

# Memorandum

**13 August 2002**

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Subject: 2041  
Doc. nr. 2041-02-03-004, rev. 2  
Number of pages: 9

**Job : Horns Rev. Introducing hard substrate habitats**

**Emne : Summary. Baseline surveys 2001**

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### 1. Introduction

The Ministry of Environment and Energy has requested ELSAM and ELTRA to establish an off-shore wind farm with an output of 150 MW in the waters of Horns Rev, approximately 15 km off Blåvandshuk, which is the most westerly point of Denmark.

The first phase of construction of the wind farm will start in spring 2002. Before the construction activities will take place a baseline description of the benthos has been conducted as a part of an Environmental Control and Monitoring Programme for the introduction of hard bottom substrates in the North Sea. The establishment of A Control and Monitoring programme is required according to some environmental guidelines for offshore wind farms prepared by the Danish Energy Agency.

This memorandum summarise the result from the baseline survey on benthos in June 2001 and the results from a comparative survey in September 2001 on benthos in relation to a programme concerning the stomach content of fish.

### 2. Survey area

In June 2001 at a total of 18 stations at 6 wind turbine locations in the wind farm area samples were recovered for macrofaunal analysis, figure 1. The 6 locations are in areas where the depth is less than 10 meters, and thus representative of the whole turbine area.

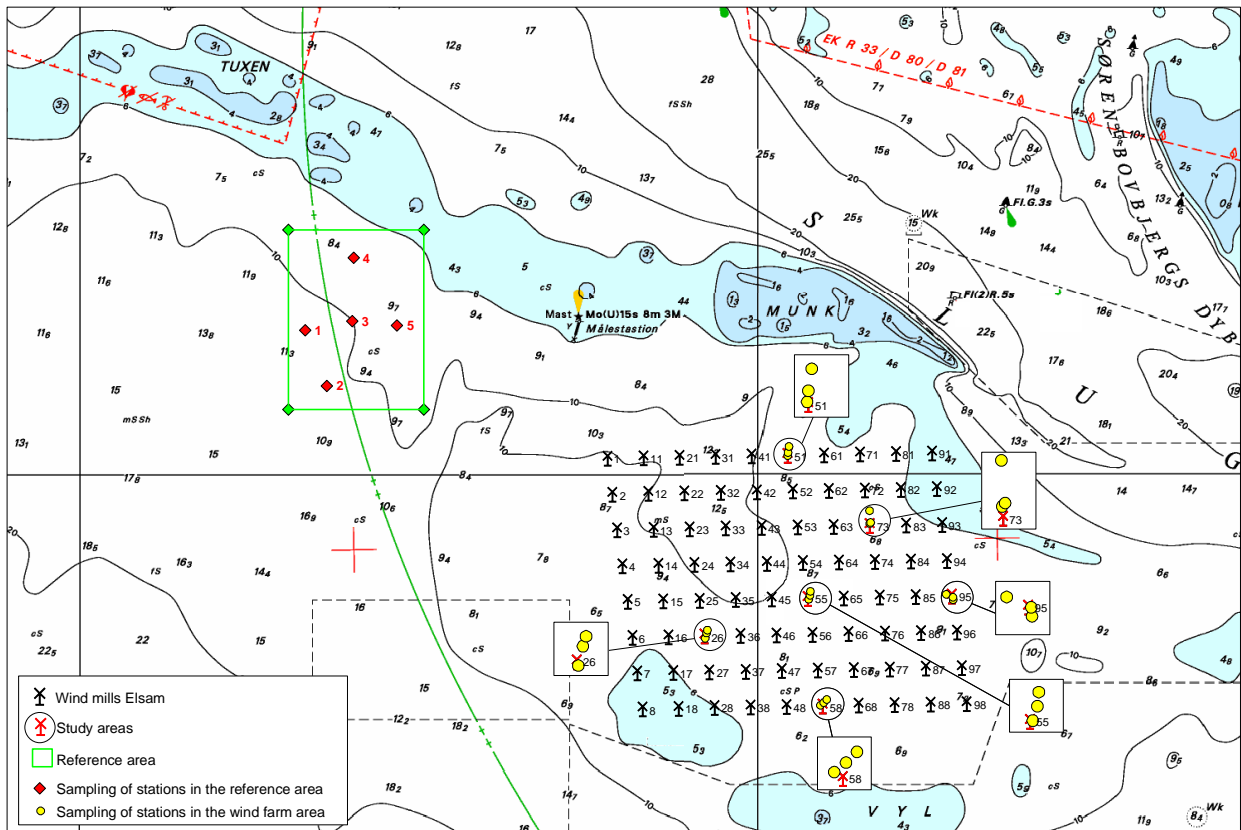


Figure 1. Map of locations sampled in June 2001.

At the wind farm site two replicates of samples for detailed macrofaunal analysis were collected by a diver from each of three stations along a transect in the lee of the prevailing current, as the expected impact will be due to the effect of possible changes in currents by the wind mill foundations. Samples were recovered using a core sampler of 0.0123m<sup>2</sup> seabed surface area. The three stations are located at distances of 5, 25 and 100 m from the edge of the planned scour protection.

In September 2001 samples were recovered from 9 stations at 3 wind turbine locations and at 5 stations in a designated reference area, figure 2. The sampling design used in the sampling in June 2001 was repeated in September 2001 at the 3 turbine locations whereas only two replicates were recovered from one position at each of the 5 locations in the reference area.

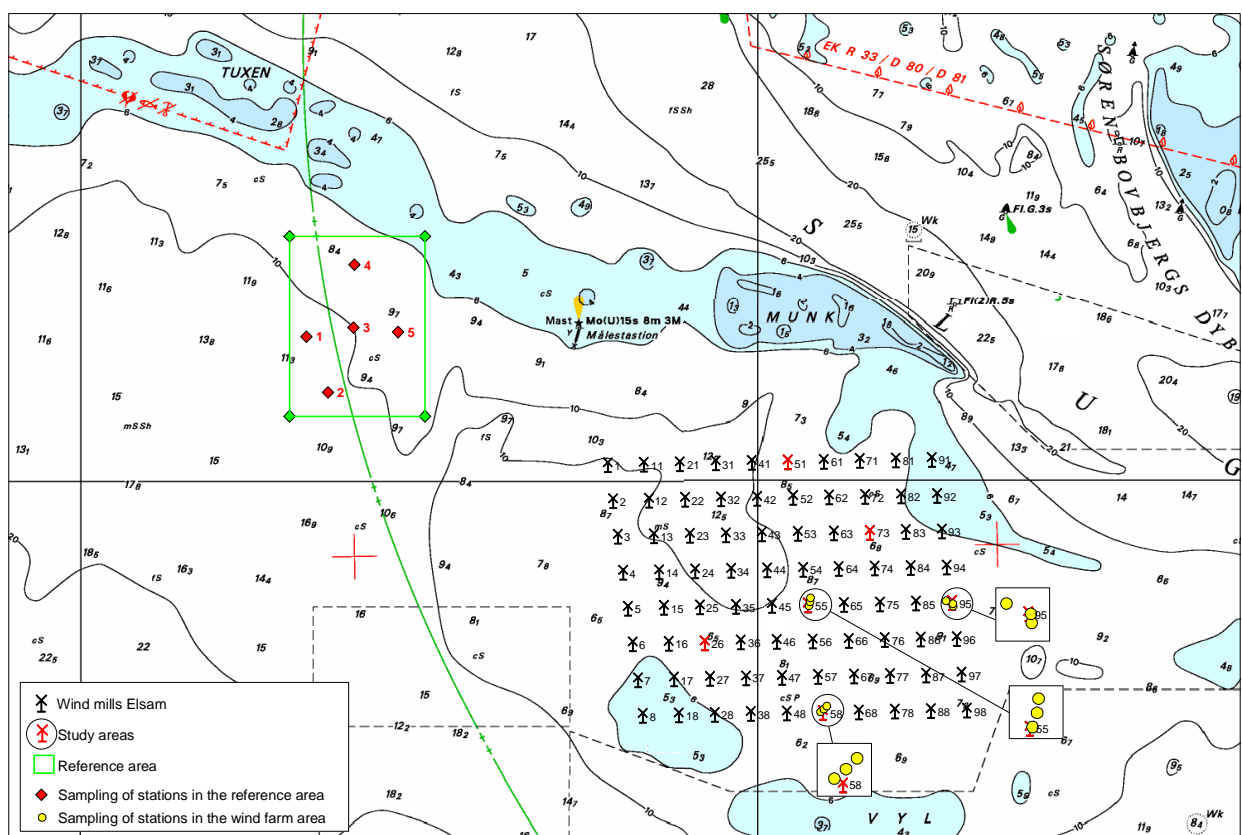


Figure 2. Map of locations sampled in September 2001.

### 3. Results and conclusion

The wind farm area and the reference area are characterised by bottom conditions that are relatively uniform with a sediment consisting of pure medium-grained sand with no organic matter. The particle sizes were found to be in the range of 228 µm to 426 µm with a median of 345 µm in the wind farm area. There is a tendency to more variation in the sediment structure in the reference area with a generally more coarse-grained sediment with a median particle size of 380 µm (range 198-478 µm). In the deeper part of the reference area the seabed is characterised by more coarse-grained sediments.

Previous studies in the Horns Rev area has revealed that the main characteristics of the faunal composition in the area can be described as an *Ophelia borealis* community, named after one of the characteristic and important marine bristle worms in the area (ELSAM, 2000). The studies also have shown that the area is very heterogeneous with regard to the faunal composition and that the number of species, density of individuals and biomass of the benthic fauna can vary greatly within the area.

The number of species recorded at the individual stations in the wind farm area in June 2001 are rather uniform and varies between 5 and 12 and the abundance and the biomass varies from 488-2,033 individuals/m<sup>2</sup> and from 2.9-489 g wet weight/m<sup>2</sup> respectively, figure 3-6. There appears to be a tendency for a generally lower number of species, lower abundance and lower biomass in the eastern and northern part of the wind farm area.

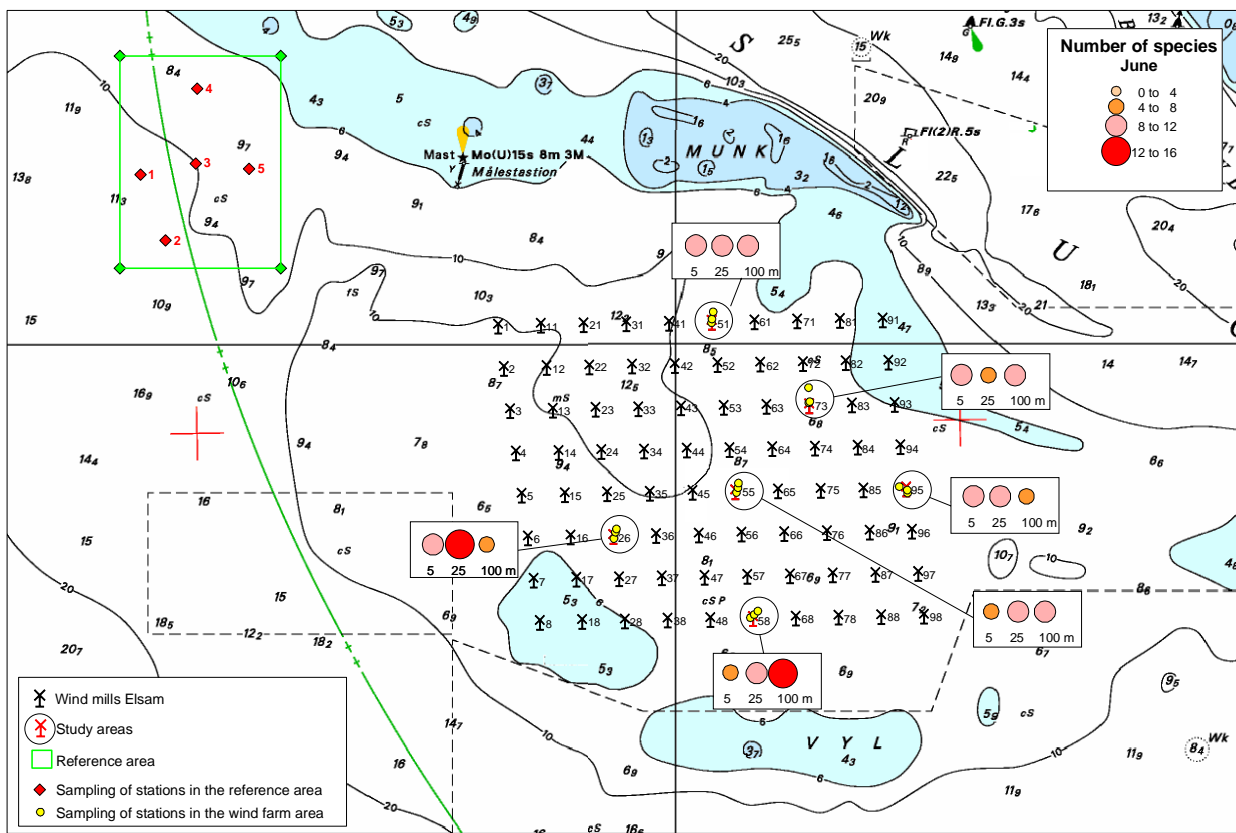


Figure 3. Species numbers at the stations on Horns Rev, June 2001.

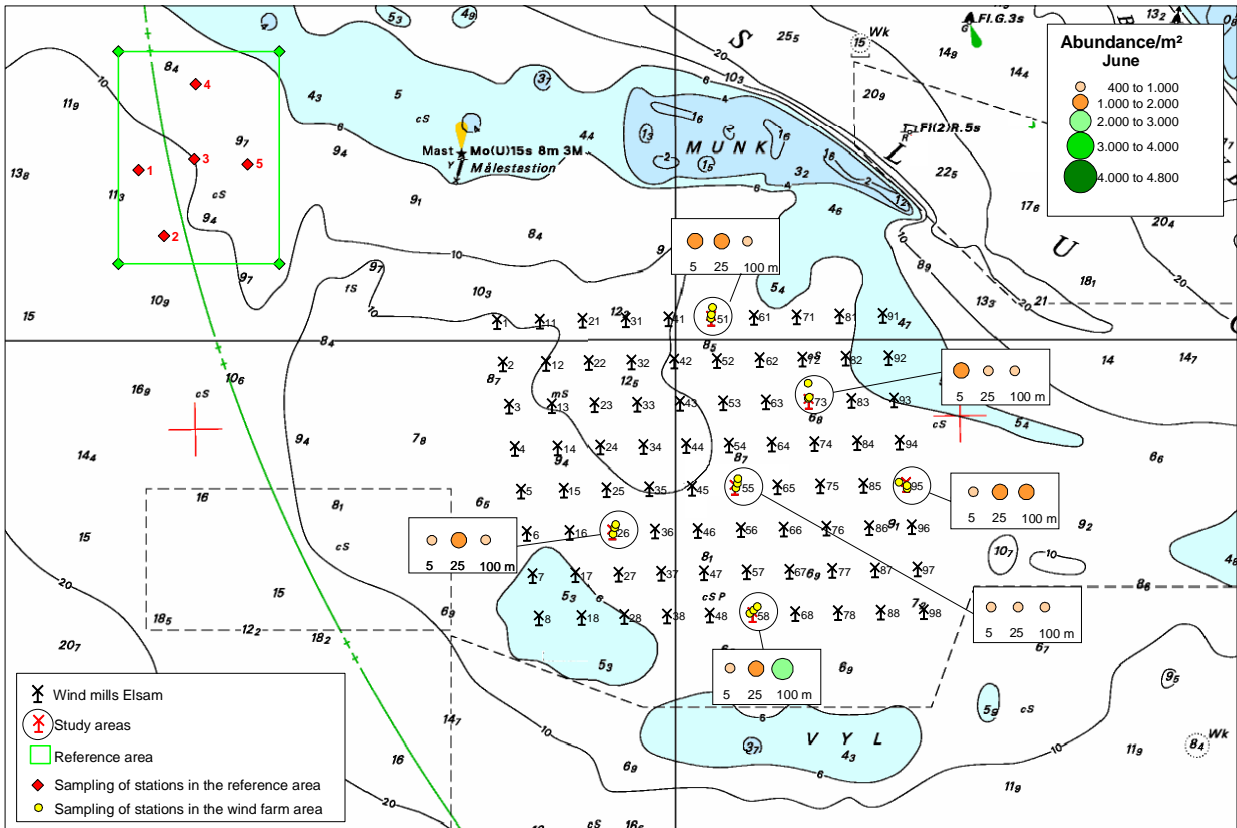


Figure 4. Abundance of benthos at the stations on Horns Rev, June 2001.

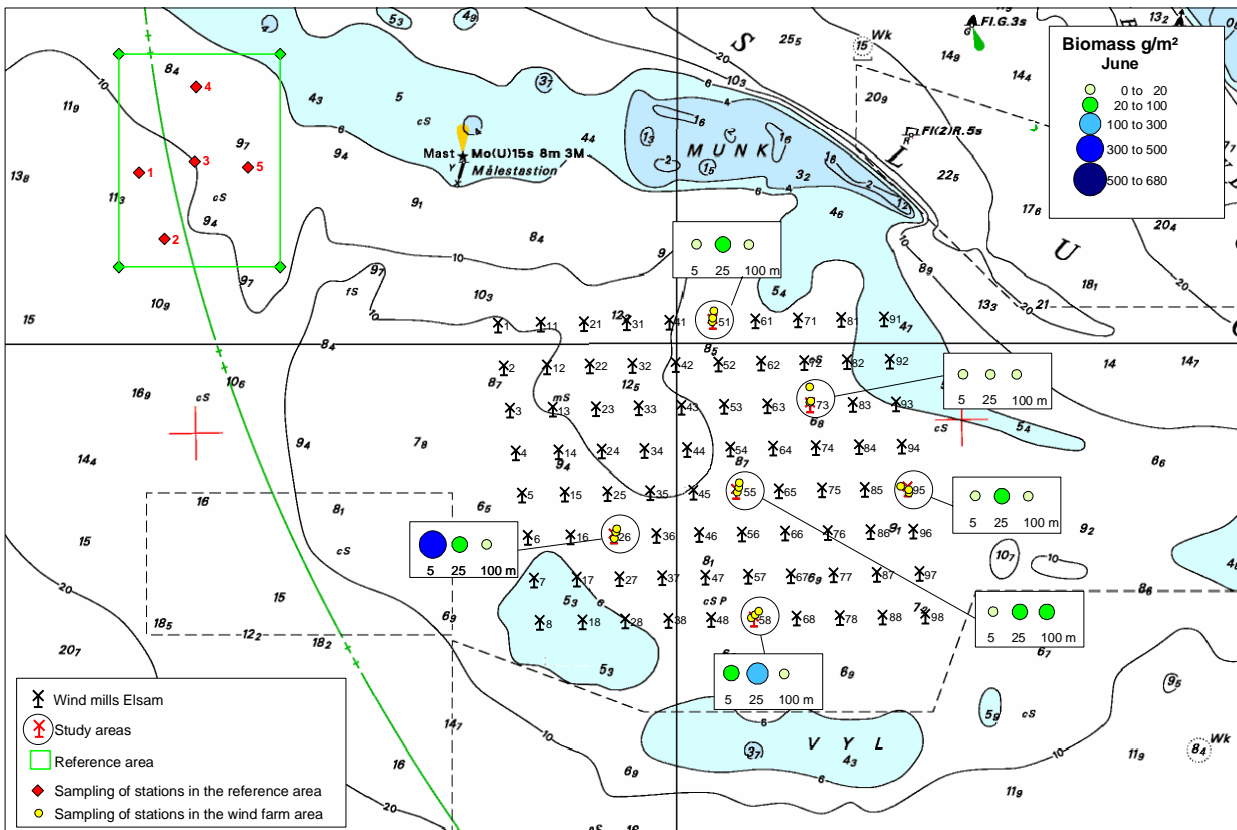


Figure 5. Biomass (wet weight) at the stations on Horns Rev, June 2001.

The number of species recorded at the individual stations in the wind farm area in September are rather uniform and varies between 9 and 15 and the abundance and the biomass varies from 772-4,797 individuals/m<sup>2</sup> and from 2-436 g wet weight/m<sup>2</sup> respectively, figure 6-8. There is apparently no generally tendency or difference in the distribution of the benthos in the area. However the number of species is slightly higher and the abundance relatively high in the deeper part of the reference area (14-16 species and 3,252-4,472 individuals/m<sup>2</sup>). The biomass in this area is generally low (3-19 g wet weight/m<sup>2</sup>) compared to the biomass in the wind farm area with the exception of reference station 3 at the slope to the deeper part, where a high number *Spisula solida* contributes to a high biomass.

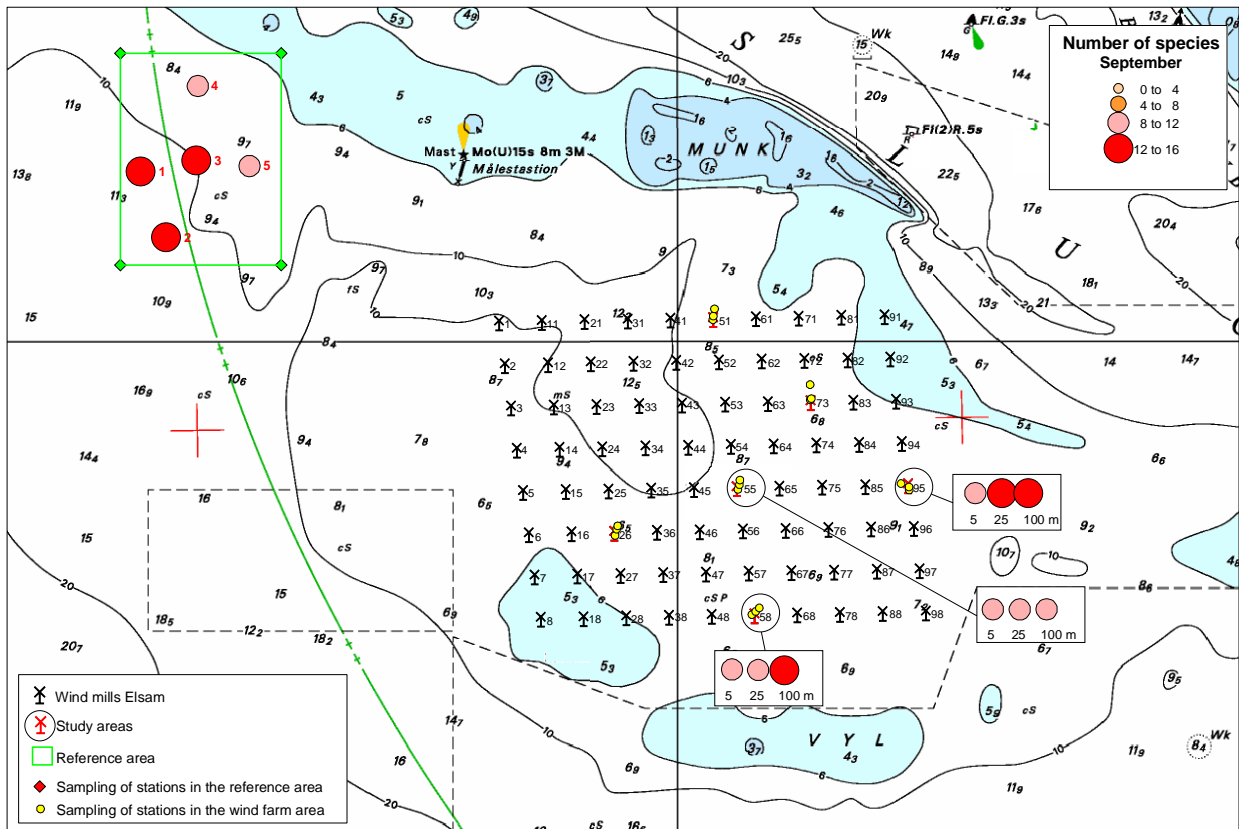


Figure 6. Species numbers at the stations on Horns Rev, September 2001.

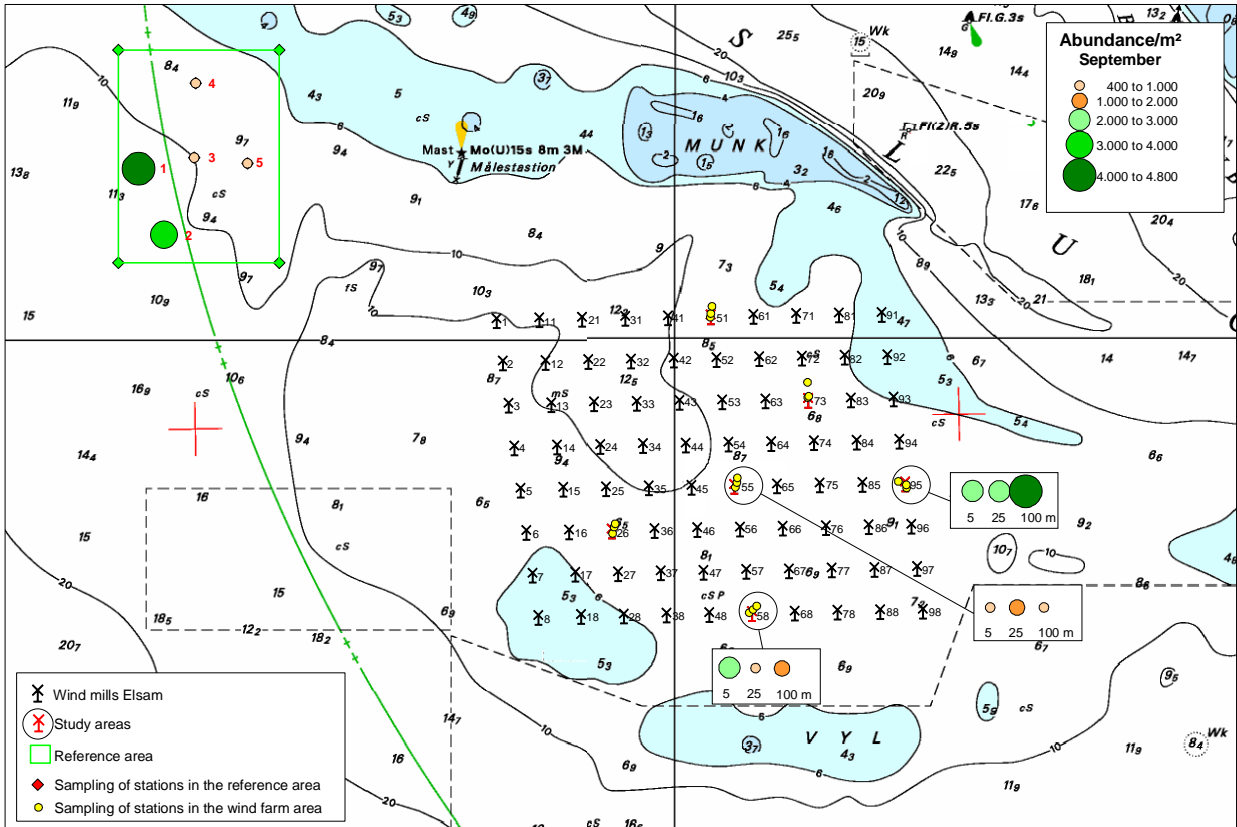


Figure 7. Abundance of benthos at the stations on Horns Rev, September 2001.

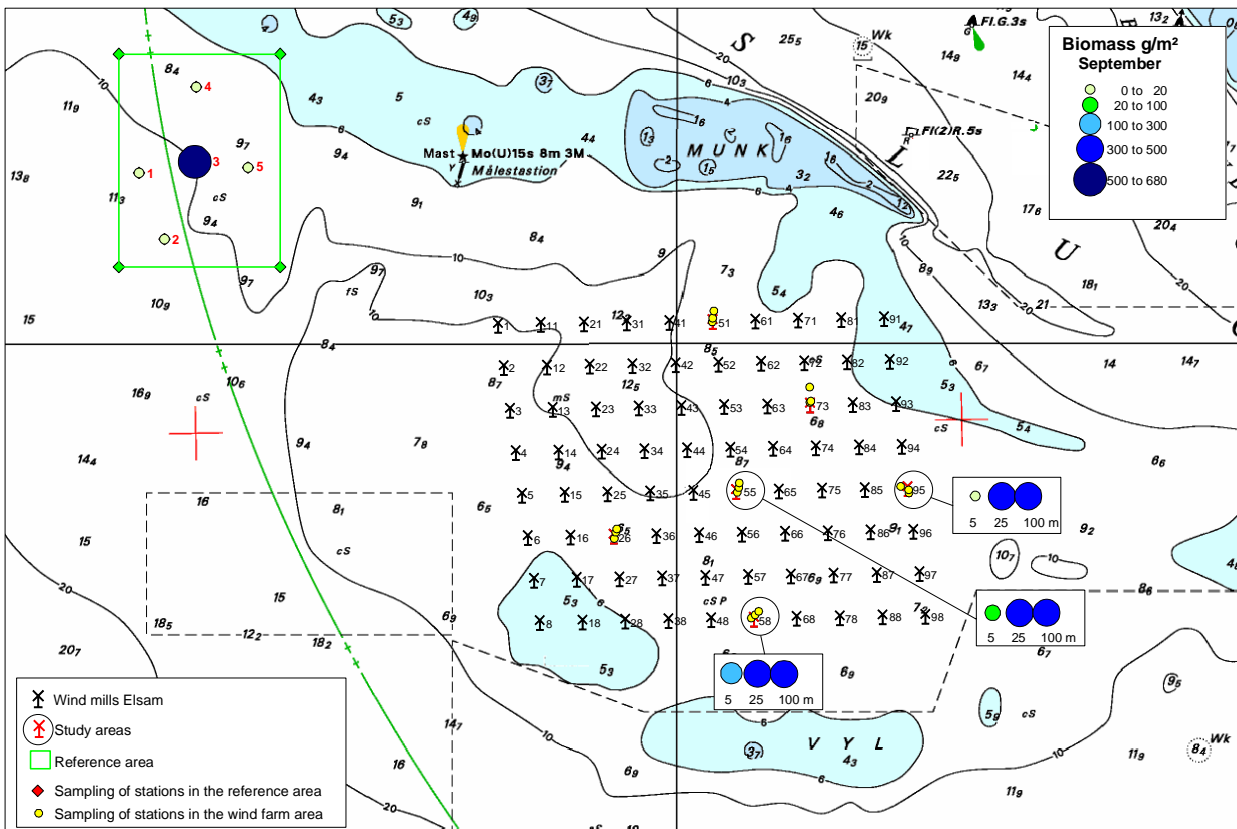


Figure 8. Biomass (wet weight) at the stations on Horns Rev, September 2001.

The dominant species in terms of abundance in both the wind farm area and the reference area are the bristle worms *Pisone remota*, *Goniadella bobretzkii*, *Spio filicornis* and *Ophelia borealis* and the mussel *Goodallia triangularis*. These species constitutes more than 58% of the total abundance.

The typical and dominant species in term of biomass in the wind farm area and in the reference area are the mussels *Spisula solida* and *Thracia phaseolina* and the bristle worm *Ophelia borealis*. These species constitutes for more than 84-95% of the total biomass in the areas.

Significant differences are recorded in terms of community structure between the wind farm area and the reference area, although the dominating species and the total abundance is almost identical at the two sites. Presumably the two areas can be used for the comparison of the stomach content of different fish species in relation to the investigation of introduction of hard substrates as the dominant benthos species are recorded from both areas.

There seems to be a remarkably uniformity in the benthos community structure in respect of selected type species between the surveys in 1999 and 2001 which indicate that these species can be used as indicator organisms for environmental changes. Although there is significant differences in abundance and biomass due to natural variations between surveys in spring/summer and autumn 2001 the results reveals a remarkable consistency in the relative dominance in respect of abundance and biomass between the indicator species, table 1-2.

Species	2001 Abundance Ind./m <sup>2</sup>	2001 Relative abundance	1999 Abundance Ind./m <sup>2</sup>	1999 Relative abundance
<i>Pisone remota</i>	176	19%	175	24%
<i>Goodallia triangularis</i>	154	16%	167	23%
<i>Goniadella bobretzkii</i>	129	14%	107	15%
<i>Spio filicornis</i>	95	10%	7	1%
<i>Thracia phaseolina</i>	59	6%	0	0%
<i>Ophelia borealis</i>	47	5%	36	5%
<i>Bathyporeia sp.</i>	38	4%	0	0%
<i>Pontocrates altamarinus</i>	32	3%	1	< 0.5%
<i>Spisula solida</i>	32	3%	6	< 1%
<i>Orbinia sertulata</i>	25	3%	21	3%

Table 1. The most frequently occurring species at Horns Rev in 1999 and 2001.

Species	2001	2001	1999	1999
	Biomass g./m <sup>2</sup>	Relative bio-mass	Biomass g./m <sup>2</sup>	Relative bio-mass
<i>Spisula solida</i>	42.109	65%	2.409	5%
<i>Thracia phaseolina</i>	7.687	12%	0	0%
<i>Ophelia borealis</i>	6.505	10%	8.948	20%
<i>Orbinia sertulata</i>	2.788	4%	2.086	5%
<i>Nephtys longosetosa</i>	2.338	3%	2.971	7%
<i>Polinices polianus</i>	1.761	3%	0.043	< 0.5%
<i>Nephtys sp.</i>	0.507	1%	0.011	< 0.5%
<i>Goodallia triangularis</i>	0.400	1%	0.584	1%
<i>Spio filicornis</i>	0.312	< 0.5%	0.058	< 0.5%
<i>Gastrosaccus spinifer</i>	0.304	< 0.5%	0	0%

Table 2. The most important species in terms of biomass wet weight at Horns Rev in 1999 and 2001

The proposed indicator species are the bristle worms *Pisone remota*, *Goniadella bobretzkii*, *Ophelia borealis*, *Orbinia sertulata* and *Nephtys longosetosa* and the mussel *Goodallia triangularis*.

No significant differences in the benthos community structure are recorded related to the distance from the planned wind turbine foundations.

Compared to the survey in 1999 some species as the mussels *Spisula solida* and *Thracia phaseolina* have a more pronounced abundance in 2001, whereas other mussels as *Fabulina fabula* and *Angulus tenuis* recorded in 1999 were absent in the samples from 2001. Presumably some small individuals of *Spisula solida* were recorded in 1999 as *Spisula elliptica* whereas *Thracia phaseolina* was not recorded in 1999.

#### 4. References

ELSAM A/S 2000. Horns Rev. Offshore Wind Power Farm. Environmental Impact Assessment of Sea Bottom and Marine Biology.