cable corridor for Shannon and Simpson indices for benthic assemblages.

As an estimated 271.82km^2 of the cable corridor remains to be surveyed, a further 36 stations in this area would be required to retain the 2010 survey density of 0.13 stations/km^2. This will ensure that the surveys conducted in the remaining areas are spatially consistent with previous work.

4.4 Epibenthic Power Analysis

4.4.1 East Anglia THREE and FOUR.

The results of the Power analysis, for both S and H' for East Anglia THREE and FOUR, are presented below in Table 4.5.

Table 4.5. Results from Power analysis for East Anglia THREE and FOUR.

Effect Size	EA FOUR (n = 6)		EA THREE (n = 4)	
	Power H'	Power S	Power H'	Power S'
0.2	0.15	0.8	0.11	0.57
0.5	0.63	0.99	0.48	0.99
0.8	0.95	1	0.85	1

The Power values from the highest effect size (0.8) are above the required Power threshold (also 0.8). As an *es* of 0.8 equates to values less than an EDPC of 50%, it is shown that an estimated sample size equal to that carried out during the 2010 survey is sufficiently powerful to detect change of less than 50%. Figure 4.3 also demonstrates this point and therefore that adequate stations have been surveyed.

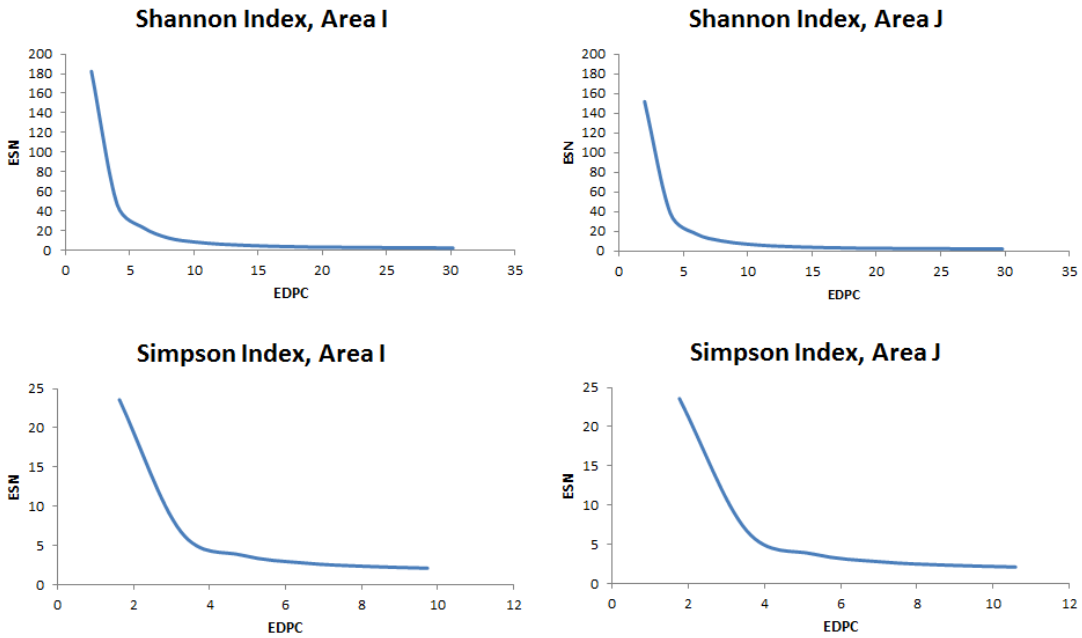


Figure 4.3. Relationship between epibenthic sample size (*y*) and percentage change detection in East Anglia THREE and FOUR for Shannon and Simpson indices.

4.4.2 Cable Corridor

Table 4.6. Results from Power analysis for estimated epibenthic surveys on the cable corridor.

Effect Size	Cable Corridor (n = 6)	
	Power H'	Power S
0.2	0.39	0.97
0.5	0.98	1
0.8	0.99	1

As with all previous assessments presented during this study, Table 4.6 demonstrates an effect size of 0.8 relates to a sufficiently high statistical Power. Table 4.2 establishes that this level of effect also relates to an EDPC of less than 50% for both Shannon and Simpson indices for the epibenthic cable corridor. Again this is confirmed for both indices by a plot of ESN and EDPC (Figure 4.4).

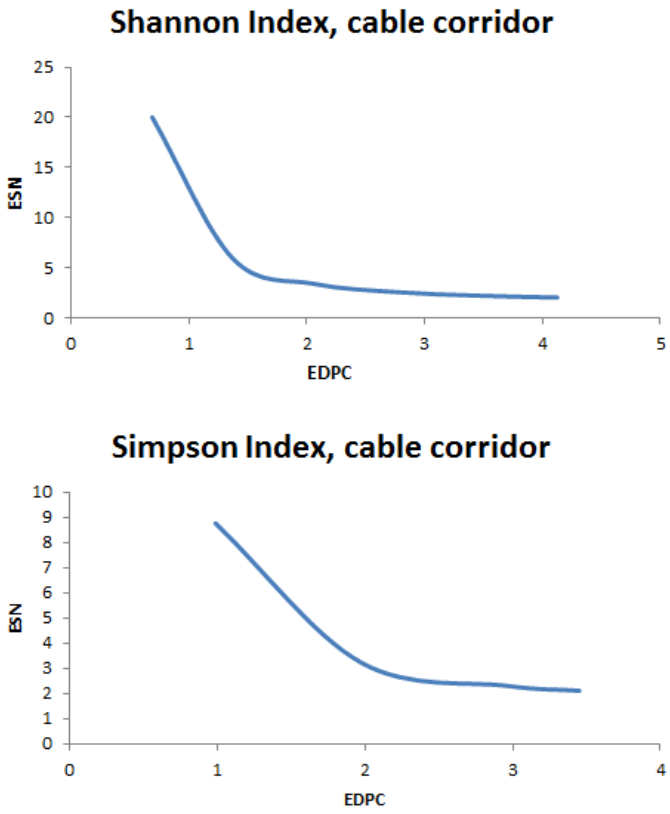


Figure 4.4. Relationship between epibenthic sample size (*y*) and percentage change detection in the cable corridor for Shannon and Simpson indices.

As part of the cable corridor remains unsurveyed an estimated 3 additional stations are required to provide the necessary coverage for robust statistical analysis and to reach the requisite sample size of 6 stations throughout the entire cable area. This is in line with the 2010 study density (MESL, 2011) of 0.01 epibenthic stations per km^2. It is recommended that 6 stations are surveyed throughout the cable corridor as a whole to avoid any temporal variation in data collected in different parts of the corridor.

5 DISCUSSION

5.1 Implications of Variance

It is evident that the low spatial variance in diversity exhibited by the benthic and epibenthic community in the Zone (MESL 2011) would have major implications for the Power analysis. It is the variance around the mean that is the main driver for the estimated sample number and, as in this case where that variance is low, Power analysis informs us that a very high statistical Power is possible with a relatively small number of samples. This is most evident in the plots of ESN against EDCP which show that the lower limit of sample size that can be estimated from a Power analysis (n = 2) is reached before an EDCP of 50% is reached. This low community variation has positive implications for the EIA, as any changes in the community structure should be easily detected.

Although the relationship between detectable change and sample number shows very high Power, we cannot, however, assume that any post impact survey will show the same low levels of variance. Increasing levels of variation in future may compromise Power and therefore a conservative approach is advised. This is because increasing variation in spatial patterns of diversity is one potential outcome of development. Nevertheless, we have shown that the current survey protocol will detect change well below the proposed 50% (doubling or halving of diversity) that is deemed appropriate for many biological communities, we can assign high confidence that it will highlight any changes in the communities present in East Anglia THREE and FOUR and the cable corridor (once adequately surveyed).

The levels of variance found also have implications beyond this study. The low EDPC/high effect size relationship has resulted in a high effect size being selected as suitable for this study; that is an *es* of 0.8 consistently relates to a percentage change substantially below the 50% threshold. It is important however, to note that an effect size of 0.8 may not be applicable to Power analysis conducted for other benthic surveys, as they may demonstrate considerably greater spatial variation in diversity than found here. Indeed, the use of an effect size of 0.8 for other studies may potentially compromise those studies to the extent that major change is not perceived, or that an unmanageable number of samples are required. In the absence of regulator guidance, we therefore recommend the tailored approach retaining the 50% detectable change level to Power Analysis for similar studies.

5.2 Benthic Surveys

It is clear from the high Power and low EDCP values shown that the number of benthic stations sampled in undertaken in East Anglia THREE and FOUR are adequate to assess any change in community structure. Indeed the level of change detectable is quite low (estimated as low as 10% for Simpson metrics in East Anglia THREE).

Assuming that the homogenous ecological diversity recorded across the Zone also applies to the unsurveyed areas, then it is assumed that the cable corridor will demonstrate similar high Power/low EDCP levels based on the variance from the

randomly selected sites used. As shown in Section 4.3.2, a further 36 benthic stations will be required in the unsurveyed areas to ensure a consistent survey effort of 0.13 stations per km^2. It should be noted however, that by surveying only these outstanding 36 stations, temporal inconsistencies could affect the cable corridor assessment and it would be prudent to discuss this temporal issue and the need for future surveys with the regulator.

5.3 Epibenthic Surveys

As found for the benthic surveys, the epibenthic characterisation effort for East Anglia THREE and FOUR is sufficient to assess any impacts to the epibenthic ecology of that area. It should be noted that this analysis is in relation to benthic invertebrate taxa only and does not include fish species, for which there was dedicated survey effort.

Similarly, as discussed in Section 5.2, assuming that the homogeneity recorded within the surveyed sites also applies in the unsurveyed areas, the epibenthic cable corridor community surveys should demonstrate similar high Power/low EDPC levels. As shown in Section 4.4.2 a further 3 benthic stations will be required in the unsurveyed areas to ensure a consistent survey effort of 0.01 stations per km^2. Due to the small number of sample stations that are required throughout the cable corridor as a whole however, (6 stations are required to achieve statistical Power and maintain consistency with the previously sampling density), APEM recommended surveying 6 stations throughout the entire cable corridor which will result in all epibenthic samples from the cable corridor being gathered within the same sample season.

5.4 Spatial v Temporal variation.

This report is tailored towards a short term, pre- and post-construction study to assess potential effects of development using analyses which compare the (pre- and post-impact) mean and variation of assemblage diversity metrics for each of the relevant areas. Nonetheless, the extremely high Power suggests that the survey effort will be suitable for a longer term monitoring program.

It is important to note however, that short term changes in climactic or physical oceanic conditions may provoke a change in ecology which could falsely be attributed to development (for example, following a severe storm event). APEM recommends therefore that consideration is given to the development of longer term monitoring, and if this is not possible due to cost or other considerations, monitoring of local marine conditions is undertaken to exclude the potential effect of other causal factors in the event of major change being discovered.

6 RECOMMENDATIONS

1. No further survey work is necessary to inform the baseline characterisation for East Anglia THREE and FOUR for both benthic and epibenthic communities, as the results of the Power analysis indicate that the number of samples already collected are more than sufficient to confidently assess greater than a 50% change in diversity index values with a high statistical Power.
2. To provide a spatially and statistically sound baseline from which to measure potential impacts of the project, unsurveyed areas from the cable corridor should be sampled, and to provide temporal consistency, consideration should be given to resampling the entire cable corridor.
3. Sampling design should be carried out using the same grid approach as that employed for the 2011 Zonal characterisation survey.
4. A reduction in sample number for future benthic surveys is possible, however due consideration of potential impacts and dialogue with the regulators is required.

7 REFERENCES

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Quinn, P. & Keough, M.J. 2003. *Experimental Design and Data Analysis for Biologists*. 2nd Ed. University Press, Cambridge, UK.

APPENDIX 3: BENTHIC AND FISH SURVEY TERMS OF REFERENCE

EAOW THREE and FOUR Benthic And Fish Survey Terms Of Reference EAOW, CEFAS and MMO – Final			
Date of meeting:	31.07.12	Venue:	CEFAS - Lowestoft

Attendees:

Name	Position	Organisation
Holly Drake (HD)	Case Officer EAOW	CEFAS
Rebecca Walker (RW)	Case Officer EAOW	CEFAS
Louise Cox (LC)	Fisheries Ecologist	CEFAS
Paul Whomersley (PW)	Benthic Ecologist	CEFAS
Alan Gibson (AG) – by phone	Case Manager	MMO
Kathleen Mongan (KM) – by phone	Case Officer	MMO
Morna Cannon (MC)	Assistant Project Manager	EAOW
Martin Whyte (MW)	Project Manager	EAOW
Holly Wilson (HW) – by phone	Assistant Project Manager	EAOW
Julia Bolton (JB) – by phone	Assistant Environment Manager	EAOW
Stephen Appleby (SA)	Fisheries Consultant	Brown and May
Victoria Allen (VA)	Senior Marine Ecologist	APEM

Apologies: n/a

Discussion	Action
Agenda 1. **Introductions** 2. **Presentation of EAOW THREE and FOUR** 3. **Fish TOR** 4. **Benthic TOR** 5. **Next Steps**	
Introductions All persons in attendance and on the phone introduced themselves and their position in the respective organisations.	
Presentation of East Anglia Projects THREE and FOUR Morna Cannon gave a brief presentation introducing EAOW and the next two projects to be developed within the Zone East Anglia THREE and FOUR. Key things to note from the presentation were: EA THREE and FOUR are separate projects which will be subject to separate DCO applications. They will however be developed in tandem by one project development team led by Keith Morrison. The East Anglia TWO project is forthcoming and will enter the development phase shortly. This project will be subject to a further DCO and will be developed by a separate project development team. **Action 120731-1: Circulate presentation to all attendees.**	**MC/MW**

Fish TOR In general CEFAS confirmed the approach put forward for characterisation surveys was appropriate. CEFAS stressed the importance of getting good coverage and collecting information on all relevant species. Based on the sample locations put forward in the TOR it was agreed that Otter and Commercial Beam trawling would be carried out at alternating stations (i.e. one station Otter the other Beam and so on). For the Commercial Beam Trawling it was agreed that a 4m beam trawl with chain mat would be sufficient. The mesh size to be used for the beam trawl would be 80 mm. The Otter Trawl would utilise a 100 – 110mm mesh. The Commercial Beam Trawl would use a trawl with 80mm cod ends Trawl durations will be 20 minutes in the first instance. If too much is caught, then trawl durations will be reduced. If too little is caught then trawl durations will be increased. With respect to the timing of surveys it was agreed that surveys should take place in February and May in order to cover key periods. **Action 120731-2: CEFAS to confirm whether or not proposed timing is acceptable and that no autumn survey will be required. Subsequently completed.** Cefas subsequently clarified: *February and May surveys to assess and characterise fish ecology should be sufficient alongside 2m beam trawls (epibenthic trawls) in September that will sample juvenile and small bodies species. The combination of these three surveys should characterise the seasonal presence of fish assemblages and important commercial species and therefore negates the requirement for an autumnal fish ecology survey.* It was noted that the project areas are deemed to be too far out to cover herring spawning areas. It was also noted that sandeels are not likely to be an issue. It was agreed that specific fish surveys would not be carried out on the cable route. Instead any fish caught during epi-benthic trawling (see below) will be preserved, analysed and reported as part of the fisheries assessment.	**LC**
Benthic TOR CEFAS confirmed that the approach put forward in the TOR for both benthic and epi-benthic survey was acceptable for characterisation. CEFAS raised some queries regarding the statistical analysis and stated that they would like their statistician to review the report. This review would not prevent survey works commencing. EAOW offered to arrange a call with the contractor who provided the statistical analysis to answer any questions raised. **Action 120731-3: PW to send back comments on minor details of the statistical analysis via email. Subsequently completed.**	**PW**

Cefas request that a volume of grab sample rather than a depth measurement of the Hamon grab should be taken. Cefas noted that sampling outside of the planned cable route area, within the central shipping lane could be useful if H&S concerns can be overcome.	
<u>Next Steps</u> EAOW agreed to revise the Fish TOR based on the discussion and re-issue for approval. **Action 120731-4: EAOW to revise Fish TOR and resubmit for approval.** EAOW will proceed with the Benthic survey based on the TOR as presented. Any questions relating to the statistical analysis will be dealt with separately	**MC**

New and Outstanding Actions	
Action 120731-1: Circulate presentation to all attendees.	**MC/MW**
Action 120731-3: EAOW to revise Fish TOR and resubmit for approval.	**MC**

10.1.3 Minutes from First Benthic Ecology Expert Topic Group Meeting

EAOW Round 3 Offshore Programme East Anglia THREE & FOUR, Benthic ETG Meeting 1			
Date of Meeting:	10.09.2013	**Venue:**	Tudor Street
Attendees			

Name	**Initials**	**Organisation**
Keith Morrison	KM	EAOW
Mandy Gloyer	MG	EAOW
Marcus Cross	MC	EOAW
Rebecca Walker	RW	Cefas
Louise Cox	LC	Cefas
Claire Ludgate	CL	Natural England
Paul Whomersley	PW	Cefas
Paolo Pizzolla	PP	Royal HaskoningDHV
David Tarrant	DT	Royal HaskoningDHV

Document Ref:		**Issue Date:**	11.09.2013

11:20-13:30

ITEM	DESCRIPTION	ACTION
1	HSE	
2	Introduction- PP presented the evidence plan expectations.	
3	Data collection- PW – concerned that there are no control sites- DT the survey was for characterisation and not for monitoring. Pre-construction stage would be the time to complete this.	
4	Impacts Worst case scenarios will be defined at the next ETG meeting **Physical disturbance** – incorporate habitat loss at construction PW *Mytilus* found in the cable route are of concern and it may be necessary to say that they will be subject to a preconstruction survey **Smothering** PP proposed that we do not do site specific modelling for suspended sediments/plumes **Habitat loss (operation)**	RHDHV to look into the data concerning the potential *Mytilus* reef. For discussion at Phys Proc ETG

ITEM	DESCRIPTION	ACTION
	PW – will mattressing be used for cable protection/ crossings? PP we will assess mattressing and rock dump.	
	Methodologies It was agreed that the definitions for use in the assessment will be circulated along with worked examples to all in the ETG	RHDHV to circulate the magnitude and sensitivities along with a worked example.
	Cumulative Cumulative assessment for all impacts can be wrapped up in a small concise section of the ESs	RHDHV to compose and circulate this section.

ID	Issue on which EAOW THREE and FOUR seek agreement on	Agreed Position
1	It was agreed that the time for specific *Sabellaria* surveys would be the preconstruction stage and would not be required for the EIA	Agreed (in line with East Anglia ONE SoCG)
2	Sufficient survey data has been collected	Agreed Natural England and Cefas would like to see the 2013 site specific survey reports. To save staggered receipt of outputs, survey reports will be provided as part of package for next ETG meeting (early 2014)
3	The list of impacts proposed in the Evidence Plan method statement and the powerpoint presentation.	Agreed
4	Agreement of the proposed methodology for each impact	Agreed
5	It is agreed that the sensitivity and magnitude definitions are appropriate	These will be circulated along with a worked example. Once this has been reviewed it will be signed off. Cefas and Natural England will review and it was agreed will return within **two weeks**.
6	Agreement that there will be no requirement for site specific modelling of sediment dispersal	Agreement in principle dependent on the outcomes of the coastal process meeting on the 12th of September 2013.
7	If *Mytilus* reef is an issue the time to survey would be preconstruction	Agreed EAOW will look at the benthic data to determine status of *Mytilus* (i.e. is it likely to be reef forming)
8	Agreement that all cumulative impacts can be wrapped up in one section of the ES	EAOW will circulate example text and then it can be signed off by the ETG. PW said consideration should be given to other projects but the idea of adding up many footprints and expressing this as a % is not appropriate. Anglia aggregate sites need consideration
9	Benthic ecology impacts can be screened out of HRA	Agreed – SAC impacts screened out as sites not overlapped and no pathway for impacts as benthic impacts largely temporary and localised (i.e. Haisborough, Hammond and Winterton, North Norfolk and Saturn Reef, Margate and Long Sands) Benthic features of Outer Thames Estuary SPA will be considered as part of the ornithology assessment

10.1.4 Clarification of Impact Assessment methodology and Approach to Cumulative impacts.

3. Provided below is the clarification of impact assessment methodology and approach to cumulative impacts. This was requested by the group at the first meeting and was distributed on the 13th September 2013 to members following the meeting.

1.1 Introduction

1. This note presents the Benthic Ecology and Fish and Shellfish Ecology definitions of sensitivity and magnitude which East Anglia Offshore Wind (EAOW) THREE and FOUR propose to use for their Environmental Impact Assessment (EIA). EAOW wish to agree these definitions with the Marine Management Organisation (MMO) Natural England and Cefas as part of the Evidence plan process. The sensitivity definitions for the two topics are slightly different and therefore both are presented below. A theoretical example of how these would be used within the ES is the presented.

2. Also included within the note is an example of the text we would wish to use to wrap up all the cumulative impacts to benthic ecology as part of the EIA.

1.2 Sensitivity and Magnitude

3. The sensitivity definitions for both Benthic Ecology and Fish and Shellfish are presented in Table 1 and Table 2 below

Table 1. Benthic ecology definitions of the different sensitivity levels for receptors:

Sensitivity	Definition
High	Individual receptor (species or habitat) has very limited or no capacity to accommodate, adapt or recover from the anticipated impact.
Medium	Individual receptor (species or habitat) has limited capacity to accommodate, adapt or recover from the anticipated impact.
Low	Individual receptor (species or habitat) has some tolerance to accommodate, adapt or recover from the anticipated impact.
Negligible	Individual receptor (species or habitat) is generally tolerant to and can accommodate or recover from the anticipated impact.

Table 2. Fish and shellfish ecology definitions of the different sensitivity levels for receptors:

Sensitivity	Definition
High	Individual receptor (species or stock) has very limited or no capacity to avoid, adapt to, accommodate or recover from the anticipated impact.
Medium	Individual receptor (species or stock) has limited capacity to avoid, adapt to, accommodate or recover from the anticipated impact.
Low	Individual receptor (species or stock) has some tolerance to accommodate, adapt or recover from the anticipated impact.
Negligible	Individual receptor (species or stock) is generally tolerant to and can accommodate or recover from the anticipated impact.

4. In addition, for some assessments the 'value' of a receptor may also be an element to add to the assessment where relevant – for instance if a receptor is a designated feature (i.e. ecological, geological or historic) or has an economic value.

5. It should be noted that high value and high sensitivity are not necessarily linked within a particular impact. A receptor could be of high value (e.g. a European (Annex 1) designated habitat) but have a low or negligible physical/ecological sensitivity to an effect – it is important not to inflate impact significance simply because a feature is 'valued'. The narrative behind the assessment is important here; the value can be used where relevant as a modifier for the sensitivity (to the effect) already assigned to the receptor.

Table 3. Value definitions

Value	Definition
High	Internationally or nationally important
Medium	Regionally important / rare
Low	Locally important / rare
Negligible	Not considered to be particularly important / rare

6. The proposed definitions for levels of magnitude are displayed in Table 4.

Table 4. Definitions of the magnitude levels for a generic receptor (which could either be a benthic receptor or a Fish and Shellfish receptor):

Magnitude	Definition
High	Fundamental, permanent / irreversible changes, over the whole receptor, and / or fundamental alteration to key characteristics or features of the particular receptors character or distinctiveness.
Medium	Considerable, permanent / irreversible changes, over the majority of the receptor, and / or discernible alteration to key characteristics or features of the particular receptors character or distinctiveness.
Low	Discernible, temporary (throughout project duration) change, over a minority of the receptor, and / or limited but discernible alteration to key characteristics or features of the particular receptors character or distinctiveness.
Negligible	Discernible, temporary (for part of the project duration) change, or barely discernible change for any length of time, over a small area of the receptor, and/or slight alteration to key characteristics or features of the particular receptors character or distinctiveness.
No change	No loss of extent or alteration to characteristics, features or elements.

7. The matrix that corresponds to the above definitions is displayed in Table 5.

Table 5 Example impact assessment matrix

Sensitivity	Magnitude				
	High	**Medium**	**Low**	**Negligible**	**No Change**
High	Major	Major	Moderate	Minor	No change
Medium	Major	Moderate	Minor	Negligible	No change
Low	Moderate	Minor	Negligible	Negligible	No change
Negligible	Minor	Negligible	Negligible	Negligible	No change

1.2.1 Worked example

8. The worked example provided below is for the smothering of *Sabellaria spinulosa* during construction. The EIA will consider the impacts of smothering of all relevant species and habitats, however to keep this example short and concise only *S. spinulosa* has been considered. Please note this is a theoretical example of how the definitions and matrices will be used and in no way represents the final EIA assessment which will be further refined by amongst other things the results of the Physical Processes assessments.

9. There is potential for the following construction activities to increase suspended sediment and therefore impact upon *S. spinulosa* through smothering:

- Seabed preparation for foundations;
- Jack up barge feet placement; and
- Cable laying activities

10. Research has shown that *S. spinulosa* has limited or no sensitivity to smothering (Last et al. 2011; Jackson and Hiscock, 2008) and that the species is able to recover quickly from such events. Therefore the sensitivity of this species to smothering is considered to be negligible.

11. Within the cable route the biotope SS.SBR.PoR.SspiMx (*S. spinulosa* on stable circalittoral mixed sediment) was identified. This biotope is of importance as it has the potential to contain Annex 1 Habitat in the form of biogenic reef. Due to its designation as an Annex 1 habitat *S. spinulosa* reef is considered to be of high value.

12. Low numbers of *S. spinulosa* were found within the East Anglia THREE site with no indication of the presence of reef forming aggregations. Slightly larger numbers of *S. spinulosa* were found within the cable route and the presence of the biotope SS.SBR.PoR.SspiMx indicates reef forming potential. The temporary impacts

associated with cable burial within the cable route and smothering within the East Anglia THREE site during construction are likely to result in a **low** magnitude of impact.

13. Considering the low sensitivity and high value of the receptor the sensitivity level has been modified from negligible to **low** and taking into account the low predicted magnitude the impact of smothering of *S.spinulosa* is likely to be of **negligible** significance.

1.3 Cumulative impacts example

14. As proposed in the Evidence plan meeting held on the 11th of September 2013 the cumulative impacts for benthic ecology (and fish and shellfish ecology with the exception of cumulative impacts upon sandeels and underwater noise impacts) will be assessed in one small concise section of the Environmental Statement (ES) chapter. The following is an example of how this may be presented. This approach may change as further information becomes available.

15. The impacts to the benthos are:

- Physical disturbance and habitat loss;
- Smothering;
- Re-mobilisation of contaminated sediments;
- Underwater noise and vibration; and
- Colonisation of foundations and cable protection

16. These impacts will mostly be temporary, small scale and localised for the East Anglia THREE. Given the distances to other activities in the region (e.g. other offshore windfarms, aggregate extraction) and the localised nature of the impacts there is no pathway for interaction between impacts cumulatively. Whilst it is recognised that across the Zone or Regional Sea there will be additive impacts, the overall combined magnitude of these will be **negligible** relative to the scale of the habitats affected. In addition given the ubiquity and low ecological sensitivity of habitats across the Southern North Sea (and indeed across areas deemed suitable for development) sensitivity is also likely to be **low or negligible** at a cumulative scale. In the case of physical disturbance and smothering during construction there is only potential for such additive impacts if project construction schedules overlap. In cases where sensitive habitats are present, these will be avoided by micro-siting and design in

those projects (as has been committed to for East Anglia THREE), therefore there would be **negligible** or **no impacts**.

17. Therefore, given that the impacts assessed for East Anglia THREE (i.e. project level impacts) are considered **negligible** or would be avoided by design it is considered that at a cumulative (i.e. additive) level, impacts upon the benthos would be **negligible**.

1.4 References

Last KS, Hendrick VJ, Beveridge CM & Davies AJ (2011). Measuring the effects of suspended particulate matter and smothering on the behaviour, growth and survival of key species found in areas associated with aggregate dredging. Report for the Marine Aggregate Levy Sustainability Fund, Project MEPF 08/P76. 69 pp

Jackson, A. and K. Hiscock 2008. *Sabellaria spinulosa*. Ross worm. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 11/09/2013]. Available from: www.marlin.ac.uk/speciessensitivity.php?speciesID=4278

10.1.5 Emailed Agreement to Outcomes of ETG Meeting 1

From: Ludgate, Claire (NE) [mailto:Claire.Ludgate@naturalengland.org.uk]
Sent: 27 September 2013 19:50
To: Tarrant, D.C. (David); Cox, Louise P.N (CEFAS); Walker, Rebecca (CEFAS); Herdson, Rebecca (NE); Whomerlsey, Paul (CEFAS); Drake, Holly (CEFAS)
Cc: Cross, M (Marcus) - Scottish Power Renewables; Mandy.gloyer@scottishpower.com; keith.morrison@ScottishPower.com; Burrows, Frances (MMO); Nicholson, Cheryl (MMO); Pearson, Fiona (Defra)
Subject: RE: Evidence Plan - Fish and Benthic Meeting Minutes [Filed 11 Oct 2013 09:06]

Hi David,

I can confirm that Natural England are content with the meeting minutes and the list of agreed points from both the fish and benthic ETG meetings and have no further comment to make on them.

With regard to the magnitude, sensitivity and cumulative impacts paper, Natural England is content with the definitions of sensitivity and magnitude to be used in the assessment.

The example cumulative impact text helpfully demonstrates the proposed approach and providing sufficient explanation is given in the text for the reasoning behind this approach, Natural England is happy for it to be used.

Kind regards,

Claire

Claire Ludgate

MSc AMIMarEST

Marine Lead Adviser

Southern North Sea Team

Natural England

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10.1.6 Emailed Agreement to Postpone ETG meeting 2

From: Ludgate, Claire (NE) [mailto:Claire.Ludgate@naturalengland.org.uk]
Sent: 17 April 2014 18:12
To: Pizzolla, P. (Paolo); Cox, Louise P.N (CEFAS); Walker, Rebecca (CEFAS); Herdson, Rebecca (NE); Browne, S (Siobhan) - Natural England; Foden, Dean (CEFAS); Drake, Holly (CEFAS); Barrio Frojan, Christopher (CEFAS)
Cc: Covey, (Roger) - Natural England; Morrison, K (Keith) - Scottish Power Renewables; mandy.gloyer@scottishpower.com; Tarrant, D.C. (David) Subject: RE: East Anglia THREE and FOUR - Evidence Plan

Dear Paolo,
Natural England are content that there is no requirement for a further meeting to discuss benthic, fish or physical processes topics prior to the PEI in May.

We have also reviewed the HRA document and are satisfied that, as discussed in the first evidence plan meeting, all potential effects on physical processes, fish and benthic have been scoped out.

Many thanks,
Claire

Claire Ludgate
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We are here to secure a healthy natural environment for people to enjoy, where wildlife is protected and England's traditional landscapes are safeguarded for future generations.

In an effort to reduce Natural England's carbon footprint, I will, wherever possible, avoid travelling to meetings and attend via audio, video or web conferencing.

Natural England is accredited to the Cabinet Office Customer Service Excellence Standard

From: Pizzolla, P. (Paolo) [mailto:paolo.pizzolla@rhdhv.com]
Sent: 27 March 2014 08:45
To: Cox, Louise P.N (CEFAS); Walker, Rebecca (CEFAS); Herdson, Rebecca (NE); Browne, Siobhan (NE); Foden, Dean (CEFAS); Drake, Holly (CEFAS); Barrio Frojan, Christopher (CEFAS)
Cc: Ludgate, Claire (NE); Covey, Roger (NE); Morrison, K (Keith) - Scottish Power Renewables; Mandy.gloyer@scottishpower.com; Tarrant, D.C. (David)
Subject: East Anglia THREE and FOUR - Evidence Plan

All
At the East Anglia THREE & FOUR evidence plan meetings (for physical processes, benthic and fish ecology) held in autumn last year EAOW stated the intention to have a second meeting in early 2014 to share the initial assessments prior to the submission of the Preliminary Environmental Information (PEI) scheduled for May. However, due to delays in the assessment process we have been unable to sufficiently progress the preliminary assessment to share with you until now. Given how close we now are to the PEI submission (late May), there would be little opportunity to enable any feedback from a meeting held before PEI to enable them to be taken into account in the PEI submission. Therefore, would people prefer to hold off on having a meeting until after PEI submission and thus see the finalised assessments?

As previously mooted, EAOW believe that it would be beneficial to have a workshop in June after PEI submission in order to discuss the assessment – given that these three topics are closely linked we could probably cover all in a one-day workshop. We believe that this would help you to put together your PEI response and enable us start our finalisation of the assessment, whilst providing an opportunity to clarify any areas of the assessment that and talk through any specific questions or queries you have. This would enable EAOW to have early warning of (and time to deal with) any issues and also begin discussions on the outline mitigation measures presented in PEI.

EAOW intends to submit the DCO application for East Anglia THREE in November this year. EAOW is still looking at the timing of the PEI for East Anglia FOUR and will update all stakeholders on this soon. The plan for East Anglia FOUR is to submit the DCO application in 2015.

In addition, please find attached the HRA Screening Report. As discussed in the first evidence plan meeting, all potential effects on physical processes, benthic and fish ecology have been screened out.

Regards

Paolo

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10.1.7 Minutes from ETG Meeting 2 (S42 Consultation)

4. Provided below are the minutes from second benthic expert topic group meeting which was held on the 3rd July 2014. At this meeting other topics were discussed including Physical Processes, Fish Ecology and Marine Mammals, however for the purposes of this Appendix only the minutes relevant to Benthic Ecology have been displayed below.

5. Also included below in section 10.1.8 is a table which was circulated following the meeting which contained further comment, by Natural England on the issues that had been discussed during the meeting. Again this table contained comment on other topics however it is only those relevant to benthic ecology which are provided below.

East Anglia Offshore Wind Limited East Anglia THREE

East Anglia THREE, Marine PEI/Evidence Plan Meeting – 03/07/14

Attendees		
Name	**Initials**	**Organisation**
Mandy Gloyer	MG	EATL
Kathy Wood	KW	EATL
Jesper Kyed Larsen	JKL	EATL
Lou Burton	LB	Natural England
Francesca Shapland	FS	Natural England
Kathleen Mongan	KM	MMO
Holly Drake	HD	Cefas
Dean Foden	DF	Cefas
Paul Whomersley	PW	Cefas
Louise Cox	LC	Cefas
Paolo Pizzolla	PP	Royal HaskoningDHV
Beth Mackey	BM	Royal HaskoningDHV
Nick Cooper	NC	Royal HaskoningDHV
Apologies		

AGENDA		
Item	**Description**	**Action**
1	Health and Safety Introductions - All	n/a
2	**Project update**	
4	**Benthic ecology**	
	Approach FS – NE broadly happy with the assessment, some minor comments FS – With regard to micro-siting for reef features – the text says that EATL would avoid or minimise impact. NE would prefer avoidance PP – EAOW will seek to avoid where possible, at this stage it is not possible to rule out some impact, and this is dependent on the pre-construction survey and final design/routeing of cables and foundations. LB – In order to determine if an area is indeed important for reef there will be a need to look at historical (characterisation survey) records as well pre-construction survey (geophys and drop down video). Ultimately the MMO will make the decision on whether adequate account has been taken of reef locations.	
	Baseline *Comment 75 – established Sabellaria* FS – there looks to be areas that are important for *Sabellaria*, please check again on these.	ACTION – look at the four areas of potential importance again, clarify in ES the importance of these and cross reference with the

		appendices
	Comment 76 – sandbanks definition PP – not aware of any recent definition for sandbanks	ACTION – FS to look at definitions again and confirm if this has changed
	Comment -78 Duration of disturbance FS – it would aid in the understanding of impacts if there was greater clarity over duration of impacts	ACTION – ES to provide indicative information on how long key activities take (i.e. foundation installation, placement of TPs and topsides)
	Comment 81 – 82 Key species HD – look at effects on key species. *Sabellaria*, mussels FS – Ophiuroidea – a threatened or decling spp.? HD – note that BAP habitats now defined as habitats of principal importance – text should reflect this	ACTION – EATL to look at key species highlighted, in particular treatment of Ophiuroidea as threatened and declining spp. ACTION – check status and nomenclature for key spp and habitats.
	Comment 84 - decommissioning NE/Cefas – would like more clarity on decommissioning processes and narrative on why the impacts are lower than for construction	ACTION – provide more information on duration of decommissioning activities and make the narrative clearer.
	In principle monitoring plan LB – an 'in principle monitoring plan' is being put together for other R3 OWFs, this would be high level and bring together offshore commitments. LB - NE would seek commitment to consideration of removal of cable protection at time of decommissioning – at present it is not clear if this is intended to be left in situ	
7	**All topics**	
	Agreement log LB – NE cannot sign off on conclusions of the assessment, this can only be done once the DCO is submitted. The agreement log is welcome as an indication of what will be covered by the SoCG	ACTION – circulate agreement logs for information only
	Project description There are areas of the project description – particularly in relation to duration of individual activities – which could be better defined to improve understanding of the impacts	
	In principle monitoring plan NE would welcome the inclusion of an in-principle monitoring plan within the DCO covering offshore topics. This would be high-level rather than prescriptive.	

	This would be referred to in the DML conditions. In particular this would be worded to allow for alternatives to site-specific monitoring to be used to discharge licence conditions.	

10.1.8 Follow up from ETG Meeting 2

6. Provided below are the further set off comments were submitted by Natural England following the ETG 2 meeting

NE Point	Page	Section	Reviewer	Comment	NE Comments following workshop 03/07/14
Chapter 10 Benthic Ecology					
62	General		FS	Overall we find the chapter on Benthic Ecology and the accompanying appendices clear and informative, with surveys carried out using appropriate methodology and data presented in an appropriate format. We recognise that the benthic ecology across the East Anglia 3 site is largely homogenous, according to the current data, consisting of few separate infaunal communities.	No Further comment
65	3	Appendix 7.3	FS	Natural England agrees that, due to the mobile nature of the species, providing pre-construction surveys and micro-siting of turbines to avoid areas of Sabellaria is a useful method to avoid adversely affecting this species/habitat. However, having reviewed the submitted survey data, we have some reservations with leaving all mitigation to the pre-construction stage. Note that there are four distinct areas showing consistently high Sabellaria presence, with reef identified in Figure 21 and Figure 50. These areas appear to be established and therefore it is our view that a buffer may be required around these areas. Natural England would welcome further discussion about the survey data and mitigation. Note that it states in Table 10.1 that 'in the event of Annex 1 habitats being present during pre-construction surveys, micro-siting would ensure impacts are minimised or avoided'. We would expect that, once the position of reef features have been	Noted by EA 3 as above for point 34 Agreed in the workshop that monitoring will be a condition of the DML. And an In Principle Monitoring Plan (IPMP) as provided by Forewind for Creyke Beck would be helpful and this was support by the MMO

NE Point	Page	Section	Reviewer	Comment	NE Comments following workshop 03/07/14
				fully established during pre-construction surveys, micro-siting should be able to avoid the impacts and where this is not possible the surveys data should be sufficiently robust to enable impacts to be minimised as much as possible and thus reducing the risk.	
66	57	10.6.1 Potential impacts during consultation	FS	Overall this section is lacking in detail. More detail on the time that specific habitats would be disturbed and the habitats and species involved would be helpful. We appreciate the timing of works has been covered in an earlier chapter but it has not specifically been related to this chapter i.e. to benthic habitat disturbance.	EA3 Going to provide some further clarity on the temporal aspects for the final ES.
67	26	10.4.2.2.3 Sampling for Epifauna Para 42		It is stated that 'where large numbers of similar sized fish and invertebrates were encountered, subsampling was carried out in an appropriate manner'. This requires more detail; what exactly is meant by 'an appropriate manner'?	To be provided in final ES.
67	41	Para 83	FS	The evidence suggests that brittlestars (ophiuroidea) represent a greater proportion of the East Anglia 3 site that on the East Anglia one site, with species found to be present at 21 of the EA3 sub sample stations and comprising 5% of the EA3 recorded data. It is not inferred in the text but note these species are listed on the OSPAR List of Threatened and/or Declining Species and Habitats (Region II North Sea and Region III – Celtic Sea). Natural England would like further discussions over these findings.	To be considered further by all parties NE can confirm that Brittlestar beds are widespread around the UK, but are uncommon on a global scale and can play a major role in local ecosystems. They are considered a species of conservation interest and although this habitat/species is not legally protected, Natural England considers it best practice to implement a monitoring regime to investigate the impacts construction and operation of human activities have on

NE Point	Page	Section	Reviewer	Comment	NE Comments following workshop 03/07/14
					brittle star beds.
68	54 in Ch 10, 81 in App 10.1	E.3 Biodiversity Action Plan 10.5.5.3 UK Biodiversity Action Plan	FS	UK BAP (Biodiversity Action Plan) habitats are now listed as habitats of principle importance' under section 41 of the 'Natural Environment and rural communities act (NERC) 2006. This should be reflected in the submitted report.	Noted in workshop by EA 3
				Note that, if the placement of structures and cable protection results in a localised increase in biodiversity yet changes the species composition of the area in question, we would consider that to be a negative effect on the environment, the term 'beneficial' in this context is misleading.	No further comment
69	App 10, p34	4.1.2.5 para 34		Note that, if the placement of structures and cable protection results in a localised increase in biodiversity yet changes the species composition of the area in question, we would consider that to be a negative effect on the environment, the term 'beneficial' in this context is misleading.	No further comment
70	App 10 36	4.1.3.1.1 para 22	FS	It is stated that '*the methods used for assessing the impacts during decommissioning will be very similar to those used during the construction phase. The operation involved will be slightly different, however it is anticipated that the magnitude of impacts will be less*'. The applicant needs to explain this in more detail. How will it differ from the methods used during the construction phase and why will the magnitude of impacts be less?	It was noted in the workshop that further expansion is required.
71	App 10	4.1.4 – Potential cumulative	FS	This section on cumulative impacts is lacking any explanation on the proposed method of assessment (which is included in all other sections). We would expect this to be included, particularly	Natural England would welcome some signposting included in this section of the

NE Point	Page	Section	Reviewer	Comment	NE Comments following workshop 03/07/14
		impacts		given potential impacts associated with the offshore cable corridor.	ES
73	17	Appendix 4.1	FS	It is stated that 'it is likely that communities are habituated to smothering from natural events and are tolerant to smothering'. Note that a recent study found an upper threshold to smothering tolerance which varies with species (Last et al, 2001) and therefore we do not agree with this statement. We also find this section lacking in detail. There is no explanation on the level of smothering or expected sediment loads in water in this chapter, for example.	Further expansion required within the ES. EA 3 confirmed at the workshop that they had looked at Marlin to consider the sensitivity and if it was not listed then looked at habitat and matched that to the sensitivity.

Appendix 10.1 Ends Here