Vattenfall Wind Power Ltd

Thanet Extension Offshore Wind Farm

Annex A to Appendix 7 to Deadline 4C Submission: Herring and sole spawning potential calculations

Relevant Examination Deadline: 4C

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Drafted By:	GoBe Consultants Ltd
Approved By:	Daniel Bates
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Contents

Tables

1 Spawning Potential Calculations for Herring and Sole

1.1 Background

1 Cefas and the MMO have raised concerns over potential underwater noise impacts from pile driving to herring and sole during their key spawning seasons. For this region within the southern North Sea, these spawning periods are defined as:

- Sole: 1st April – 15th May inclusive (a period of 44 days)
- Herring: 23rd November – 15th January inclusive (a period of 53 days) for the Downs/East Channel stock of relevance. (*Note: the Thames/Herne Bay stock spawns later in February – April but is outside the noise impact ranges from Thanet Extension and is considered a smaller sub-stock*).

1.2 Applicant's Response

2 The Applicant has produced calculations for spawning potential (defined as the spawning area available multiplied by the time available for spawning). This approach has been previously adopted for UK offshore wind farm projects including Walney Extension and Gwynt y Môr and aims to contextualise spatial impacts in terms of their temporal overlap with spawning periods. The use of a spawning potential approach is therefore established for NSIPs, and in particular has been applied to consideration of potential effects on sole (Gwynt y Môr) and herring (Walney Extension).

Spawning Potential

3 The first step is to define the spawning potential for each species in terms of its spatial and temporal extent. To do this, the spawning periods for each species (t) are multiplied by the spawning area (a) to give the spawning potential S(pot).

4 Combining the spawning area and spawning period allows the calculation of the total spawning potential for each species which could be affected by the Thanet Extension piling activity, using the formula:

$$t \times a = S(pot)$$

5 For sole, this area is the higher intensity area in the south-east defined by Ellis *et al*. (2012), ranging from the East English Channel to mid-East Anglia, an area of approximately 31,869 km^2.

6 For Herring, this is defined by the Coull *et al.* (1998) Downs stock which includes 3 areas from the Strait of Dover out into the southern North Sea, the Eastern Channel and Normandy. The spawning potentials for sole and herring are described in Table 1, using the spawning periods outlined in paragraph 1 above.

Piling Time

7 Piling time is calculated as a worst-case, defined as 6 hours per monopile, though the average time is likely to be 3 hours at most as described in the Offshore Project Description chapter. Assuming a worst-case of 6 hours per monopile, and a total of 36 monopiles (including 34 WTG foundations, one meteorological mast foundation and one OSS foundation), the total active piling time is 216 hours.

Piling Area

8 The piling area is the area describes the area of potential spawning area affected by the noise impact and is represented by the area of the modelled noise contours that overlap with the spawning grounds for sole and herring. In the case of sole, this is just the area covered by these noise contours as they fully overlap with the defined sole spawning grounds. For herring, there is a partial overlap and therefore the piling area is represented by the area of overlap between the modelled noise contours and the defined herring spawning grounds.

9 In Table 1, these areas have been presented in terms of both the fleeing receptor modelling presented in the ES and supported by scientific literature including alignment with mean swim speeds recorded during the spawning season, and the additional stationary receptor modelling requested by Cefas/MMO during examination.

10 It should be noted that the maximum values given are reliant on piling at the worst-case modelled location being piled for the full 216 hours, and that as piling moves westwards into the array, the spatial extent of overlap will reduce (tending towards the minimum) due to smaller impact ranges at shallower depths and increased distance from spawning grounds (in the case of herring). Therefore, the maximum values presented are highly conservative. As such the mean value is also presented to provide context when considering the likely impact on spawning potential.

Percentage of Spawning Potential Affected

11 For the percentage of spawning potential affected, the affected spawning potential (area affected multiplied by piling time) is expressed as a percentage of the total spawning potential for each species, and has been agreed as a suitable method of calculating the scale of potential impact on other OWFs within UK waters. Table 1 describes that, with the exception of herring considered as a stationary receptor, the spawning potential affected is less than 1% for all receptors, with the exception of herring under the maximum worst case for all piling events combined. As has been noted previously in this document, this should be contextualised against the fact that the worst case only occurs at the most easterly location, and all subsequent piling events will be of a lesser impact, with the reality being 1/36 of that value for a single event at the worst case location (0.049%) which reduces down to 1/36 of the combined total for the most distant location (0.004%). Any given piling event will therefore have an impact of between 0.049 and 0.004%. When the worst case for 207dB SELcum is considered, using the above calculation but applied to the modelled (2.63km^2) area of interaction, this provides a worst case of 0.007% impact on spawning potential.

12 Regarding the impact to herring spawning, the area considered within this review of spawning potential is the historic spawning ground recorded in Coull *et al.*, 1998. More recent data (IHLS) as presented in the ES illustrates that herring spawning for the Downs Stock over the last 10 years has been concentrated in the Eastern Channel. As such, any interaction with the more conservative areas identified by Coull *et al* (*ibid*) can be considered to be highly precautionary and conservative.

13 When combined with the request to provide impact ranges based on a stationary receptor, and the worst case modelled location, it can be seen that there are multiple layers of precaution applied to the assessment, the result of which is still an effect which can be considered not significant, with no potential for significant effect on the spawning stock of sole or herring. In this context any mitigation in the form of a seasonal restriction or application of bubble curtains can be considered to be entirely disproportionate to the scale of effect.

Table 1: Spawning potential affected by piling for sole and herring.

Total Spawning Potential		
Sole	Total spawning time 1st April to 15th May (44 days) (hours)	1056
	Total high intensity spawning area (km2)	31869
	Total Maximum spawning potential (expressed as km2 hours)	33653664
Herring	Total spawning time 23rd November - 15th January (53 days) (hours)	1272
	Total spawning area (Coull et al. (1998) polygon (km2)	3333
	Total Maximum spawning potential (expressed as km2 hours)	4239576
Piling Time		
Sole	Piling Time over 44 Day period 1st April - 15th May (Hours)	
	Max piling time over 44 days (Assumes 36 monopiles (34 WTGs, 1 Met-mast, 1 OSS)	216
Herring	Piling Time over 53 Day period 23rd November - 15th January (Hours)	
	Max piling time over 53 days (Assumes 36 monopiles (34 WTGs, 1 Met-mast, 1 OSS)	216
Piling Area		
	Estimated Area Affected by Subsea Piling Noise at 186 dB SELcum (km^2)	
Sole	Max (stationary receptor)	1224
	Mean (stationary receptor) (	877
	Min (stationary receptor)	530
	Max (Assuming 1.5m/s fleeing speed)	163
	Mean (Assuming 1.5m/s fleeing speed)	97
	Min (Assuming 1.5m/s fleeing speed)	31
Herring	Max (stationary receptor)	641
	Mean (stationary receptor)	349
	Min (stationary receptor)	57
	Max (Assuming 1.5m/s fleeing speed	73
	Mean (Assuming 1.5m/s fleeing speed)	36.5
	Min (Assuming 1.5m/s fleeing speed)	0
% of Total Spawning Potential Affected by Piling (TTS 186 dB SELcum)		
	36 monopiles total (34 WTGs, 1 met-mast, 1 OSS)	
Sole	Max (stationary receptor)	0.786
	Mean (stationary receptor)	0.563
	Min (stationary receptor)	0.340
	Max (Assuming 1.5m/s fleeing speed)	0.105
	Mean (Assuming 1.5m/s fleeing speed)	0.062

	Min (Assuming 1.5m/s fleeing speed)	0.020
Herring	Max (stationary receptor)	1.768
	Mean (stationary receptor)	0.962
	Min (stationary receptor)	0.157
	Max (Assuming 1.5m/s fleeing speed	0.201
	Mean (Assuming 1.5m/s fleeing speed)	0.101
	Min (Assuming 1.5m/s fleeing speed)	0.000