

Horns Rev

Offshore Wind Power Farm

Environmental Impact Assessment
on Water Quality

Prepared for:

I/S ELSAM, Overgade 45, DK-7000 Fredericia, Denmark

Carried out by:

Bio/consult A/S, Johs. Ewalds Vej 42-44, DK-8230 Åbyhøj, Denmark

Text:

Per Andersen

Editing:

Gitte Spanggaard

Translation:

Word Design ApS

04.05.2000

Contents

SUMMARY	4
1. INTRODUCTION.....	6
2. RESEARCH AREA.....	7
3. BACKGROUND DATA	9
4. EXISTING CONDITIONS.....	10
4.1. PHYSICAL CONDITIONS	10
4.1.1. Salinity.....	10
4.1.2. Temperature	12
4.2. WATER QUALITY.....	14
4.2.1. Inorganic nutrients.....	14
5. IMPACTS	18
6. CONCLUSION.....	22
7. REFERENCES	23

Summary

As part of an overall Environmental Impact Assessment (EIA) undertaken in connection with a planned 150 MW offshore wind farm at Horns Rev, an assessment was made of the effects the wind farm would have on the water quality in the area.

This EIA study was drawn up in accordance with the guidelines laid down by the Danish Ministry of Environment and Energy in the publication "Guidelines for the preparation of EIA studies for offshore wind farms."

Horns Rev is situated off Blåvands Huk, which is Denmark's most westerly point. It is a shallow reef with water depths between 2 and 9 metres and is primarily composed of sand, gravel and pebbles.

Only local and minor changes are anticipated in connection with the currents, sediments and wave conditions during the production phase. These will occur in the immediate vicinity of the individual foundations. For these reasons, no changes are expected in the water quality. This also includes also the pelagic primary production and the occurrence of plankton in the area.

Increased local copper contamination of phytoplankton and zooplankton may be expected during the production phase, as a result of the total annual discharge of 206 kg copper from the slip-rings in the wind turbines. The contamination will potentially result in a local reduction of the pelagic primary production and changes in the species composition of the plankton.

The wind turbines will be sandblasted and painted once during their lifetime, as part of the routine maintenance. The sandblasting and painting will lead to a temporary spill of paint, paint waste and sand. The impacts on water quality and plankton production are unknown. It is recommended that factors such as the toxicity of the paint be investigated, and that spills and the impact of waste be reduced as much as possible.

The water quality and the plankton in the wind farm area and along the cable line's passage to shore through the international protected area, will only be affected in a minor way during the construction phase. The impacts will be from sediment spill and resuspension, caused by the construction of the wind-turbine foundations and water jetting the cable into the sediment.

On the basis of the expected impact from the establishment of the wind farm, it is not deemed necessary to carry out special programmes during the construction phase for monitoring of the water quality and plankton.

A monitoring and control programme is recommended during the production phase in order to follow the impact of increased copper concentration on the pelagic primary production

and the qualitative and quantitative composition of the plankton. The alternative is to initiate recovery or elimination of the copper-laden waste.

1. Introduction

The Ministry of Environment and Energy has requested ELSAM and ELTRA to establish a demonstration project consisting of an offshore wind farm with an output of 150 MW in the waters of Horns Rev, approximately 15 km off Blåvands Huk. Before final approval can be given for the establishment of the wind farm, an Environmental Impact Assessment (EIA) must be carried out in accordance with the guidelines prepared by the Danish Energy Agency in collaboration with the Danish Forest and Nature Agency (Danish Ministry of Environment and Energy, 1999).

The demonstration project at Horns Rev lies outside the RAMSAR area in the Wadden Sea. The planned line for the cable passes through the RAMSAR area, which is also governed by EU bird protection and habitat directives. The coastal area that the cable line passes through is also designated by the county as an Objective II area, the aims of which include intensified control and specific requirements (County of Ribe, 1999). The area has the following functions:

- Foraging and breeding area for birds
- Breeding and resting area for seals
- Spawning and nursery area for fish that spend their adult period in the North Sea
- Recreational activities such as bathing and wind-surfing

Developing an offshore wind farm at Horns Rev can have an impact during both the construction and production phases on local water quality and primary production, including the qualitative and quantitative composition of phytoplankton and zooplankton. In order to assess the impact during the construction and production phases, existing data relating to the water quality in the area of the proposed wind farm has been collected in accordance with ELSAM's order no. 40 for studies in connection with the offshore wind farm at Horns Rev.

This report is part of a total EIA for the construction and production phases of the wind farm at Horns Rev. In accordance with the requirements, the following subjects will be dealt with:

- Water quality, also comprising primary production and plankton

2. Research area

Horns Rev is an extension of Blåvands Huk, which is Denmark's most westerly point. The reef consists primarily of pebbles, gravel and sand. The water depth over the reef varies between 2 and 9 metres, and the width varies between 1 and 5 km.

Horns Rev is considered to be a stable landform that has not changed position since it was formed (Danish Hydraulic Institute, 1999). Blåvands Huk forms the northern extremity of the European Wadden Sea area, which covers the area within the Wadden Sea islands from Den Helder in the Netherlands to Blåvands Huk.

The planned wind farm area has the shape of an equal-sided trapeze, with a side length of 2.4 nautical miles, and the north-east corner located approximately 8 nautical miles west-south-west of Blåvands Huk, equivalent to approximately 15 km off Blåvands Huk (figure 1). The area is delimited by lines drawn between the following four points:

55 30 08N 07 47 71E
55 30 12N 07 51 96E
55 27 73N 07 52 55E
55 27 69N 07 48 30E

The wind farm site has an area of 20 km². Figure 1 shows the position of the wind farm site and the preliminary location of the cable line to land. One of the County of Ribe's measuring stations, located in this area, is also marked.

According to the charts, depths in the wind farm site vary from 5 to 13 m.

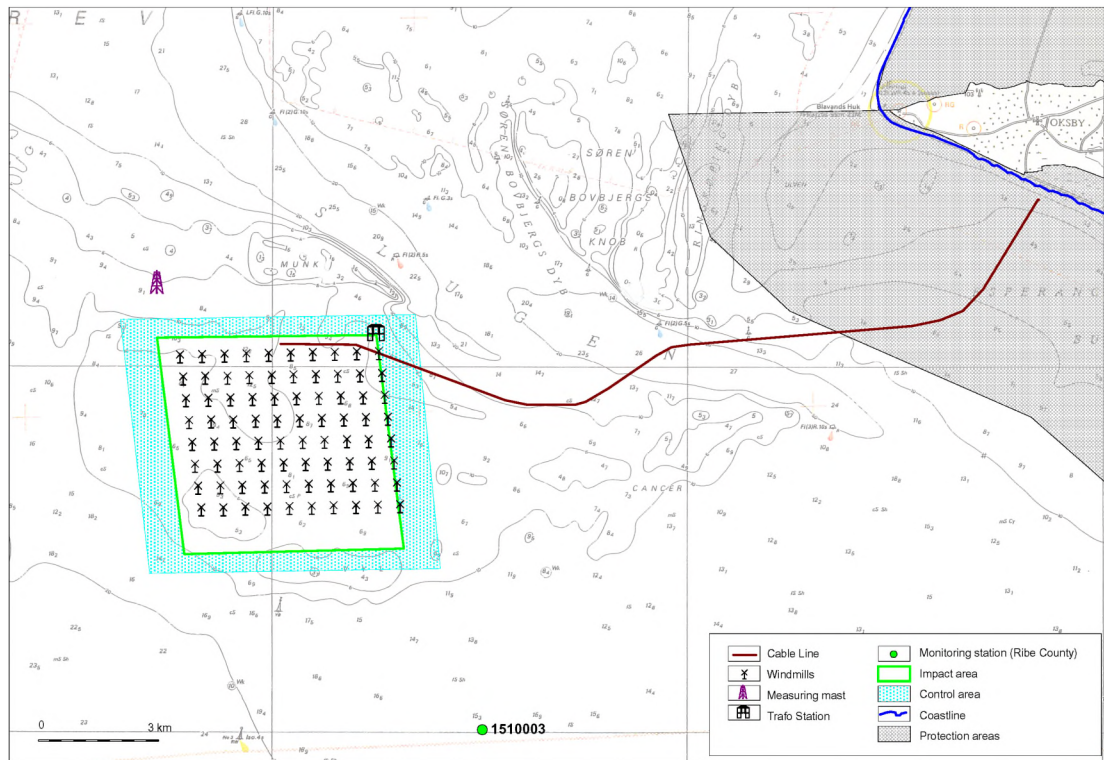


Figure 1. Map of Horns Rev showing the position of the planned wind farm and the line of the cable to land. The County of Ribe’s measuring station, located in this area, is also marked.

3. Background data

No fieldwork to assess water quality has been undertaken in connection with the present EIA. The main part of the background data originates from the County of Ribe's monitoring of the local coastal waters.

Over a period of some years, the County of Ribe has monitored water quality by monthly visits to three stations south of Blåvands Huk. The three stations are known as East Blåvand, Mid Blåvand and West Blåvand, and have depths of approximately 4 m, 11 m, and 14 m, respectively. These stations will be named EB, MB and WB, respectively, in the following material.

WB lies approximately 3 nautical miles from the south-east corner of the planned wind farm site and can therefore be regarded as representative of the area. Salinity, temperature, oxygen and transparency (Secchi disk transparency) have been recorded throughout the water column at each of the stations. Water samples have also been taken from the surface layer for analysis of the plant nutrients nitrogen and phosphorus, and analysis of chlorophyll *a* content as well as primary production.

Supplementing the data from the County of Ribe, is data from monitoring carried out by the Danish Environmental Research Institute in the area over a period of several years in connection with the winter cruises (February) of the North Sea. A similar programme for measurement and analysis has been carried out at 30 stations distributed throughout the North Sea.

Hydrographic conditions, including salinity and temperature, are discussed by the Danish Environmental Agency in a report from 1991 entitled "The Coastal Currents of Jutland", (Danish Environmental Agency, 1991).

Other data has been assembled from several additional sources including "North Sea Quality, Status Report – 1993" (North Sea Task Force, 1993).

4. Existing conditions

4.1. Physical conditions

Depths at the wind farm site vary from 5.8 m to 17.5 m. The shallowest depth of approximately 6 m is recorded at the stations in the north-east corner of the research area, while the deepest areas of 14–17.5 m are recorded in the south-east corner. In its progression towards the land, the planned cable line crosses a deeper channel called the “Slugen”, with maximum depths of approximately 26 m.

4.1.1. Salinity

The salinity of the area (30–34 psu) is partially determined by the inflow of fresh water from the German rivers to the German Bight, and partially by the supply of relatively saline water from the North Sea. On account of the massive fresh water supply to the Wadden Sea region, the surface salinity falls from north to south along the west coast of Denmark. The salinity of the area is also strongly dependent on the season and on the prevailing wind conditions.

There is generally no thermocline in the area. Small differences in salinity of 1–1.5 psu have infrequently been recorded between the surface and bottom layers, especially after long periods of strong south-easterly winds. The differences recorded between surface and bottom layers can better be characterised as a gradient than a discontinuity.

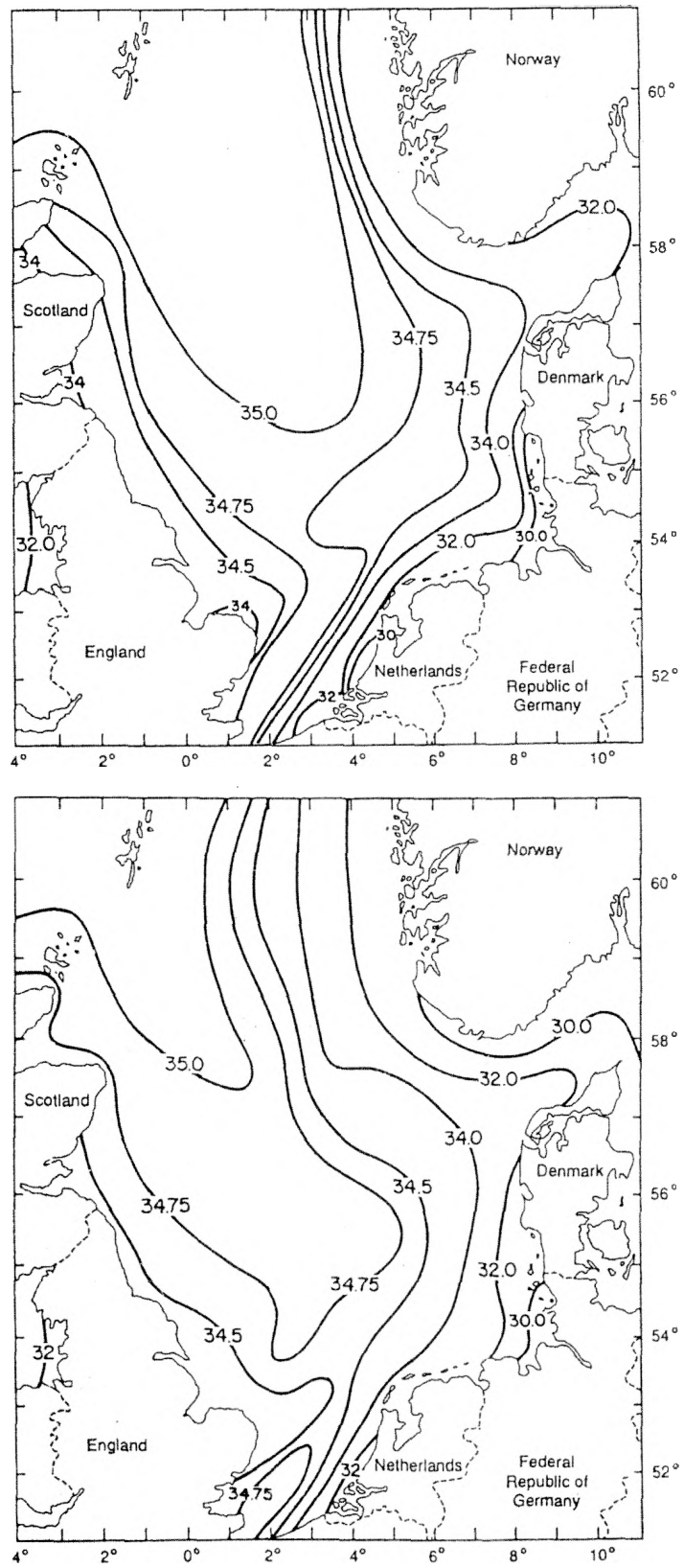


Figure 2. Surface salinity in the North Sea in February and August, according to the Danish Environmental Agency (1991).

4.1.2. Temperature

Figure 3 shows the typical picture for surface temperatures in the North Sea during the months of February and August. Thermoclines occur in the central part of the North Sea during most of the summer period. More even temperatures, due to mixing by wind and tide, are recorded throughout the water column in the coastal areas. The area of Horns Rev lies on the frontier between the water masses of the North Sea and the coastal zone. The County of Ribe's measurements generally note the same temperature in the surface and the bottom layers at station WB.

The diagrams showing salinity and temperature in February are, for the most part, confirmed by measurements made by the Danish Environmental Research Institute in February 1999.

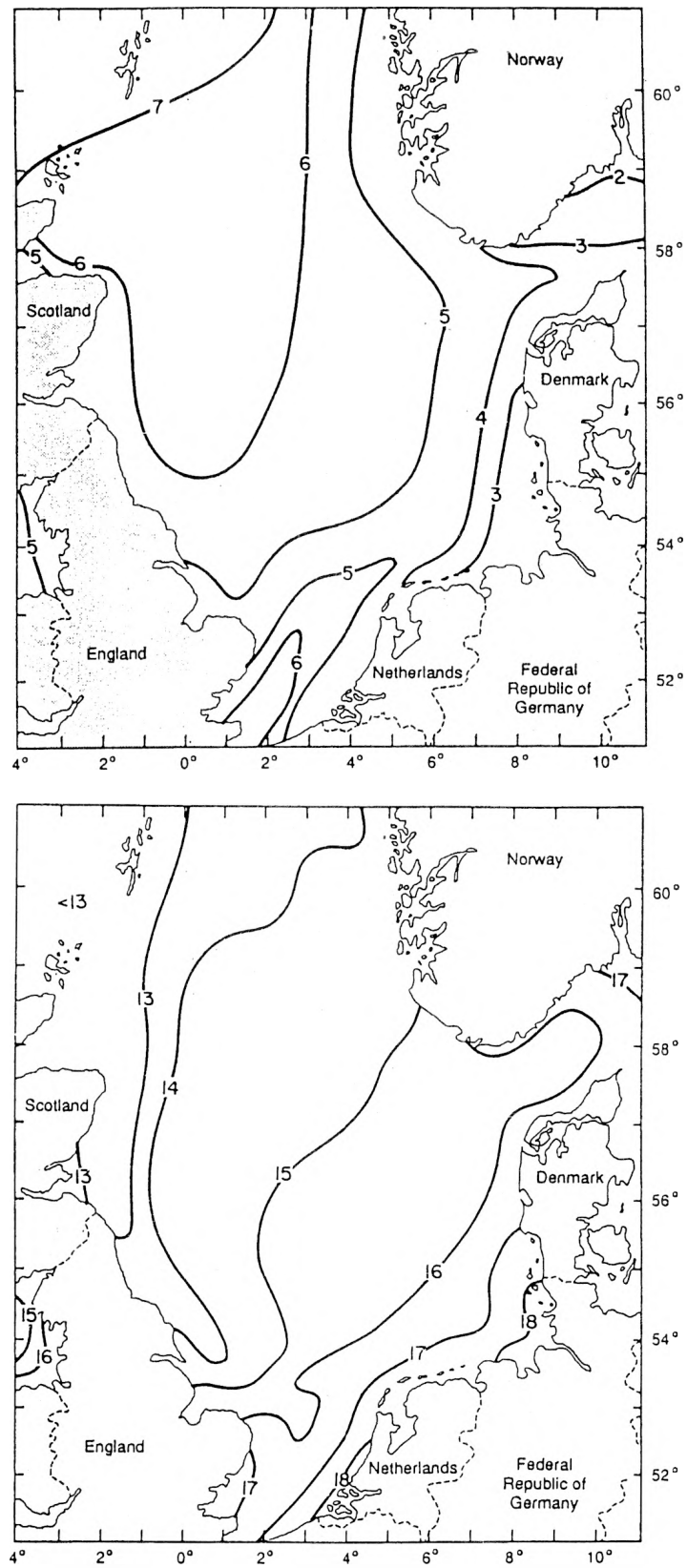


Figure 3. Surface temperature in the North Sea in February and August, according to the Danish Environmental Agency (1991)

4.2. Water quality

4.2.1. Inorganic nutrients

The County of Ribe's monitoring of water quality at WB includes records of the inorganic plant nutrients nitrogen, phosphorus and silica in the surface layer. However, there is only data for the end of the 1980s for the first two of these nutrients. Analyses of the plant pigment chlorophyll *a*, which gives a rough measurement of the content of phytoplankton in the water, were also carried out for station WB.

The general picture for most of the parameters used to determine the water quality is that there is a gradual fall in the concentrations moving northwards from the Wadden Sea along the west coast of Denmark. Winter levels at Blåvand are between 1.5 and 2.0 times the levels at Hirtshals. The water-quality gradient, with the highest values for nutrients and chlorophyll *a* in the most southerly part of the North Sea, primarily reflects the discharge of nutrient-rich water from the German rivers. Other sources of nutrient loading that are worthy of mention are regional run-off from land, and atmospheric deposition over the North Sea. No quantitative partitioning of the various sources is available.

The conclusions made in the present report are primarily based on winter values for nutrient concentrations, since these are less affected by the influences of biological processes than summer values, and are thus more readily comparable.

There can be significant variation from year to year, even for winter levels. This is partly explained by differences in meteorological and hydrographical conditions at the sampling times.

Winter concentrations of inorganic nitrogen and inorganic phosphorus show more or less unchanged levels, verging on a slight reduction over the period of the 1990s. The concentrations of total nitrogen and total phosphorus show, however, a marked reduction (figure 4).

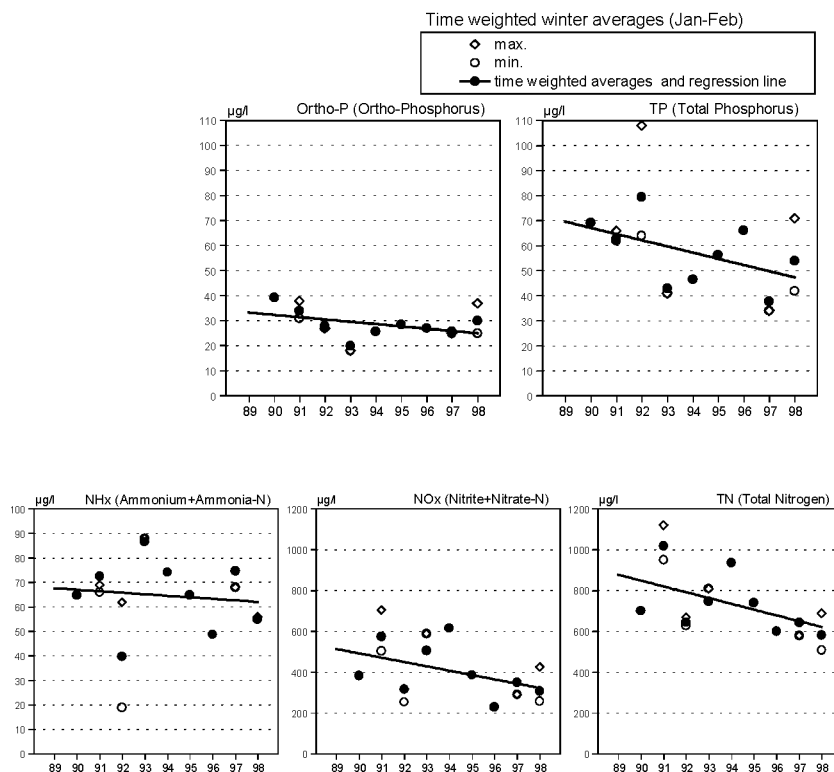


Figure 4. Winter values of NO_x , NH_x , Total N, Ortho-P and Total P at station WB (County of North Jutland, County of Ringkjøbing and County of Ribe, 1999; and County of North Jutland, County of Ringkjøbing and County of Ribe, 1998).

Summer levels from the 1990s include nutrient concentrations that may be so low that they can limit the phytoplankton's primary production.

The concentration of nitrate+nitrite-N at station WB is generally lower than $14 \mu\text{g/l}$ for a period each summer. According to the Danish Environmental Research Institute, concentrations below this level can lead to nitrogen limitation. On the other hand there are generally sufficient quantities of organic nitrogen available in the form of ammonium. It is therefore doubtful that nitrogen limitation occurs in the area.

The concentration of inorganic phosphorus (orthophosphate) is similarly greater than $2 \mu\text{g/l}$ throughout the time series, which is above the level for phosphorus limitation.

Oxygen

Oxygen concentrations in the area are high, as a result of the generally good mixing conditions in the coastal areas of the North Sea, and hypoxia is rarely recorded at the bottom. It is however worth mentioning that low oxygen concentrations ($4\text{--}5 \text{ mg O}_2/\text{l}$) and hypoxic conditions ($<2 \text{ mg O}_2/\text{l}$) have been recorded along the west coast of Jutland, in an area north and north-west of Horns Rev during 1984–86, and in Grådyb in 1995 (North Sea Task Force, 1993).

Plankton, primary production and transparency

Phytoplankton

The County of Ribe has not collected or analysed phytoplankton samples from station WB. Chlorophyll concentrations have instead been measured. The chlorophyll concentration gives a rough measure of the phytoplankton biomass and has been found to lie in the region 3–5 µg Chl/l during the spring and 5–10 µg Chl/l during the summer. Increasing concentrations of chlorophyll were recorded in spring and summer samples taken in the period 1989–97 (figure 5).

The phytoplankton in the coastal area of the south-east part of the North Sea are dominated by diatoms, dinoflagellates and flagellates (County of Ribe, 1994). Blooms of phytoplankton are a normal phenomenon in the coastal waters. Blooms of the colony-forming flagellate *Phaeocystis* are often recorded in spring. When the blooms break down, large amounts of foam can be formed along the coastline, if wind and currents bring the large amounts of biomass onto the shore. The summer can often bring large blooms of diatoms and dinoflagellates. Blooms of the heterotrophic dinoflagellate *Noctiluca scintillans*, which gives phosphorescence, are often recorded in the late summer. Local areas with hypoxic conditions can occur if there is still weather in connection with the build up of the bloom, and particularly at the time of its collapse. This can create unpleasant conditions on bathing beaches. Toxic algae, including the genus *Dinophysis*, commonly occur in the Wadden Sea area during summer. They can cause accumulation of algal toxins in shellfish such as the common mussel, the cockle and the trough shell. Several instances of Diarrhoeic Shellfish Poison (DSP) have been recorded in bivalves from the Wadden Sea and from Horns Rev in the period 1991–99 (Andersen and Thorbjørnsen, 1999).

Primary production

The primary production at station WB shows a gradual increase over the period 1990–98. Average values lie between 500 and 1,300 mg C/m²/d (figure 5), (County of North Jutland, County of Viborg, County of Ringkjøbing and County of Ribe, 1998). The primary production level in the North Sea lies in the range 150–250 g C/m²/yr, while levels in coastal waters can be over 400 g C/m²/yr (Cadée, 1992).

Transparency

The summer averages for Secchi disk transparency measurements at station WB have shown marked increases in transparency during the 1990s. The present level is approximately 5 m (figure 5). The relatively low transparency recorded in the area is due to a high level of suspended material, including plankton, in the water column. The resuspension of sediment is primarily caused by the relatively shallow water depths, combined with the regional current, wind and tidal conditions in the Wadden Sea and along the west coast of Jutland as a whole.

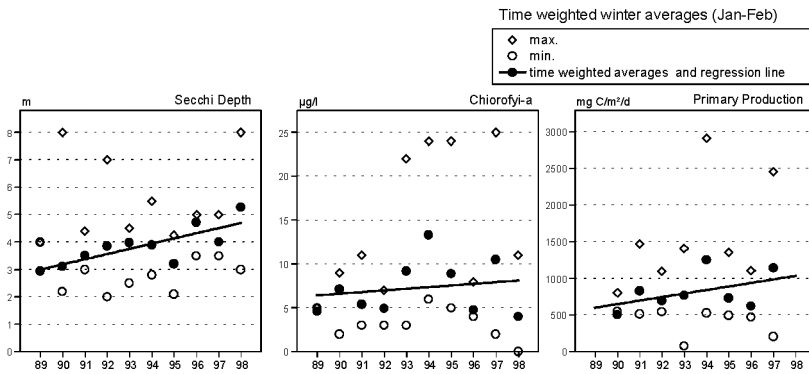


Figure 5. Summer values at station WB. Chlorophyll *a* and Secchi disk transparency 1990–98, and primary production 1990–97. (County of North Jutland, County of Viborg, County of Ringkjøbing and County of Ribe, 1999; and County of North Jutland, County of Viborg, County of Ringkjøbing and County of Ribe, 1998).

5. Impacts

Two classes of environmental impacts are considered. Potential permanent changes connected with the construction and **production phases**, and potential temporary changes from the **construction phase**.

At the present time, it is planned that the wind turbines be established as mono-pile foundations with a diameter of 3.5 m. To this will be added a scour-protecting revetment of large boulders, to give a total foundation diameter of 7.5 m. The mono-pile will be sunk into the bottom during the construction phase. The reclamation area necessary to construct the foundations for the wind turbines covers a total area of approximately 14,500 m² of sea bottom.

Work on the erection of the wind farm will also affect a narrow area along the approximately 19.5 km long cable line towards the land. The location of the cable line is not yet finalised.

Production phase

Potential direct or indirect impacts during the production phase are:

- Permanent impact on current, sediment, water exchange and wave conditions of the area
- Discharge of pollutants
- Temporary impact due to oil spills, etc.

The water exchange in the area of Horns Rev will not be significantly affected by the construction of the wind farm (Danish Hydraulic Institute, 1999), and no impact is therefore expected on water quality including phytoplankton and zooplankton. Alterations in the water exchange conditions of the area could otherwise lead to changes such as accumulation of plankton, effects on primary production, oxygen conditions or changes in the transport of inorganic nutrients between the sediment and the aqueous phase.

There will be minor local impact on current, wave conditions and sediment transport in the immediate area of the foundations (Danish Hydraulic Institute, 1999). This is not expected to have an effect on the water quality, primary production or plankton. Construction of the wind farm will not affect the regional wave conditions, currents or sediment transport along the coast of Jutland at Blåvands Huk and Skallingen. Thus no impact is expected on the water quality or the plankton within the international protected area.

Increased copper contamination resulting in temporary inhibition of plankton organisms is expected to occur during the production phase. This is likely to be caused by discharge of copper and carbon dust from abrasion of the slip-rings of the wind turbines. A total of 206 kg copper is expected to be discharged each year. The effect is expected to be relatively minor because the temporary local increase in copper concentration will in the worst case be 1.4 µg/l (Danish Hydraulic Institute, 2000) compared with a background concentration of around 0.2 µg/l recorded in the outer part of the German Bight (Schmidt 1996). The impact will be local and within the wind farm area since the temporary increase of copper concentration in the aqueous phase will be less than 1 µg/l. The extent of the dispersion area,

which primarily extends north of the wind farm site, has been documented (Danish Hydraulic Institute, 2000).

A review of the literature on the sensitivity of plankton to copper shows that effects on plankton can be expected at the calculated concentrations, but also that the degree of sensitivity differs from species to species. Growth inhibition has been recorded with concentrations of a few nanograms of copper per litre. Flagellates and blue-green algae are generally more sensitive than green alga, while sensitivity for diatoms varies widely. Experiments with natural plankton populations have shown that copper at a concentration of 6.4 µg Cu/l brought about a marked change in primary production. However, 10 days after the addition of the copper, primary production was up to normal levels again (Morris, 1980).

It is also worth noting that copper is included in the list of dangerous substances, for which the Danish Environmental Agency's proclamation no. 921 of 8 October 1996 decrees "they shall be limited to the greatest possible extent using the best available technology." The proclamation further states that "best available technology means technology that is technically feasible and economically capable of being implemented by the specific type of company."

It may be necessary to sandblast the wind turbine towers and foundations as part of the surface maintenance. ELSAM estimates that it will be impossible to gather up the sand and paint flakes from this treatment, and that they will end in the water. It is estimated that the foundations will require one treatment in the course of their lifetime. The maintenance will require the use of 16 m³ of paint. The sandblasting will use an estimated 3,150 tons of sand. It is estimated that 20% of the wind-turbine towers will need surface maintenance during the course of the 20-year lifetime. The maintenance will use a combination of different paints, a total of approx. 5.500 m³ of paint is estimated. The sandblasting will use an estimated 1,265 tons. All paints used will be traditional epoxy-polyurethane products. Water-based products are under development and will be used if it is documented that they are of equal quality to the epoxy-polyurethane compounds. It may be possible to use a high-pressure water-jet system for cleaning the tower surfaces, rather than sandblasting (ELSAM project, 2000).

The sand used in the sandblasting operations is only expected to make short term temporal and local impacts on water quality in the area.. It is unknown at the present time whether the paint flakes and waste that are removed from the foundation and towers will have a negative effect on the water quality. Although there is no evidence that the paint waste is toxic to the plankton, it may lead to reduced primary production and changes in the species composition of the plankton. The paint flakes would also cause problems if they were to float to the surface, flocculate and end up on the coast. It is recommended that experiments be made on the solubility and dispersal characteristics of the various paint types and that toxicity tests be done for plankton, benthic micro algae, benthic animals and fish. It is further recommended that systems or methods be devised or optimised to reduce waste from maintenance activities and that the actual waste quantities be monitored.

The degree of impact on the plankton and primary production resulting from other accidents such as an oil spill, cable rupture, or collision with a wind turbine, has not been calculated.

Construction phase

Potential direct or indirect impacts on the water quality during the construction phase are:

- Impact on the water quality, plankton and primary production as a result of sedimentary spill.

The use of wind turbines of the mono-pile type of foundation will cause little or no spill. Spill simulations have been done for a worst-case scenario where the foundation is composed of a caisson with associated excavation (Danish Hydraulic Institute, 1999). Two simulations show that it is improbable that there will be any impact from spill in the worst case scenario. In this, there is a spill percentage of 5% comprising a total of 1,196 tons/day over a period of 8 days. The spill concentrations will exceed 10 mg/l during 50% of the excavation period within a very limited area of the wind farm. This figure lies within the natural variation of the area where concentrations of suspended material can vary from a background level of 2–10 mg/l to several hundred mg/l.

It is not envisaged that spill on this scale will have any quantifiable impact on water quality, pelagic production or the occurrence and distribution of phytoplankton or zooplankton for the area as a whole.

Suggested monitoring programme

The aim of a monitoring programme is to document and, if possible, to quantify the calculated expected impact, and even unforeseen impacts, during the construction and/or production phases. It must be stressed that the baseline data needs to be designed and organised to be able to register both the expected changes relative to the baseline situation (Green, 1979) and the criteria set by the controlling authorities. It is not sufficient to focus on data quantity and quality alone.

Monitoring programme for the construction phase

Potential impacts from the construction phase are:

- Impact on the water quality, plankton and primary production as a result of sedimentary spill

Special programmes for monitoring the water quality, primary production and plankton during the construction phase are not deemed to be necessary. This is based on the very limited and temporary spill impact associated with construction of the wind farm and the cable line.

Monitoring programme during the production phase

Possible impacts during the production phase are:

- Permanent impact on current, sediment, water exchange and wave conditions of the area
- Discharge of copper from the slip-rings of the wind turbines
- Addition of paint flakes and sand waste in connection with maintenance of the foundations and towers

- Effects of oil spills in connection with accident and cable rupture

No significant or general changes are expected in the water quality, primary production or occurrence of phytoplankton as a result of the establishment of the wind farm, since no changes or only insignificant local changes on the water exchange, currents, sediment and wave conditions are envisaged.

The discharge of copper from the slip-rings can cause a locally increased contamination of the plankton in the area. It is therefore recommended that a control and monitoring programme be implemented to follow the copper content in the pelagic primary production and the occurrence of plankton during the production period. Or alternatively that the copper waste is avoided or collected.

It should be noted that no suitable baseline exists for a potential monitoring programme for the primary production or the plankton community.

6. Conclusion

Present situation

The wind farm area is characterised by relatively high concentrations of inorganic nutrients, low transparency due to large amounts of resuspended material in the water column, total mixing of the water column and generally good oxygen conditions. Hypoxic conditions have been recorded in the adjoining areas. Recurring blooms of phytoplankton have been seen in the same areas. These can agglomerate on beaches where they can create problems with smell, unsightliness, etc. Several toxic plankton types have been recorded and can lead to accumulation of algal toxins in bivalves of commercial importance.

Impacts

The impact on current and sediment conditions in the area from establishing the wind farm will be very local and limited, in both the construction and production phases. No general changes in the water quality of this area are thus expected.

A minor increase in copper contamination of the plankton is expected to occur during the production phase as a result of the discharge of 206 kg copper annually from the slip-rings in the wind turbines. It is recommended that a control programme be initiated to monitor the effect of this source of copper on the pelagic primary production and the occurrence of plankton in the area. The alternative is that the copper waste is avoided or collected.

A temporary contamination with paint flakes and sandblasting waste, including sand from the maintenance of foundations and towers is also expected during the production phase. It is recommended that the toxicity of the paints be further investigated and that the waste of paint and paint flakes and the effects of the waste be minimised as much as possible. It is considered that the spill of sandblasting sand will only have negligible effects on the water quality.

7. References

- Andersen, P. & B. R. Thorbjørnsen 1999. *Statusrapport over overvågningen af toksiske alger og algetoksiner 1998*. (Status report on the monitoring of toxic algae and algal toxins 1998). Report to the Veterinary and Food Directorate. (In Danish).
- Blegvad, H. 1922. Animal Communities in the Southern North Sea. *Proc. Zool. Soc.*: 27–32.
- Cadée, G. C. 1992. Trends in Marsdiep phytoplankton. In: Present and future conservation of the Wadden Sea. pp. 143–149. Eds: Danker, N., C. J. Schmidt & M. Scholl. Proceedings of the 7th International Wadden Sea Symposium. Ameland 1990. *Neth. Inst. sea. Res. Publ. Ser.* 20.
- County of North Jutland, County of Viborg, County of Ringkjøbing and County of Ribe, 1998. *Åbne farvande langs Vestkysten*. (The sea along the west coast of Jutland). (In Danish).
- County of Ribe, 1997. *Marine områder. Vandmiljøovervågning*. (Marine areas. Monitoring the aquatic environment). 1997: 1–159. (In Danish).
- County of Ribe, 1994. *Ribe Amts vandområder - 1990-93 - Planteplankton temarapport*. (The aquatic areas in the County of Ribe – 1990–93 – Phytoplankton, thematic report). (In Danish).
- County of Ribe, 1999. *Regionalplan 2008. Administrativ del 1999*. (Regional plan 2008. Administrative section 1999). (In Danish).
- Danish Environmental Agency, 1991. *Den Jyske Kyststrøm*. (The Coastal Currents of Jutland). *Havforskning fra Miljøstyrelsen, rapport no. 6*. (In Danish).
- Danish Hydraulic Institute 1999. Horns Rev Wind Power Plant. Environmental Impact Assessment of Hydrography. Report to ELSAM.
- Danish Hydraulic Institute 2000. Horns Rev Wind Power Plant. Preliminary EIA of Copper Pollution. Technical Note to ELSAM.
- Danish Ministry of Environment and Energy 1999. *Retningslinier for udarbejdelse af VVM-redegørelser for vindmølleparker på havet*. (Guidelines for the preparation of Environmental Impact Assessments (EIAs) for offshore wind farms. Draft note). (in Danish).
- ELSAM project 2000. *ELSAM. Havmøller. Vedligeholdelse af overflader på fundament og tårn*. (ELSAM. Offshore wind turbines. Surface maintenance of foundations and towers). Memo, 13 January 2000. (In Danish).

- Green, R. H. 1979. Sampling Design and Statistical Methods for Environmental Biologists. New York: 1–257.
- Morris, I. 1980. The physiological ecology of phytoplankton. Studies in Ecology Vol. 7. Blackwell, Oxford.
- North Sea Task Force 1993. North Sea Quality Status Report – 1993. Oslo and Paris Commissions/ICES. Olsen & Olsen, Fredensborg.
- Westernhagen, H. V., W. Hickel, E. Bauerfeind, U. Niermann & I. Kröncke 1986. Sources and effects of oxygen deficiencies in the south-eastern North Sea. *Ophelia*, 26: 457–473. 1986.