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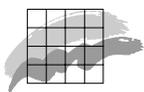
# Remote video registration of seals at Rødsand seal sanctuary

Technical improvements and feasibility for detecting  
effects of the construction of Nysted Offshore Wind Farm

*Research Notes from NERI No. 187*



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# Remote video registration of seals at Rødsand seal sanctuary

Technical improvements and feasibility for detecting  
effects of the construction of Nysted Offshore Wind Farm

*Research Notes from NERI No. 187*  
**2003**

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## Data sheet

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Abstract:	This report describes the preliminary use of a remote-controlled web-based camera system in the Rødsand seal sanctuary. The camera systems, powered by solar and wind energy are designed to operate under extreme weather conditions. Live images and still photos are transmitted to a land station, from where it is streamed to the Internet. The cameras are operated remotely and pictures are stored every 5 – 10 seconds. From April through June 2002 seals were present on 76% of the days but only on 9% of the days seals were present all day. From July to the end of August 2002 seals were either present (41%) or absent (43%) the whole day. From the end of August to mid October the seals were present nearly every day but only on 23% of these days seals were hauled-out throughout the whole day. From mid October to the end of March seals were again either present (14%) or absent (79%) the whole day. Neither ramming/vibration of one sheet piling nor a seal scammer turned on just before the ramming session had an effect on seals hauling out in the sanctuary.
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# Summary

## *Remote camera system*

This report describes the preliminary use of a remote-controlled web-based camera system in the Rødsand seal sanctuary. The camera system powered by solar and wind energy is designed to operate under extreme weather conditions. Live images and still photos are transmitted to a land station, from where it is streamed to the Internet. The cameras are operated remotely and pictures are stored every 5 – 10 seconds.

Two cameras were mounted on a 6 m high tower in Rødsand seal sanctuary. On Marts 20, 2002 the tower was installed 900 m from the seals' preferred haul-out site. To improve the resolution and quality of the photos, the tower was moved 300 m closer (i.e. about 600 m from the seals) to the haul-out site on August 14, 2002.

From April through June 2002 seals were present on 76% of the days but only on 9% of the days seals were present all day. From July to the end of August 2002 seals were either present (41%) or absent (43%) the whole day. From the end of August to mid October the seals were present nearly every day but only on 23% of these days seals were hauled-out throughout the whole day. From mid October to the end of March seals were again either present (14%) or absent (79%) the whole day.

At one position the seabed was not stable enough to hold a turbine foundation and ramming/vibration of sheet piling were made for stabilisation. A seal scammer only heard under water was turned on before the ramming session. Neither the ramming nor the seal scammer had an effect on seals hauling out in the sanctuary.

## *New-born grey seal pup*

On February 25, 2003 a well nourished grey seal pup was discovered within the sanctuary as researchers were inspecting the cameras. At the same time three adult grey seals were seen swimming close by. The following day another grey seal pup was spotted via the camera. The grey seal used to be the most common seal in Denmark but due to human persecution, grey seals were exterminated from the Danish waters in the beginning of the 20th century. Today the grey seal population is believed to be somewhere between 25 and 50 individuals and a maximum of 17 grey seals were recorded on Rødsand sanctuary in June and July 2001. Very few grey seal pups have been reported over the last 100 years. The recording of two live grey seal pups provide hope for a revival of grey seals regularly breeding in Danish waters.

## Resumé

### *Fjernstyret videoovervågning*

Denne rapport præsenterer de foreløbige resultater af kameraovervågning af sæler ved Rødsand sælreservat. Kameraovervågningen indgår som en del af grundlaget for en vurdering af mulige effekter af Nysted Havmøllepark syd for Nysted på Lolland. De fjernstyrede kameraer forsynes med strøm fra sol- og vindenergi og er konstrueret til at kunne modstå ekstreme vejrforhold. Direkte videooptagelser transmitteres til en modtagestation på land og videre ud på Internettet, hvor optagelserne kan ses og kameraerne drejes og zoomes. Billeder fra kameraerne lagres på en computer hvert 5.-10. sekund.

Den 20. marts, 2002 blev to kameraer monteret på en 6 m høj mast 900 m fra sælernes foretrukne yngle- og rasteplass. For at øge opløsningen og kvaliteten af billederne, blev masten den 14. august 2002 flyttet 300 m tættere på sælernes rasteplass.

Fra april til slutningen af juni 2002 lå der sæler på land i 76 % af dagene, men kun i 9% af disse dage lå der sæler på land hele dagen. Fra juli til slutningen af august var sælerne enten tilstede (41%) eller fraværende (43%) hele dagen. Fra slutningen af august til midten af oktober lå der sæler på land næsten hver dag, men kun i 23 % af disse dage lå der sæler på land hele dagen. Fra midten af oktober til slutningen af marts var sælerne igen enten tilstede (14%) eller fraværende (79%) hele dagen.

Ved en af møllerne blev en spunsvæg rammet/vibreret ned i havbunden til stabilisering af fundamentet. Før hver ramme-periode blev en 'sælkræmmer' tændt under vandet. Hverken ramningen eller 'sælkræmmeren' havde nogen effekt på sælerne på land ved Rødsand sælreservat.

### *Gråsælunger*

I februar 2003 blev der observeret to gråsælunger ved Rødsand. Gråsælen forsvandt fra de danske farvande i begyndelsen af 1900-tallet, men er langsomt begyndt at vende tilbage. I dag findes der ca. 50 gråsæler i Danmark. Der er kun set ganske få gråsælunger i danske farvande de seneste 100 år, så optagelsen af de to gråsælunger ved Rødsand er tegn på at gråsælen er ved at vende tilbage som yngleart i de danske farvande.

# 1 Introduction

## 1.1 Background and purpose

### *Offshore wind farm*

The Danish government has introduced several action plans with the goal of reducing the annual emissions of CO<sub>2</sub> to half of 1998 levels by 2030. In order to help achieve this, the amount of energy produced from renewable energy sources, including offshore wind farms, is to be increased. The Ministry of the Environment has issued the energy companies Energi E2 and SEAS a commission to erect a wind farm, "Nysted Offshore Wind Farm", close to Rødsand (south of Lolland). The wind farm will consist of 72 x 2,2 MW turbines. The initial construction work on the foundations started in the end of June 2002 and the wind farm is planned to be in operation in the fall 2003.

Part of the present work is to assess the extent to which the erection of the wind farm in this area will cause measurable, temporary or permanent, changes in the presence and behaviour of harbour seals (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) in the Rødsand area.

### *Preliminary study*

During June-August 2001 a master student (Pernille Bondo Harders, supervised by NERI) monitored the seals in the sanctuary from a bird observation tower. She collected data on diurnal behaviour and disturbances of the seals as well as weather parameters during 43 days. These are the first systematically collected data at Rødsand and will be valuable as part of the baseline data. To monitor the diurnal behaviour continuous monitoring is necessary. This can be done either manually or automatically. To reduce manpower and increase data sampling, we proposed to deploy year-round video monitoring of the seals hauling out in the sanctuary. The present report describes the method and some preliminary results.

## 1.2 Possible effects on seals from establishment and operation of offshore wind farms

### *Possible effect on seals*

It is possible that some of the activities involved in construction and operation of the wind farm will have a negative impact on the seals in and near the wind farm area. The most significant sources of these effects may be the physical presence of the wind farm and the noise from ships and construction work as well as temporary and even permanent loss of habitats near the wind farm.

In order to study the possible effects from the erection and operation of the wind farm on the seal population a number of investigations have been initiated. An Internet video camera will determine the use of and diurnal activity in the Rødsand seal sanctuary in relation to the establishment and operation of the wind farm. In addition aerial surveys will determine the use of alternative haul-out localities, and satellite telemetry is documenting the general displacement, habitat selection and use of the wind farm area.

## 2 Description of the offshore wind farm and seal sites at Rødsand

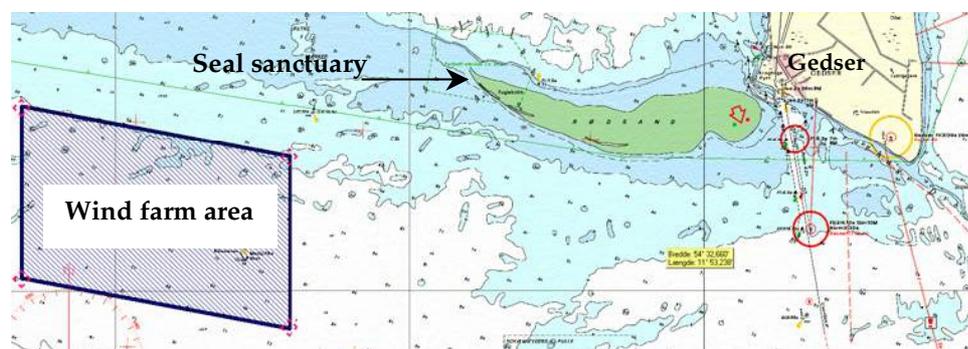


Figure 2.1 Map of the wind farm area and the seal sanctuary.

### 2.1 The area of the offshore wind farm

#### *Wind farm area*

Nysted Offshore Wind Farm will be placed in Femarn Belt around 10 km south of the city Nysted (Lolland, Fig. 2.1). The water depth in the wind farm area is between 5.5 m and 9.5 m. The largest part of the area consists of sand bottom with larger and smaller ridges. In places there are pebbles, gravel or shells. Although there are outcrops of stones >10 cm, no reef-like aggregations have been recorded.

#### *Ideal habitat for seals*

About 2 km north of the wind farm is a shallow (<4m deep) lagoon-like area between Southeast Falster and Southwest Lolland. This area is used by a large number of coastal fishermen mainly using fyke and pound nets. The area also constitutes an ideal habitat for harbour and grey seals, where they go ashore on remote sand banks (Rødsand seal sanctuary) or stone reefs (Vitten and Flintehorne Odde) away from human disturbance. The wind farm will be placed 4 km south-west of the seal sanctuary.

### 2.2 Seal sites at Rødsand

#### *Rødsand seal sanctuary*

At the western tip of the Rødsand sandbank (54°35'N, 11°49'E, Fig. 2.1 and 2.2), a seal sanctuary was established in 1978 (Bøgebjerg 1986). The seal sanctuary is protected from all access from March 1 – September 30 in a distance of about 500 m around the western tip of the sand bank (Ministry of the Environment and Energy 1993). The seals prefer the most western tip of the sandbank because currents always keep a deep-water channel very close to the bank where they can rapidly escape. This is the most important haul-out and breeding site for harbour seals in the western Baltic Sea (Teilmann & Heide-Jørgensen 2001). Haul-out sites are important for the breeding, moulting and resting of the seals. The sandbank is flooded in extreme weather and appears to be in a state of constant alteration as a result of currents and sand deposition.

According to fishermen interviewed in the Environmental Impact Assessment (EIA, Dietz et al. 2000) the seals also use the stones around Vitten and Skrollen, near Hyllekrog about 10 km west of the seal reserve. This has now been confirmed by aerial surveys and during this study (see later). Throughout the Rødsand lagoon seals are often observed sporadically on rocks and in the water. In the deeper water south of the lagoon fishermen and other users of the area often observe seals (Dietz et al. 2000).



*Figure 2.2* The seal sanctuary at Rødsand taken during an aerial count in April 2002 (Photo: Rune Dietz).

## 3 Materials and methods

### 3.1 Camera type

#### *Remote-controlled camera*

The camera system is build by SeeMore Wildlife System Inc., (Alaska, USA, [www.seemorewildlife.com](http://www.seemorewildlife.com)). The digital camera systems are wireless, solar and wind powered, and designed to operate in extremely foul-weather environments. The cameras are rugged and waterproof (submersible). They have fully Remote-controlled pan, tilt, zoom, auto focus, windshield wiper, squirter, water storage, two-way data transmitters and self diagnostics function (Fig. 3.1). All equipment is designed for remote 12vdc power.

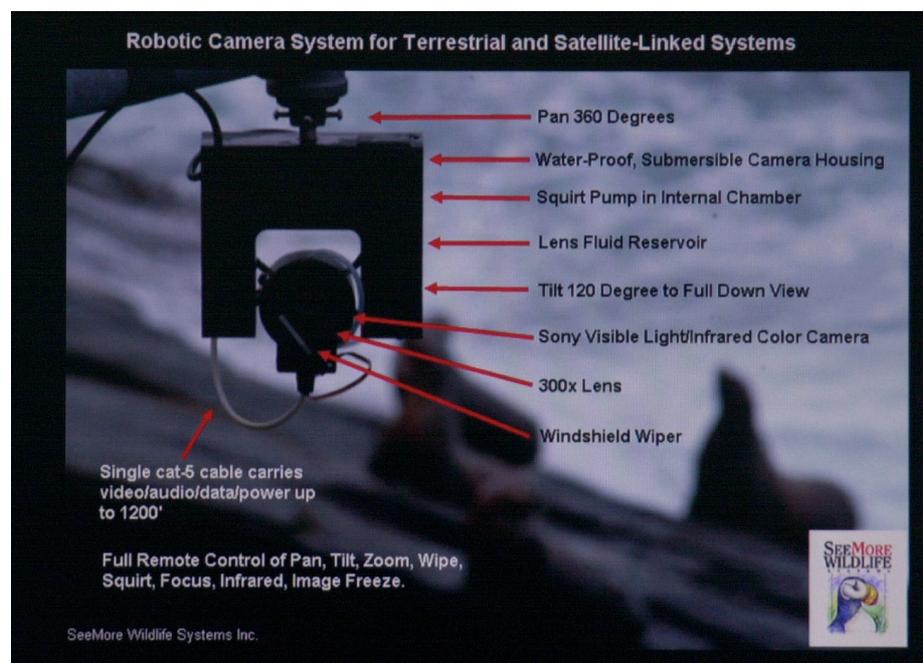


Figure 3.1 Camera system similar to the ones used at Rødsand (picture from [www.seemorewildlife.com](http://www.seemorewildlife.com)).

#### *Internet control of camera*

The cameras have 360-degree panorama scan and a 120-degree tilt that is remotely controlled over the Internet and by specially designed software. This enables us to make regular scans of the surroundings to detect potential disturbances of seals.

### 3.2 New cameras and software

#### *Start problems*

In the beginning too many users were able to control the camera. The cameras were not easy to control and therefore not always left in the right position for the right images to be stored. Therefore a lot of data were lost. On February 5, 2003 two new cameras and new software replaced the cameras. The new software made it easier to control the cameras and positions could be stored at prefixed positions. A click on a prefixed position would return the camera to one of the stored positions.

### 3.3 Deployment of cameras

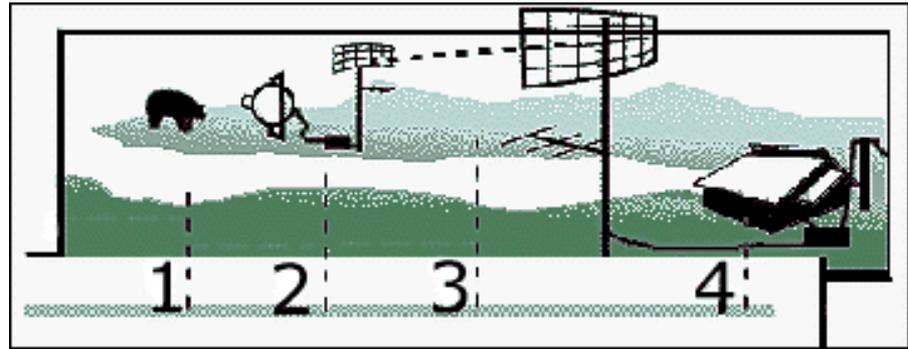


Figure 3.2 Schematic illustration of the camera system. 1) seal sanctuary. 2) Tower with cameras. 3) Signals are sent to receiver in Gedser by use of microwave. 4) NERI in Roskilde where the cameras can be controlled and pictures are analysed (illustration from [www.seemorewildlife.com](http://www.seemorewildlife.com)).

Two visible-light cameras with 300X telephoto capability are mounted on a 6 m high tower (2 in Fig. 3.2 and Fig. 3.3). The tower was first deployed 900 m from the seals preferred haul-out site but was moved to 600 m later on. The tower is secured to a basis consisting of 4 stainless steel cases (105x105x53 cm) filled with sand. Each case weighs around 1 ton. Eight stainless steel wires are mounted to minimise vibrations of the tower during strong winds. 12vcd batteries powered by two solar panels and a wind generator situated on the top of the tower power the cameras. Rødsand seal sanctuary is situated many km from the nearest power or phone connection (1 in Fig. 3.2). With the use of microwave the video signal is sent to the control centre in Gedser (3 in Fig. 3.2) where a computer receives the signal.

#### *Control centre*

The system is reliable even in the harshest climate. It uses very little power. The cameras, control centre, and transmission equipment are inconspicuous and completely self-contained. The computer is situated in a little shed used for control of a power line to Germany by SEAS. The images from the cameras are full-bandwidth and can be recorded on real-time or time-lapse tapes, or digitised for storage on computer hard disk drives. Live images may also be encoded and streamed onto the Internet for world-wide distribution.

#### *Camera access*

At the moment it is not possible for the public to get access to live images from the camera, but authorised observers (4 in Fig. 3.2) can access the remote control program for the cameras and remotely control them from their computer.



Figure 3.3 Camera tower at Rødsand Seal Sanctuary with antenna, wind generator, solar panels and battery box.

### 3.4 Camera control

#### *Camera software*

The view of the cameras was regularly controlled, panned, tilted and zoomed to obtain an optimal view on animals in view (see Fig. 3.4). SeeMore Wildlife improved the software during the monitoring period to facilitate operation from the distant location of the tower. Only one camera can be operated at a time. Clicking on the camera buttons on the screen image (Fig. 3.4, Camera 1 and Camera 2) chooses the camera. Still photos can only be stored from the active camera. The camera view can be controlled by the up, down, right, and left bottoms in screen image (Fig. 3.4). The 1 to 10 bottoms to the left on the screen image are used to zoom in and out in steps. The camera view can also be gradually zoomed by the 'zoom in' and 'zoom out' buttons. Just below the zoom bottoms there is a button for the lens wiper.

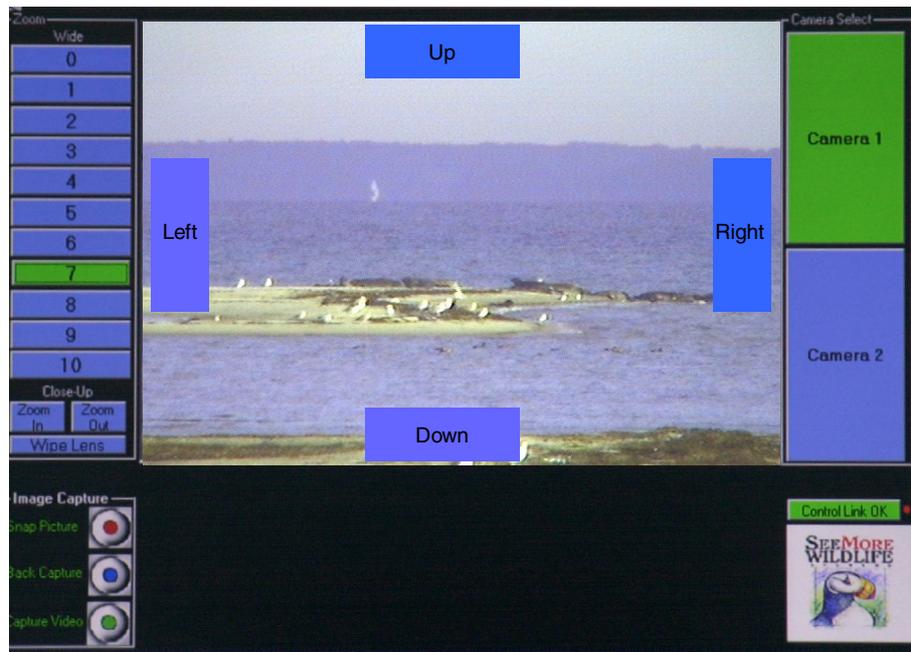


Figure 3.4 The remote camera view software from SeeMore Wildlife used for operating the two cameras. The image shows the seals preferred haul-out site on the tip of Rødsand seal sanctuary on September 12, at 8:08 a.m.

### 3.5 Data collection and analysis

#### *Images storage*

Live images are digitised to JPEG format and stored every 5 seconds from sunrise to sundown on the computer at the receiver station for later analysis. Every morning at 9 a.m. pictures from the past day are transferred through an ADSL link to the computer storage facility at NERI in Roskilde. Here all pictures are being analysed and stored on DVD disks regularly. The software program ThumbsPlus 4.10 is used for handling the pictures. Information from the pictures are extracted and stored in a database.

### 3.6 The occurrence of seals

As the distance is too long and the observation angle too low it is difficult to count the seals when more than 20 animals are present. The quality of the photos does not allow for detailed behavioural studies. Therefore only rough estimates of the seal numbers are registered, but the cameras always provide data on whether seals are present or not.

To calculate the occurrence of seals on land over time and to determine the time with seals on land all pictures were analysed. As long as at least one seal was present on land it counted for 100 %. No seals present counted for 0%. The percentage of seals on land per day could then be calculated from the time with and without seals hauled-out. For example a day with seals present 6 out of 12 hours the occurrence that day would be 50 %.

## 4 Results and discussion

### 4.1 Placement of the tower

#### *Movement of tower*

In order to minimize disturbance of the seals the tower was initially placed distant (900 m) from the haul-out site and then later moved closer to the seals. At the first location the tower with the two cameras was deployed on Marts 20, 2002. The great distance and the low angle from the cameras to the seals made it very difficult to count the seals when more than 20 seals were present or when many birds were on land, as they were shading for each other. The quality of the photos was too poor to extract behavioural information. Therefore the tower was moved to a site approximately 600 m from the haul-out site on August 14, 2002.



*Figure 4.1* The image shows the seals' preferred haul-out site on the tip of Rødsand seal sanctuary on September 17, 2002 at 15:06. The distance and the angle from the camera made it difficult to count the seals lying behind the flock of cormorants (*Phalacrocorax carbo*).

Even after moving the tower to a distance of 600 m from the seals the angle was still not steep enough to avoid the shading effect (Fig. 4.1).

#### *Suggested improvement*

A possible solution to this problem would be to increase the height of the tower to get a better angle to overlook the closely packed seals. A higher tower, however, would cause a greater vibration of the tower during windy days resulting in poorer picture quality. Another solution could be to further reduce the distance to the haul-out site, which would improve both picture quality and the camera angle.

#### *Disturbance of seals*

The presence of the tower has not yet proved to have any effect on the seals. During the movement of the tower with the presence of 10

persons, the seals stayed on land during the whole process. Even when the pegs were hammered into the ground, the seals did not seem to be affected. The SeeMore Wildlife Systems are used on other species including stellar sea lions (*Eumetopias jubatus*) and elephant seals (*Mirounga angustirostris*) on a much closer range without disturbance effect (Daniel Zatz, pers. comm).

As long as the sanctuary is entered from the north-eastern or south-eastern side the effect on hauled-out seals seem negligible.

The cameras only need very little supervision, as the system is self-contained. In case of another displacement of the tower it would only cause disturbance of the sanctuary for half a day. The tower is a stationary object, which it is believed to be tolerated by the seals very quickly.

## 4.2 Seal registration and abundance

### *Large database*

From April 2002 to March 2003 more than 2 million pictures have been stored from 238 days, providing us with large database with information on the seal's use of the seal sanctuary.

### *Seal abundance categorised*

Because of the long distance and low angle from the camera to the seals it could not be distinguished when more than 20 seals were lying on land at the same time. The seal abundance was therefore divided into categories of 0, 1-5, 6-10, 11-15, 16-20, and >20 seals. The maximum numbers of seals per day are shown in Fig. 4.2.

The data files for May, June, and July are stored on the computer at the receiver station in Gedser. The stored pictures from these months are larger than the other months, which has caused problems transferring them to NERI. Only 4 pictures per hour from 12:00 to 20:00 in these months have been received for analysing. Therefore the maximum number of seals for these three months (Fig. 4.2) could be higher.

### *Seal abundance*

On 36 % of the days from April through August there is more than 20 seals on land at the time. In September there is only a maximum of 10 - 20 seals on land. From October to January there is many days without seals, but on those days with seals on land the number tends to exceed 20 seals. From February to March there has only been few days with seals present and only 2 – 10 seals at the time. The number of seals and their presence in these months was also low in previous years with only occasional observations of 1-3 seals (Falster Skovdistrikt 1999).

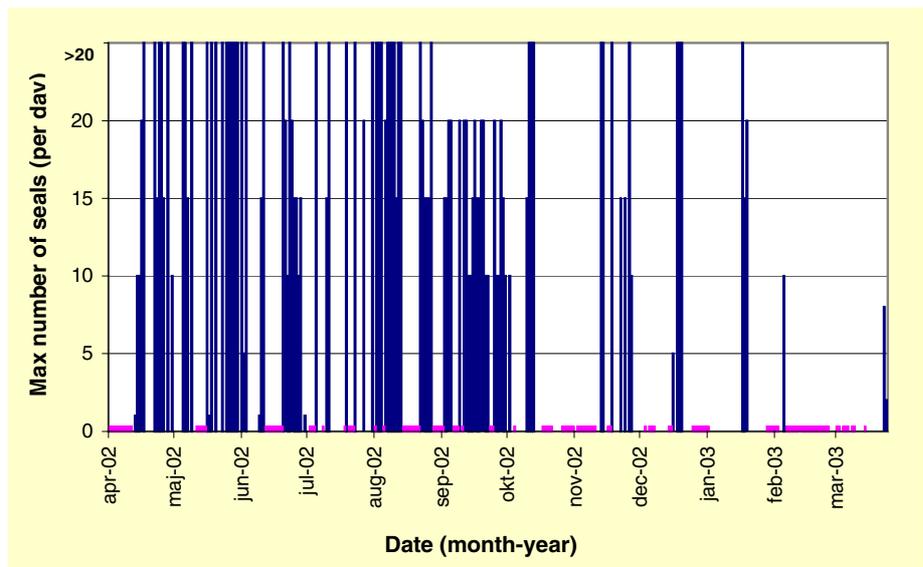


Figure 4.2 Maximum number of seals per day on land in Rødsand sanctuary illustrated by blue bars. Data based on more than 1 million pictures from 238 days. Period with missing data are marked with pink bars.

### 4.3 Diurnal occurrence of seals

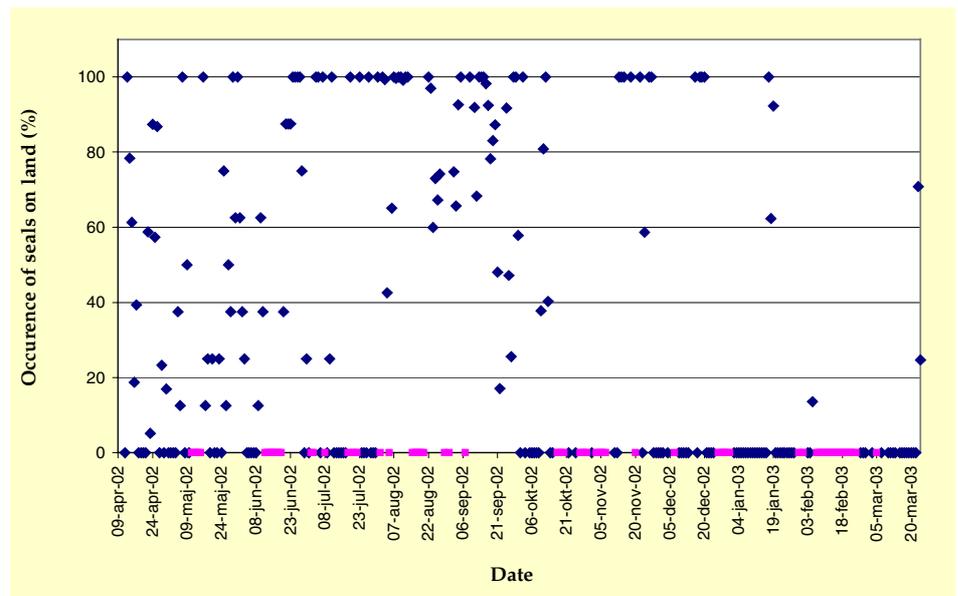


Figure 4.3 Occurrence of harbour seals on land at Rødsand sanctuary during light hours. Data based on more than 1 million pictures from 238 days (Periods with missing data are marked in pink).

The diurnal occurrences of harbour seals at Rødsand seal sanctuary are shown in Fig. 4.3 and 4.4.

#### *Yearly variation*

From April through June 2002 seals were present on 76% of the days but only on 9% of the days seals were present all day. From July through August 2002 seals were either present (41%) or absent (43%) the whole day. From the end of August to mid October 2002 the seals were present nearly every day but only on 23% of these days seals were hauled-out throughout the whole day. From mid October 2002 through March 2003 seals were again either present or absent the

whole day. On 79% of the days no seals were present and on 14% of the days seals were present the whole day.

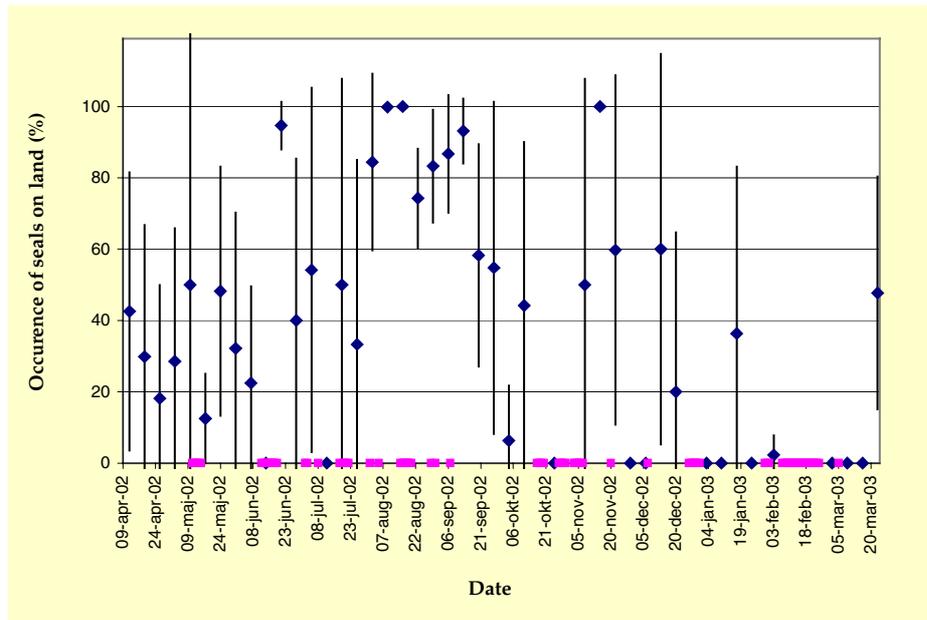


Figure 4.4. Occurrence of harbour seals on land at Rødsand sanctuary during daylight hours on week basis. The black vertical lines illustrate standard deviation. Data based on more than 2 million pictures from 228 days. Periods with missing data are marked with pink bars.

The presence of the seals spend on land tends to peak in the beginning of August (Fig. 4.4). From April to August there is a high variation in the time seals spend on land as the presence of seals through out day and month vary a lot (Fig. 4.3 and 4.4). In August there is only a very little variation in the time seals spend on land per day but from the end of September to mid January this variation becomes higher as the seals are either present or absent the whole day (Fig. 4.3 and 4.4).

Days when seals were present the whole day are also days when the maximum number of seals reached more than 20.

#### 4.4 Daily and monthly variation in occurrence of seals

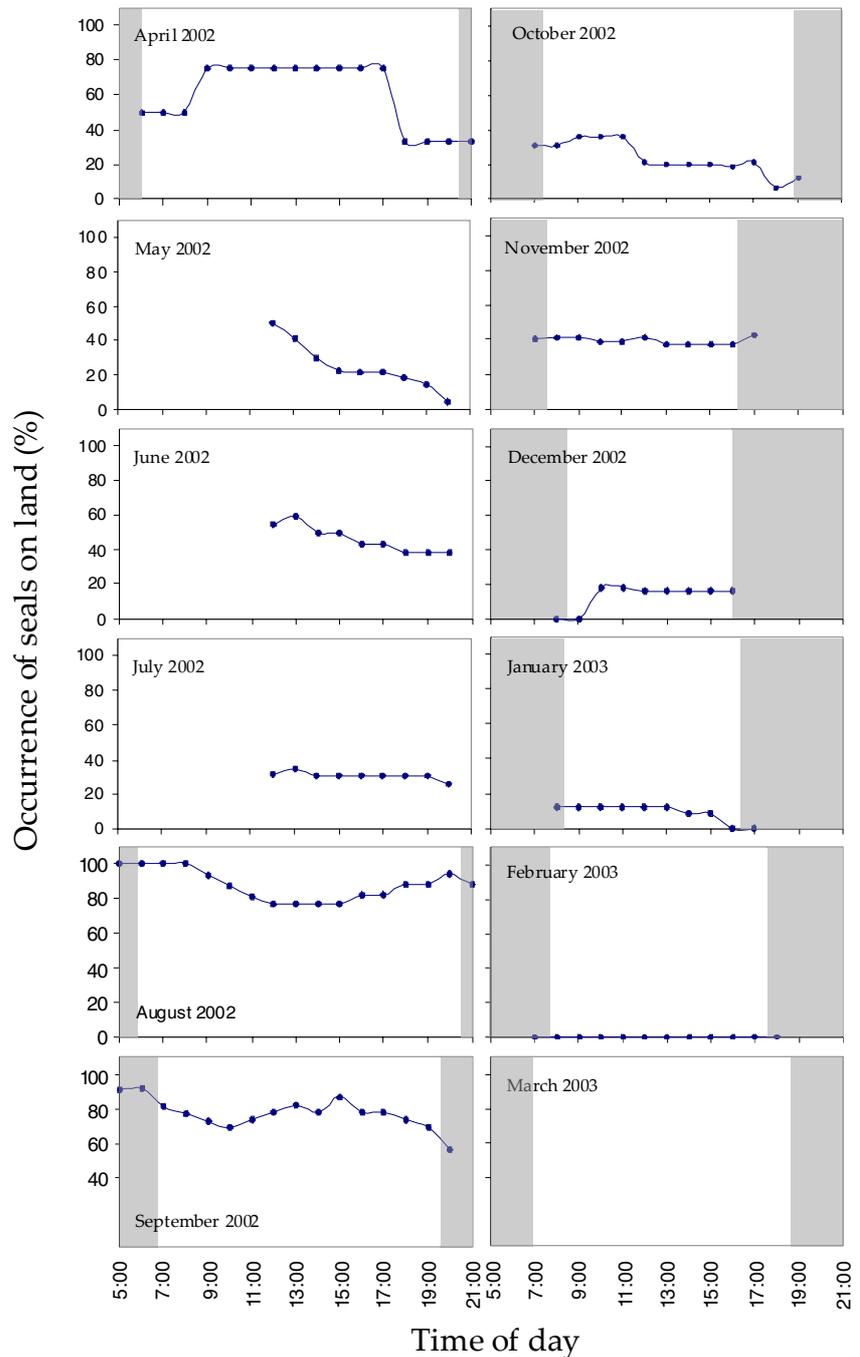


Figure 4.5 Monthly variation in occurrence of harbour seals on land at Rødsand sanctuary during daylight hours. Shaded areas represent hours with twilight or darkness. Only 4 pictures each hour from 12:00 to 20:00 in May, June and July have been received for analyse.

The diurnal pattern of the occurrence of the seals on land changes over the month (Fig. 4.5). In April 2002 the occurrence of seals increases from 50% to almost 80% after 8:00 and decreases to ca. 30% after 17:00. In May, June and July further data handling is required to draw any firm conclusions. In August the occurrence of seals on land is highest. The occurrence of seals on land decreases after 8:00 to

wards 80% around noon and then again increased to ca 90% after 15:00 which is the opposite behaviour than observed in April. From September 2002 to March 2003 the occurrence for the seals being on land decreases. However, the diurnal pattern was less variable.

## 4.5 Grey seals

It is not always possible to distinguish grey seals from harbour seals on the stored photos. The easiest way to distinguish the two species is from the shape of the head. But the resolution of the photos is too low in most cases to see this feature. Sometimes groupings of the animals, the darker colour and larger size help to distinguish the two species.



Figure 4.6 Grey seal pup observed at Rødsand seal sanctuary on February 25, 2002 by researcher attending the camera tower. (Photo: Susi M.C. Edrén).

### *New-born grey seal pup*

On February 25 two researchers from NERI were attending the cameras at Rødsand seal sanctuary. The cameras had not been working since February 5. While working on the cameras they spotted a large and healthy grey seal pup (Fig. 4.6). Three adult grey seals were swimming close by. The next day another pup was registered on the camera (Fig. 4.7).

The grey seal was exterminated in the Danish waters more than 100 years ago (Søndergaard *et al.* 1976). From 1889 through 1927 there was a reward on every seal shot, and 37 000 seals were shot during that period. The grey seal pup does not enter the water for the first week or two after birth and was therefore an easy target for the hunters. The grey seal has been totally protected since 1967 in Denmark (Søndergaard *et al.* 1976). Today it is believed that between 25 and 50 grey seals are visiting Danish locations with Rødsand as the most important area (Teilmann & Heide-Jørgensen 2001). Recently it has been documented that grey seals travel between Rødsand, Sweden and Estonia (Dietz *et al.* 2003). The Baltic Sea population gives birth in February-March. Three times since 1982 dead grey seal pups have been found in Denmark, twice on Anholt in 1982 and 1996, and once on Rødsand in 1993 (Dietz & Heide-Jørgensen 1982, Heide-Jørgensen *et al.* 1997, Dietz *et al.* 2000). One live grey seal pup 2-3 weeks of age was found on Hirtsholmene on 7 December 1996 (Flensted 1997).

Three grey seal pups were recorded in October 1966, 1967 and 1969 on skerries of Northern Halland in Sweden (Ahlebrand & Dahlbeck 1969). During winter it is not uncommon to see weak or dead grey seal pups on the west coast of Jutland (Henrik Lykke Sørensen pers. comm.) The finding of the pups at Rødsand is the first time in over 100 years that two healthy live grey seal pups have been observed in Denmark.



Figure 4.7 Image from video camera on February 28 at 12:26. Two adult grey seal and two grey seal pups.

In the end of February the whole sanctuary was covered with ice, which made it hard to detect the pups. The presence of the adults often revealed their position. After March 3 only one pup was spotted with the camera and only 2 adults (the mother and an adult male) were seen. After March 4 no adult grey seal were seen any longer. On March 11 the seal pup was seen for the last time swimming around in a small and shallow pond in the sand.

It is believed that both pups have survived and left Rødsand seal sanctuary about March 1 and 11, respectively.

#### **4.6 Effect of the wind turbine construction on the seals**

So far only information on ramming activities are available (Table 4.1). More detailed data on the construction work together with information on wind, cloud cover, temperature will later be compared with the images stored by the camera system to analyse for effects on the diurnal and seasonal use of the sanctuary by the seals.

##### *Ramming of sheet pilings*

At position A8 (about 10 km away from the seal haulout site) the seabed was not stable enough to hold a turbine foundation and ramming/vibration of sheet pilings were made for stabilisation. In total 52 interlocking steel sheet piles constituting the sheet piling (20 m circumference) were driven 10 m below the seabed, and covered by a 10 m layer of stable gravel and stones on which the foundation were placed. The noise from this operation has not been estimated or

measured and it is therefore unknown whether the seal on land in the sanctuary could hear the noise.

*Table 4.1* Time when seal scrammer was turned on and off at position A8 (about 10 km from seal site). Within this time period the ramming of 52 interlocking steel sheet piles were rammed 20 metres into the seabed.

Date	ON	OFF
26.08.02	11.00	15.00
27.08.02	09.30	17.45
28.08.02	09.00	17.45
29.08.02	10.45	18.15
30.08.02	16.40	21.30
02.09.02	10.55	19.05
03.09.02	09.30	16.55
05.09.02	09.35	19.00
08.09.02	09.10	17.05
12.09.02	11.30	15.15
13.09.02	09.30	12.00
19.09.02	15.30	19.05
20.09.02	08.55	10.20
24.09.02	12.30	16.15
25.09.02	10.00	14.25
25.09.02	17.45	21.15
26.09.02	08.45	13.35
26.09.02	15.45	20.15
27.09.02	09.00	13.00
30.09.02	10.15	16.15
01.10.02	11.20	17.30
22.10.02	14.30	22.50
15.11.02	12.15	16.00
19.11.02	11.00	15.00
20.11.02	10.00	16.00

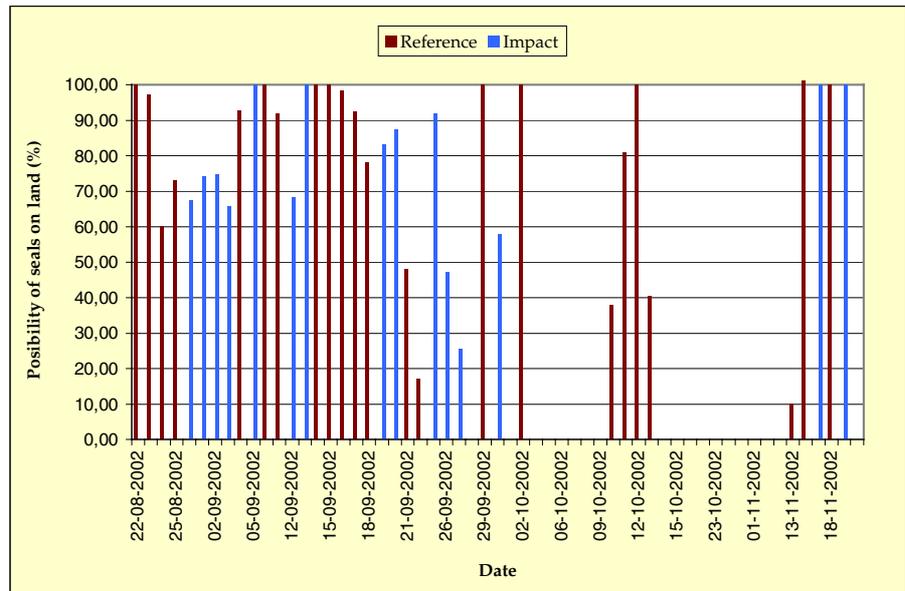


Figure 4.8 Occurrence of seals on land during the ramming periods. Ramming days (n=17) are illustrated by blue bars and reference days (n=38) by red bars.

### Seal scammer

Half an hour before each ramming session occurred a seal scammer was turned on to secure that no seals were within a critical hearing damage distance of the ramming. The seal scammer can only be heard under water and does not affect the seals hauling out in the seal sanctuary. The occurrence of seals on land on the days before the ramming period ( $\bar{x} = 55.4\% \mp 43.8\%$ ) were not significantly different from the occurrence of seals during days with ramming ( $\bar{x} = 67.2\% \mp 32.5\%$ ,  $P = 0.6$ , Mann-Whitney U-test,  $n = 17$ , Fig. 4.8). The maximum number of seals during hours of ramming exceeds the number of seals in the morning hours just before the ramming in 5 out of 13 days. On 6 of the days the maximum number of seals are the same and on 2 of the days the maximum number of seals decreased after the beginning of the ramming (Fig. 4.9). Therefore, we conclude that there is no systematic effect of the ramming and the seal scammer on seals hauling out in the sanctuary. The variation in the maximum number of seals we see could be an effect of the different time of day.

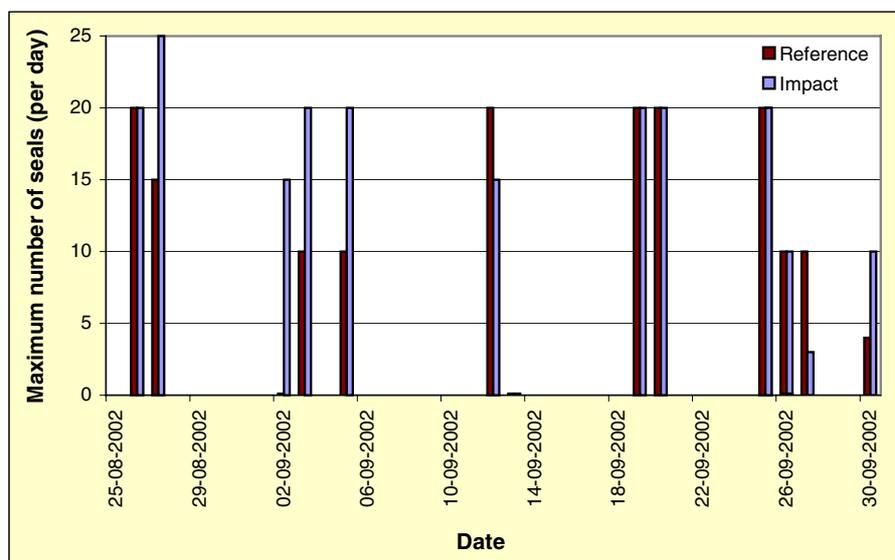


Figure 4.9 Maximum numbers of seals per day on days with ramming (n=13) at the offshore wind farm. Maximum number of seals in the hours before ramming are illustrated by red bars and in the hours of ramming by blue bars.

## 4.7 Statistical analysis

When the construction of the wind farm is finished and all details on construction activity and weather is available, the following statistics will be applied.

All statistical analyses are based on a model describing the underlying significant mechanisms grouping the number of seals. It is therefore important that all external factors that may influence the number of seals are simultaneously recorded. We assume, that the number of seals at Rødsand can be described as a function of variations in wind, water level, cloud cover, temperature, season, disturbances from boats etc. and random fluctuations.

The main hypothesis is that: “The diurnal haul-out behaviour of both harbour seals and grey seal will not change significantly at the Rødsand seal sanctuary during and after construction of the wind farm.” If we assume, that the relation between number of seals and climatic variation is unaffected by the construction work, then the potential effect will be revealed in the parameters of the model that describe the natural behaviour and behaviour related to disturbances. The alternative hypothesis is that the model parameters describing the behaviour of seals change during construction and operation indicating a different behaviour to external disturbances. The potential change in seal behaviour will be tested by means of a likelihood ratio test.

The above outlined statistical method is different to the classical BACI type analyses, as there are only data from the impact area. The proposed statistical method above relies on a good model description that incorporates all external factors (including the population size within the larger-scale area) influencing the behaviour of seals. This assumption, that all external factors are quantitatively linked to seal

behaviour, may be relaxed, provided that it is documented, that some of the external factors are either constant over the entire period of monitoring, or that the variations are equal in the two considered regimes (before and after).

## 4.8 Monitoring human disturbances

The video cameras can also be used for other purposes than observing seals such as recordings of human disturbances. Rødsand sanctuary is closed from March to October. Outside this period human access is not restricted in the area. No human disturbances have been recorded during the closed periods except for the few times the cameras were attended and the tower moved to another position. Only very few disturbances by humans have been recorded outside the closed period Figure 4.10 shows three hunters at the sanctuary on October 14, 2002 from early morning (7:26) and the following 6.5 hours (until 13:58). Hunting for migrating birds is legal from October through January.



*Figure 4.10* Stored image from the camera from October 14, 2002 showing three hunters walking around in Rødsand seal sanctuary at 7:26 and leaving the sanctuary 13:58 in a boat.

Unfortunately only disturbances captured on the pictures are recorded. An on-line observer has the possibility to pan the cameras to check for a possible boat sailing close by or the presence of humans on Rødsand when a sudden disturbance is observed but this is only done occasionally.

## 4.9 Public access to the pictures

One of the perspectives of the remote sensing of the seals is public access to live images on-line over the Internet or playback of interesting activity. This implies that the program running the cameras would have to stream the images to the one controlling the camera, to the web, and capture high quality still pictures at the same time. This is possible at the moment, but it will cause a decrease in the quality of the still pictures stored for later analysis. The simplest way would be to set up a second computer and get a new IP address for this computer. Another option is to install a special video card, that allows two programs to share the video card. This way the remote control program could use one "stream" from the card, while another program like Real Producer or Windows Media Encoder could "stream" another part. The second methods have not been tested yet.

## 5 Conclusion

*First period has provided good results*

The first period of video registration of the seals at Rødsand seal sanctuary has provided useful data for analysing possible effects of the construction of the Nysted Offshore Wind Farm on the seals. Though the distance from the tower to the preferred haul-out site has caused some difficulties with counting the exact number of seals, data for the presence of seals during the day and over the month have shown good results. The problem with counting the seals will hopefully be solved by moving the tower closer to the seals, which is planned for in April 2003.

*Good sampling method*

Even with the problems in the starting phase of the video registration, we conclude that the amount of data achieved by this method exceed the amount that can be cost-realistically collected by an observer. In behavioural studies the presence of an observer may have an effect on the animals and thereby bias the result. We believe that the stationary camera tower poses no significant disturbance to the seals, as they have been observed on land throughout most of the year and because seals usually habituate to stationary structures (Richardson et al. 1983). An example is the bridge between Copenhagen and Malmø, where harbour seals haul-out on stones a few hundred meters from the bridge.

## 6 Recommendations

- Continued video monitoring* Video monitoring should be continued during and after the planned construction work. By comparing the baseline data from this report the possible effects on haul-out behaviour from the construction activity and operation of the offshore wind farm can be evaluated.
- Camera closer to seals* The camera will be moved closer to the seal haul-out site in April 2003 to increase the resolution of the logged pictures and improve the observation angle to the seals in the sanctuary.
- Live on-line images* The camera views should be made available to the public as live on-line images over the Internet or as playback of downloaded interesting activity sequences.

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