

Final report on aerial monitoring of seals near Nysted Offshore Wind Farm



Technical report to Energi E2 A/S

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1 Summary

Introduction

This report describes the results of the aerial seal surveys of the seal population around Nysted Offshore Wind Farm from 2002-2005. This was done to investigate if seals tend to avoid the disturbance from the wind farm, and use alternative seal sites further away from the wind farm than before the construction. Rødsand seal sanctuary, lies 4 km away from the wind farm, and is therefore the closest land site for seals in the area. Rødsand and five other seal haulout sites in the area are believed to hold a closed harbour seal population with little exchange to other harbour seal populations (management area 4).

Method

Monthly aerial counts of harbour and grey seals were conducted from March 2002 to October 2005. Furthermore, aerial surveys from late August from 1990-2000 are included as part of the baseline data. The aerial surveys provide information on the seasonal and inter-annual use of the different seal haulout sites.

Population increase from 2002 to 2005

The seal epidemic in 2002 killed about 20% of the harbour seals in management area 4, but in August 2003 the number of harbour seals had almost recovered completely. During 2003-2005 the population increased by almost 17%.

Importance of Rødsand during the construction and operation periods

During the construction of the wind farm the relative importance of Rødsand seal sanctuary decreased slightly, but not significantly compared to the other five most important seal localities in the south-western Baltic Sea area (Vitten, Avnø, Bøgestrømmen, Saltholm, Falsterbo). During the operation of the wind farm in 2004 and 2005 the proportion of seals (harbour and grey seals combined) at Rødsand increased to 34 and 33% of seals from the entire management area 4, respectively, and thereby again became the most important seal site in south-western Baltic.

The seasonal proportion of seals at Rødsand

Except for an increasing importance of Rødsand during operation in May and June 2004-2005, no general shift in proportion of seals (harbour and grey seals combined) at Rødsand relative to the other localities was seen. Whether the increasing proportion of seals during operation in May and June 2004-2005 could be due to a positive effect from the wind farm is unknown. The significant seasonal variation between Rødsand and Vitten suggests that some seals move from Rødsand to Vitten in June and July, to return afterwards to Rødsand in August and September. Rødsand remains less important to the harbour seals during October-March.

Effect of the construction and operation periods

There are no indications that the construction activities from late June 2002 to December 2003 and the first two years of operation of the wind farm in 2004-2005 affected the local Rødsand harbour and grey seal populations differently from the other populations in the western Baltic Sea. The Rødsand seal population has increased substantially in size in 2004 and 2005. Whether there are any positive effects from the wind farm, e.g. by creating an artificial reef that attracts more fishes, and hence more seals remains to be investigated.

2 Background

The Danish government has introduced several action plans with the goal of reducing the annual emissions of CO₂. The Ministry of the Environment and Energy issued Energi E2 and SEAS Transmission a commission to construct Nysted Offshore Wind Farm, close to Rødsand (south of Lolland). The seventy-two 2.3 MW turbines have been in operation since 1 December 2003.

The Environmental Impact Assessment was carried out in 2000 following the guidelines jointly drafted by the Danish Energy Agency and the National Forest and Nature Agency (Dietz et al. 2000). The goal of the present study has been to assess the impact of construction and operation of Nysted Offshore Wind Farm on the number of harbour seals (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) resting on land close to the wind farm compared to seal sites further away.

Based on the number of seals on land, Rødsand is considered the most important haulout (places where seals rest on land) and breeding site for harbour seals in the south-western Baltic Sea (management area 4, Teilmann & Heide-Jørgensen 2001). From satellite tracking of harbour and grey seals in Rødsand seal sanctuary (Dietz et al. 2003), both species were found to use several other haulout sites. They frequently visited Vitten (about 10 km west of the seal sanctuary, fig. 1) and Flintehorne Odde (about 5 km north of the sanctuary). Grey seals also visited seal localities in Bøgestrømmen, at Saltholm, and Falsterbo in the western Baltic as well as several sites along the Swedish East Coast and Estonia in the central Baltic (Dietz et al. 2003).

In summer 2002 all harbour seal colonies in Denmark were hit by a measles-like seal epidemic (phocine distemper virus, PDV). The virus was not lethal to the grey seals. The calculated mortality of harbour seals based on aerial surveys carried out during this study before and after the epidemic was 16% in area 4, while the mortality based on the number of dead seals found was 22% (Härkönen et al. 2006). We therefore conclude that about 20% of the seals in management area 4 died in 2002.

Rødsand seal sanctuary and Vitten are the seal haulout sites closest to the wind farm and therefore expected to be most affected by the construction and operation of the wind farm. Management area 4 consists of a population of harbour seals with little exchange to other areas (Olsen et al. 2005). A possible reaction to disturbance from the construction and operation of the wind farm may be that the seals at Rødsand use alternative haulout sites to avoid disturbances. Alternatively, seals may spend more time in the water as entering the water is the normal escape reaction to all disturbances.

It is possible that some of the activities involved in the construction and operation of the wind farm had a negative impact on the seals in

and near the wind farm area. The most significant sources of disturbances are the physical presence of the wind turbines and the noise from turbines, ships and construction work (SEAS 2000). These disturbances potentially lead to temporary or permanent loss of habitats near the wind farm. This may result in seals moving out of the area to forage or show preference to haulout sites further away from the wind farm.

In order to study the possible effects from the construction and operation of the wind farm on the local seal stock, a number of investigations have been carried out. Besides the aerial surveys described in this report, a remote video system monitored the diurnal activity and the use of the Rødsand seal sanctuary (Edrén et al. 2005), while satellite tracking of individual seals showed the movements and habitat selection (Dietz et al. 2003).

3 Objective

Investigate the effect of the construction and operation of Nysted Offshore Wind Farm on seasonal patterns and inter-annual variation in the number of harbour and grey seals combined on land close to the wind farm relative to seal sites further away.

4 Description of the study area and seal sites

4.1 Wind farm area

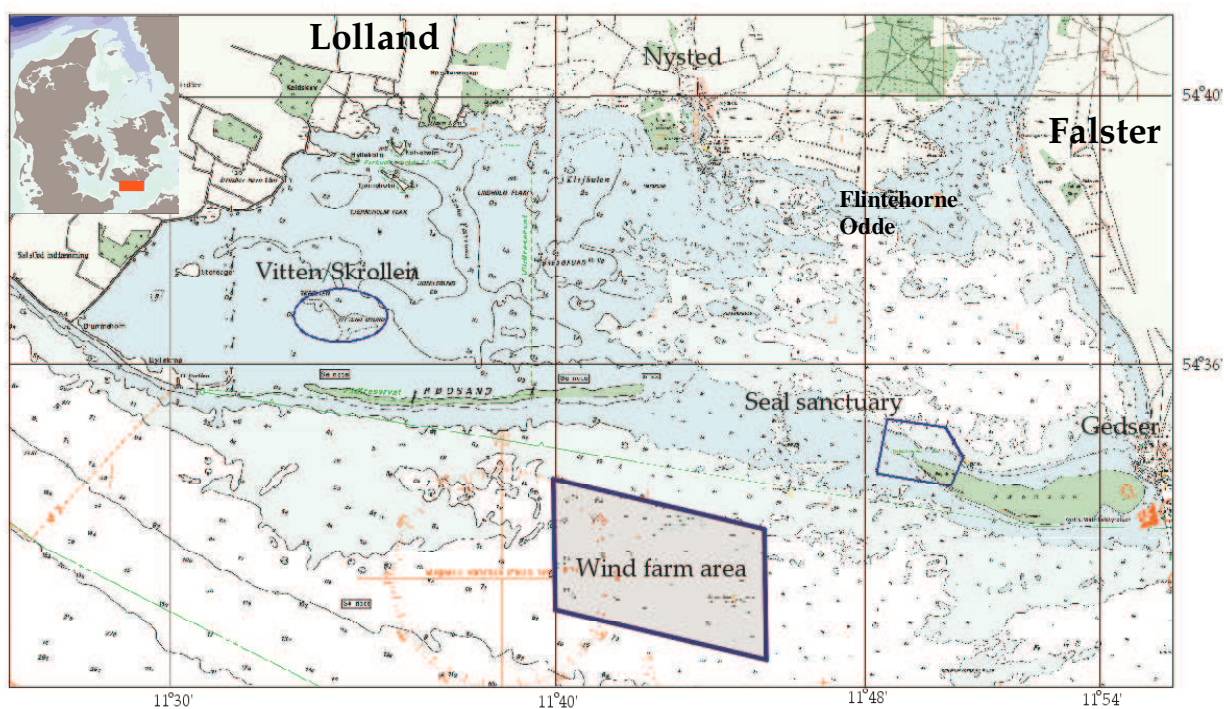


Figure 1. Map of study area showing the wind farm and the three seal sites: Rødsand seal sanctuary, Vitten and Flintehorne Odde.

Nysted Offshore Wind Farm is situated in Fehmarn Belt about 10 km south of the town Nysted (Lolland). The water depth in the wind farm area is between 5.5 m and 9.5 m. A large part of the area consists of sand bottom with larger and smaller ridges, in some cases with pebbles, gravel or shells. Although there are outcrops of stones larger than 10 cm, no reef-like aggregations are known.

About 2 km north of the wind farm is a shallow (less than 8 m deep) lagoon-like area between Southwest Falster and Southeast Lolland (Fig. 1). This area is used by coastal fishermen mainly using fish traps (fyke nets) 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 large scattered stones (Vitten and Flintehorne Odde) away from human disturbance. The north east corner of the wind farm area is placed 4 km from the seal sanctuary (Fig. 1).

4.2 Construction and operation of wind farm

The construction of Nysted Offshore Wind Farm was separated into two major phases. The first phase included preparations for the actual construction work, such as excavation for the foundations, digging of cable trenches and at one of the turbine positions seabed securing with steel sheet piles. The second phase included cabling and erection of the wind turbines. Each of the two phases was divided into several activities scheduled as shown in Figure 2. The construction work began 20 June 2002 with excavations for foundations. The last wind turbine was mounted 27 July 2003, and the wind farm was in full operation 1 December 2003.

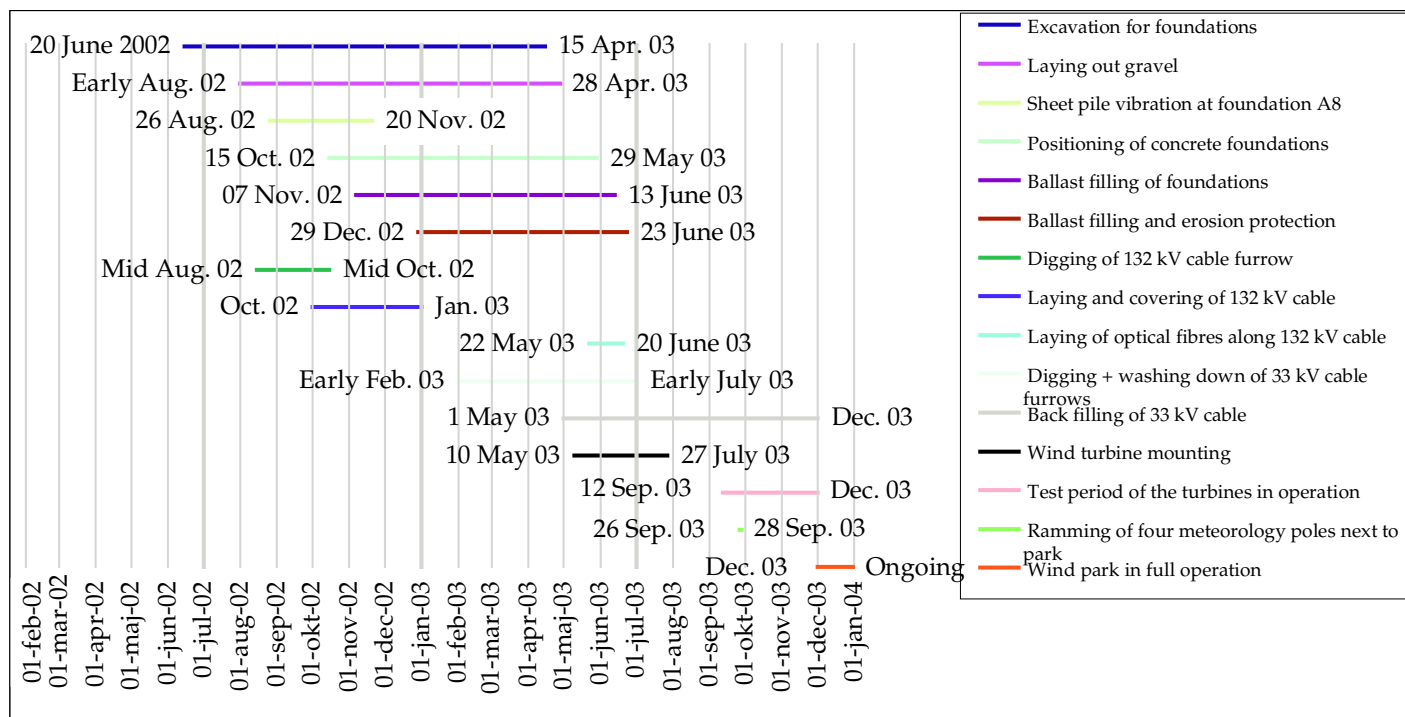


Figure 2. Time schedule for the construction of Nysted Offshore Wind Farm.

The construction work during the first 6 months was less intense and less noisy than later in the construction period. Furthermore, the activities primarily took place in the south-western corner of the wind farm furthest away from the seal haulout sites. Thus, it is expected that the disturbance of the seals resting on land was minor until the digging of the 132 kV cable from the park to Nysted (passing close by the seal sanctuary) and when the sheet pile vibration on foundation position no. A8 (about 10 km from the seal sanctuary) started in mid August 2002. In order to assess the potential impact of the construction works, it was decided that surveys before 16 August 2002 were included as part of the baseline data.

Since 1 December 2003 when the wind farm came in full operation, a medium size semi-planning vessel has made daily (depending on the weather) service visits to individual turbines in the wind farm as part of the general maintenance routine.

4.3 Seal sites near Nysted Offshore Wind Farm

At the western tip of the Rødsand sandbank (54°35'N, 11°49'E), a seal sanctuary was established in 1978 (Bøgebjerg 1986). The seal sanctuary is protected from public access from 1 March to 30 September 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 open very close to the bank, through which they can rapidly escape. Vitten and Flintehorne Odde consist of scattered large stones in shallow water, which makes it difficult to access from a boat. Besides the year-round protection of the seals from hunting, there is no protection by law of these two sites. Peaceful haulout sites are important for the breeding, moulting and resting of the seals.

Based on the number of seals on land, Rødsand is considered the most important haulout and breeding site for harbour seals in the south-western Baltic Sea (Teilmann & Heide-Jørgensen 2001). In February and March 2003, 2004, and 2005 the first grey seal pups alive (2, 2, and 3 pups, respectively) were observed in Denmark for many decades (Edrén et al. 2005). As grey seals are present most of the time and only few observations of grey seals are recorded elsewhere in Denmark, Rødsand is considered to be the most important Danish haulout and breeding site for this species. From satellite tracking of harbour and grey seals tagged at Rødsand, it was seen that both species used several other haulout sites. They frequently visited Vitten (about 10 km west of the seal sanctuary) and Flintehorne Odde (about 5 km north of the sanctuary). Grey seals also visited seal localities in Bøgestrømmen, at Saltholm, and Falsterbo in the western Baltic as well as several sites along the Swedish East Coast and Estonia in the central Baltic. This confirms findings from other areas that harbour seals are relatively resident while grey seals utilise a much greater area (Dietz et al. 2003).

5 Materials and methods

5.1 Aerial surveys

The seasonal haulout pattern and the effect from the wind farm have been studied by monthly aerial surveys of all seal localities in management area 4 carried out since March 2002. In addition the inter-annual changes in number of seals on land are studied from aerial surveys in August, which have been conducted since 1990, as part of the national seal monitoring program under Danish Forest and Nature Agency (Teilmann & Heide-Jørgensen 2001).

Because of several reasons we decided to combine the number of harbour and grey seals in the statistical analysis. These reasons are because relatively few grey seals were observed, because it is difficult to distinguish between grey seals and harbour seals on stony haulout sites (Saltholm, Bøgestrømmen, Vitten and Avnø Fjord) and because young grey seals and adult harbour seals look very similar from the air. If only “seals” are mentioned it means the total number of both seal species.

The same flight type (Cessna 172), two pilots and a small group of observers have conducted the surveys since 1990. Two observers are counting the seals by vision and in addition pictures are taken for verification of the counting for groups larger than 10 individuals. This procedure minimises the risk of some seals being overlooked. Seals on land and in the water next to the haulout site were included in the counting.

Two types of error may occur:

- 1) Some seals may move between sites during a single survey.
- 2) The number of seals hauled out may vary during the day, due to the weather, time of day, or because of disturbances.

Surveying all sites within a short time period (app. 2 hrs) eliminates the first error. The second type of error is reduced by conducting the surveys at the same time of day and during similar weather conditions every time (e.g. avoid rain and strong wind).



Figure 3. Map of management area 4 (South-western Baltic) with area names and seal sites. Seal haulout sites are indicated with arrows.

Since 1990, aerial surveys have been conducted in the south-western Baltic Sea (management area 4, Fig. 3) every year, or every second year, three times during the moult in late August. The region consists of the seal sites at Rødsand, Vitten, Flintehorne Odde, Avnø Fjord, Dyrefod, Lolland NE, Falster NW, Bøgestrømmen, Saltholm, and Falsterbo (Fig. 3). These sites are considered to host parts of the same stock of harbour seals. Although never confirmed, there may be regular movements between these sites. The surveys are part of the Danish monitoring program of seals. In 1999, three supplementary surveys were conducted in late August during the EIA preparations for the Rødsand wind farm.

Monthly aerial surveys for the monitoring program started in March 2002 and continued until September 2002. In some months it was only possible to conduct surveys early in the following month due to weather constraints. After a pause in the monitoring program the surveys were resumed in February 2003. Surveys in November and December were cancelled in 2004 and 2005 due to the small number of seals resting on land during these months in previous surveys and from the video monitoring (Edrén et al. 2005). This report includes data from the monthly surveys until October 2005 as well as three surveys conducted in most years in late August during 1990-2005.

5.2 Data quality

Data from 71 surveys conducted from 1990 to 2005 were analysed to investigate seasonal patterns and inter-annual variation in the number of seals (harbour and grey seals combined) on land and the potential effect from construction of Nysted offshore wind farm. During 1990-2000 surveys were conducted in August only, and from 2002 to 2005 surveys covered most of the year (Table 1).

Table 1. List of surveys conducted. If more than one survey were carried out in the respective year and month the number is given in brackets.

Month	Survey year
January	2004(2)
February	2003,2004,2005
March	2002,2003,2004,2005(2)
April	2002,2003,2004,2005
May	2002,2003,2005
June	2002,2003,2004(2),2005
July	2003,2004,2005
August	1990(5),1991(3),1992(3),1994(3),1996(3),1998(3),1999(3),2000(3),2002(4),2003(3),2004(3),2005(3)
September	2002,2003,2005
October	2003,2004,2005
November	
December	2003

One flight observation in 1990 appeared highly suspect by having zero seals observed at Rødsand and only 2 seals at Avnø Fjord. The normal counts of seals are normally above 50 at Rødsand and above 30 at Avnø Fjord in August. The exact conditions (weather, disturbances, etc.) during this particular flight were not retrievable, and due to the extremity of the seal counts this observation was not included in the analyses.

During all years, very few seals were observed at Rødsand in March. Since these observations do not provide any substantial information on potential effects before and after construction and will affect estimates from the other months, they were discarded from the statistical analysis.

Similarly, no seals were observed at Rødsand during flight observations in October and December 2003. Since these zero observations cannot be used for evaluating the properties of the Rødsand population, these observations were not used in the analyses.

Finally, the flight observation in February 2003 did not include Saltholm and Falsterbo due to weather conditions, and hence did not provide an estimate of the total population over the 6 localities. This survey was not used for modelling the proportion of seals at Rødsand relative to the total population.

Consequently, the 64 remaining surveys were included in the statistical model.

5.3 Model for population at Rødsand

The counted seals at Rødsand is considered to be a binomial distributed variable with a parameter (p) denoting the proportion of seals here relative to the total number of seals within the 6 main localities that are considered to be a distinct population of the western Baltic Sea (Rødsand, Vitten, Avnø, Bøgestrømmen, Saltholm, and Falsterbo). We will also consider the proportion of seals at Rødsand relative to a sub-population comprised of the two localities, Rødsand and Vitten. The proportion of seals at Rødsand is modelled by yearly and monthly factors as well as a factor describing the three considered periods (baseline, construction and operation). The yearly factor was nested within the three periods. The logistic transformation was used as link function and data were analysed by means of generalised linear models in SAS (PROC GENMOD). The models generally showed overdispersion tendencies and this was accounted for in the test statistics by calculating the scaled deviance (see e.g. McCullagh and Nelder 1989). The number of seals counted at Rødsand was similarly analysed as a log-normal distributed variable subject to the same sources of variation. The significance of the different factors was tested using the Likelihood Ratio test (at the 5% significance level). Post hoc tests were carried out by calculating contrasts.

5.4 Calculation of the population size

During any survey a number of seals will always be in the water. The fraction of seals in the water varies during the year (Härkönen et al. 1999). To estimate the actual population size from aerial counts a correction factor must be applied. However, in the present study a correction factor was not applied, since adding a constant for seals in the water, will not improve or change the results. Therefore all results are presented as the number of seal counted during the surveys.

6 Results and discussion

6.1 Abundance and trend in south-western Baltic seal stock

South-western Baltic (management area 4) consists of 6 main localities, 2 characterised by sandbars (Rødsand and Falsterbo), and 4 by large scattered stones in shallow water (Saltholm, Bøgestrømmen, Vitten and Avnø Fjord).

The annual surveys in August represent the best estimate of the population size, because a high and stable number of harbour seals rest on land while moulting. During August, Rødsand has the largest stock of harbour seals within management area 4. The number of seals at Rødsand, Avnø, and Falsterbo has gradually increased since 1990 except for 2002, when the seal epidemic caused a mortality of about 20% (Fig. 4). At Vitten, Bøgestrømmen and Saltholm a relatively low number of harbour seals haulout in August and since 1990 (for Vitten since 2000) no obvious trend have been observed. The total number of seals in management area 4 had an overall exponential increase of 8% from 1990-2000 and an increase of 16.7% from 2003-2005. This shows that in 2003 the population had recovered to 2000 level and that in 2004 and 2005 the population reached the highest number in the study period.

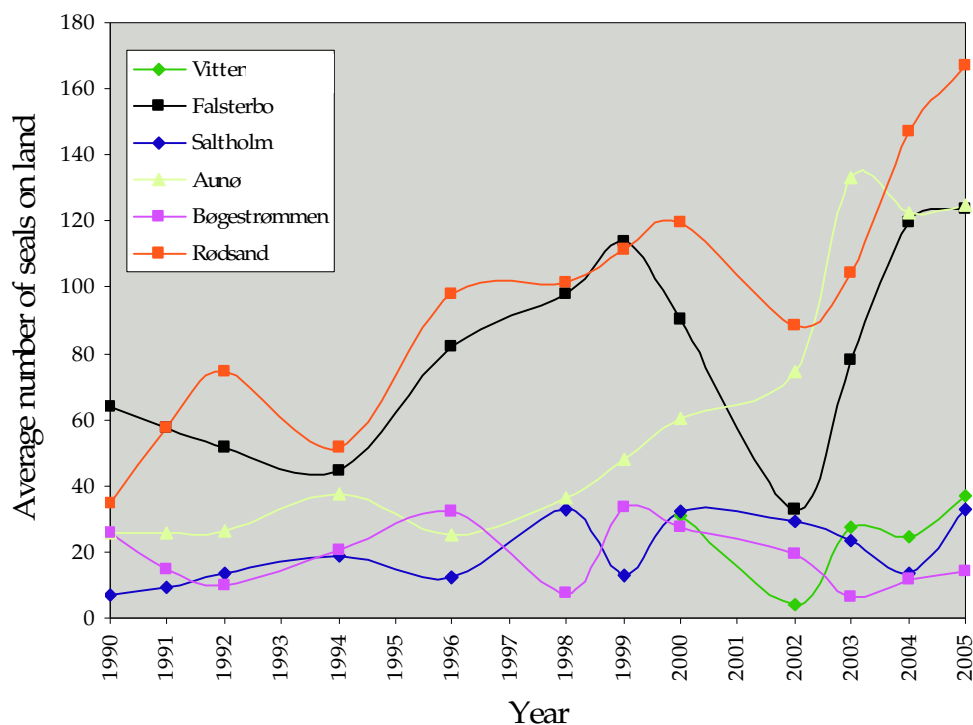


Figure 4. Annual mean number of harbour seals from the 6 most important localities in management area 4. Each point is an average of the three (1990: 5 and 2002: 4) counts made in late August each year. No correction for seals in the water is made.

6.2 Monthly surveys

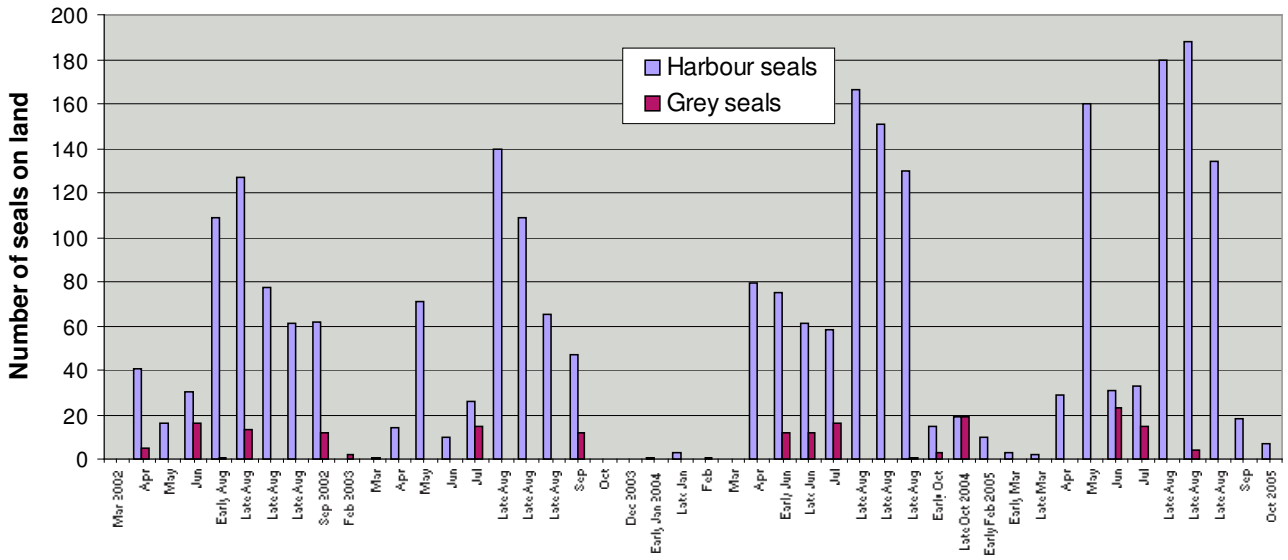
The number of seals on land shows a clear seasonal variation, with the number of seals peaking during summer (Fig. 5). At Rødsand no harbour seals were observed in March 2002 and February, March, October, December 2003, and February, March 2004 (Fig. 5). As also revealed by the video monitoring (Edrén et al. 2005) only few seals were observed at Rødsand during late autumn, winter and early spring. The number of seals peaked in August. The same general pattern was seen at Falsterbo, Avnø, and Bøgestrømmen, while Saltholm and Vitten show a more variable pattern with relatively more seals during spring (Fig. 5). This probably means that some harbour seals are moving between sites at certain time of the year to breed, utilise better food resources or rest at more undisturbed or protected haulout sites.

Grey seals were only seen at Falsterbo and Rødsand with certainty. A few grey seals was probably missed at the other localities because species identification was not possible. A few pups are born in February-March at both Rødsand and Falsterbo but these localities mainly serve as resting/feeding areas for non-breeding animals or for adults outside the breeding season (Edrén et al. 2005). This is confirmed by the results in figure 5 where it is clearly seen that grey seals are mostly seen during the summer months.

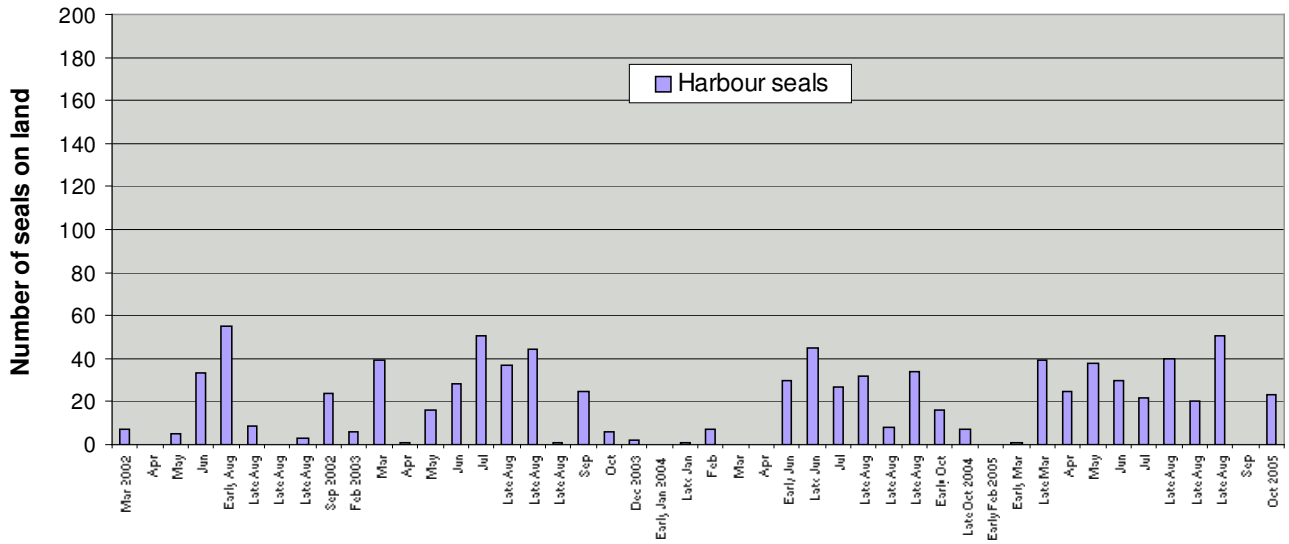
According to the satellite tracking results obtained during the baseline study of the wind farm, the grey seals at Rødsand were found to move between Falsterbo, Saltholm, Bøgestrømmen and the Swedish east coast and Estonia (Dietz et al. 2003). These results suggest that all grey seals in management area 4 belong to the Baltic grey seal population that breed in February-March.

A maximum of 23 grey seals were observed at Rødsand in Juni 2005. The maximum at Falsterbo was 131 in May 2005. Although the maximum number of grey seals were found in 2005 there were no significant trend in observations during 2001-2005.

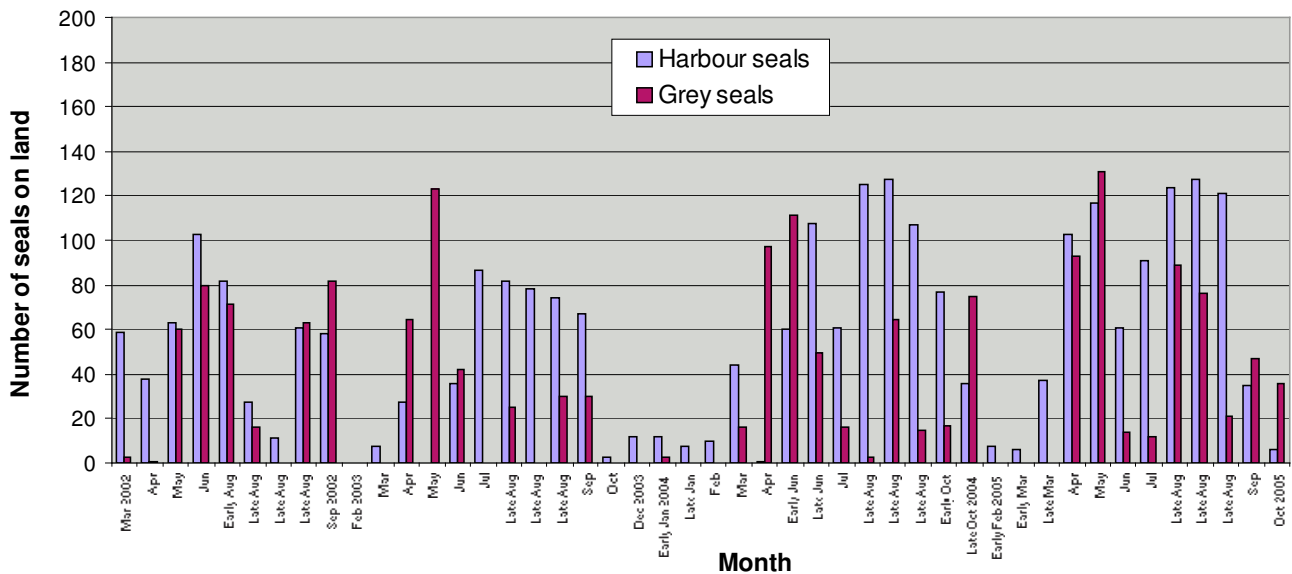
Rødsand



Vitten

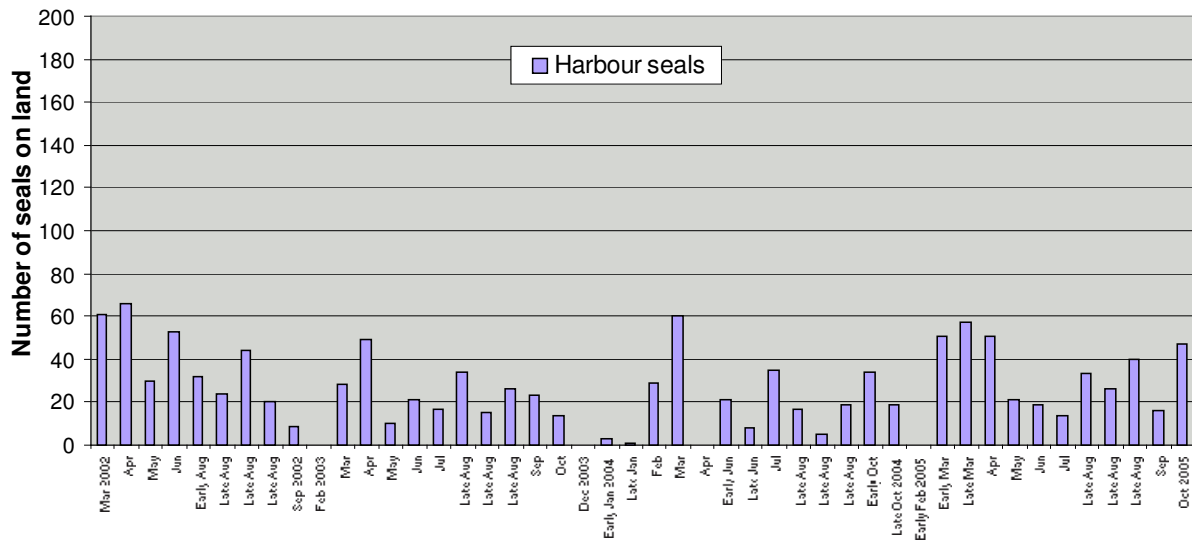


Falsterbo

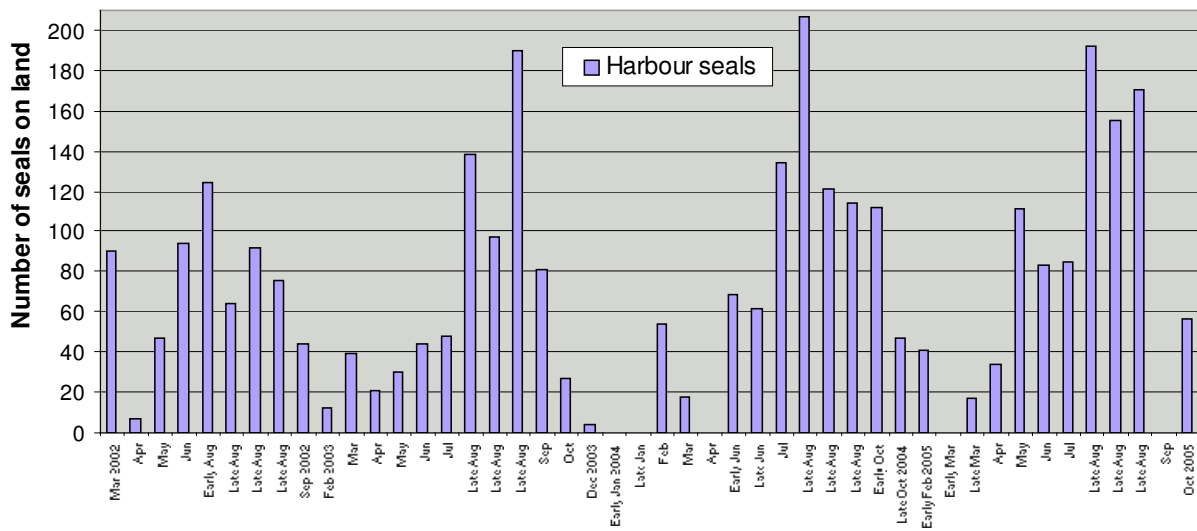


Month

Saltholm



Avnø (incl. observations at adjacent stone reefs in Smålandsfarvandet)



Bøgestrømmen

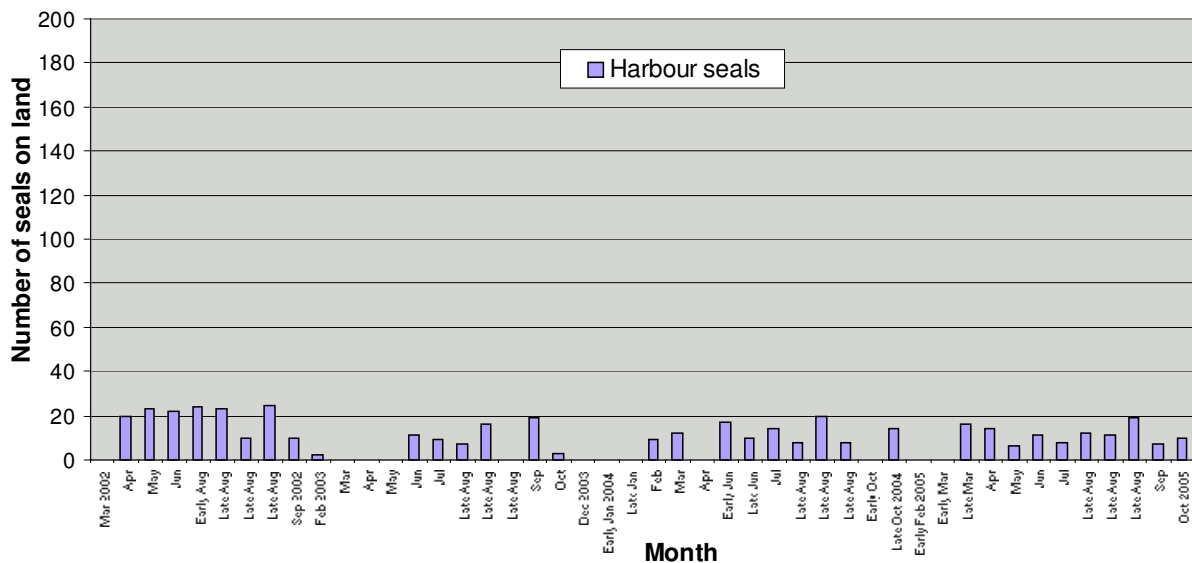


Figure 5. Results for monthly surveys in south-western Baltic (management area 4) from March 2002 to October 2005. No correction for seals in the water was made. Note that some months are missing and that additional surveys were conducted in late August to strengthen the comparisons with baseline data (partly as part of the national seal monitoring program). In this figure the smaller haulout sites in Smålandsfarvandet close to Avnø (Dyrefod, Lolland NE and Falster NW) are combined, due to the short distance between them and therefore likely the same seals moving around.

6.3 Interannual importance of Rødsand

A long time series is available for August observations, so the first analysis investigates the proportion of seals at Rødsand in August with one factor describing a potential shift from baseline through construction to operation period and inter-annual variation within all of these periods (year). Although the proportions of seals at Rødsand compared to the other sites were lower in the years of construction (2002-2003), the analysis showed no significant difference between the three periods ($\chi^2(2)=1.06$, $p=0.5890$) nor was the inter-annual variation significant ($\chi^2(9)=6.12$, $p=0.7276$).

The relative importance of Rødsand compared to the other four most important seal localities in the area (Avnø, Bøgestrømmen, Saltholm, Falsterbo (Vitten is not included in this long-term analysis as monitoring first started here in 2000)) was relatively constant around 30-35% (Fig. 6) with the exception of 1990 and 2003 where only 24 and 27% of the seals were found at Rødsand, respectively. During the operation of the wind farm in 2004 and 2005 the proportion at Rødsand increased to 34 and 33%, respectively, and was from hereon again the most important seal site in south-western Baltic.

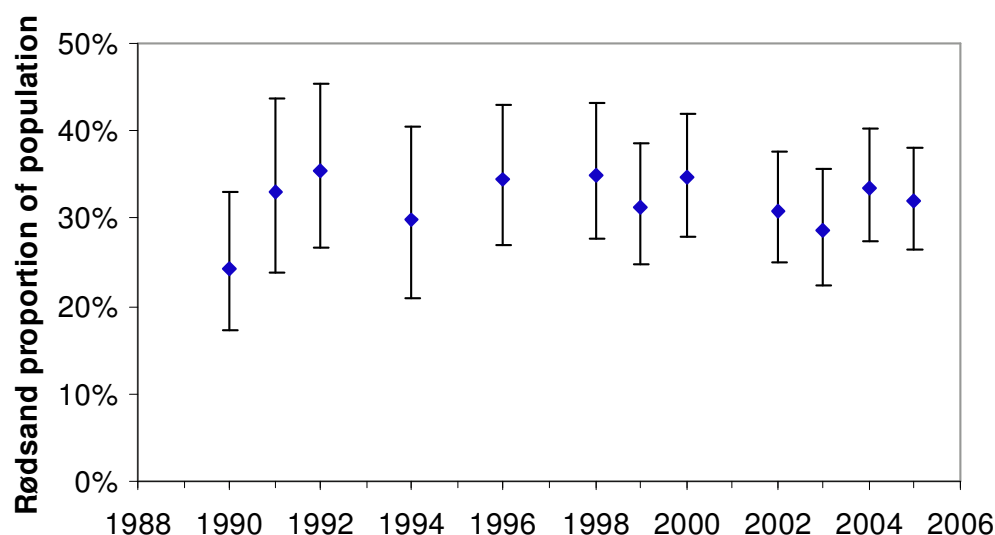


Figure 6. Estimated proportion of seals at Rødsand in August relative to all five localities (Rødsand, Avnø, Bøgestrømmen, Saltholm and Falsterbo). The error bars show the 95% confidence limits of the estimated proportions.

6.4 Potential shift in seasonal proportion

The second analysis investigated the potential shift from baseline to the construction and operation periods (period) taking interannual variation (year) and seasonal variation (month) into account as well as a difference in the shift between the periods for different months of monitoring. The final model was progressively found by eliminating the least significant factor until all remaining factors were significant (Table 2).

Table 2. Model data of the shift in seasonal proportion of seals between periods (baseline, construction, operation) at Rødsand compared to the other localities. Significant results are given in bold.

	Period	Year(period)	Month	Period*month
1. model	0.1117	0.6033	<0.0001	0.0690
2. model	0.0979		<0.0001	0.0117
Final model			<0.0001	0.0136

The seasonal proportion of seals at Rødsand relative to the other localities has changed significantly between baseline, construction and operation ($p=0.0136$), although there was no general significant change between periods common to all months (period not significant). There is a strong seasonal variation over the entire period (1990-2005) with the lowest proportion in February and October followed by January and September. The highest proportion was found in May and August. The estimated proportion of seals at Rødsand for the various months during baseline, construction and operation is shown in Fig. 7.

The significance of period*month is due to differences between the considered periods in May and June. In May the proportion of seals in the baseline was significantly lower than in the construction period ($p=0.0210$) and in the operation period ($p=0.0098$). In June the proportion of seals at Rødsand was higher in the operation period compared to both the baseline ($p=0.0679$) and the construction ($p=0.0873$), although these two contrast are borderline significant. In May 2003 the proportion of seals at Rødsand was high mainly due to a low count of seals at several of the other localities (Falsterbo, Saltholm and Bøgestrømmen). These results indicate that the Rødsand seal population is likely to have increased relative to the other locations during the operation period for the months of May and June, but no change was found for the other months.

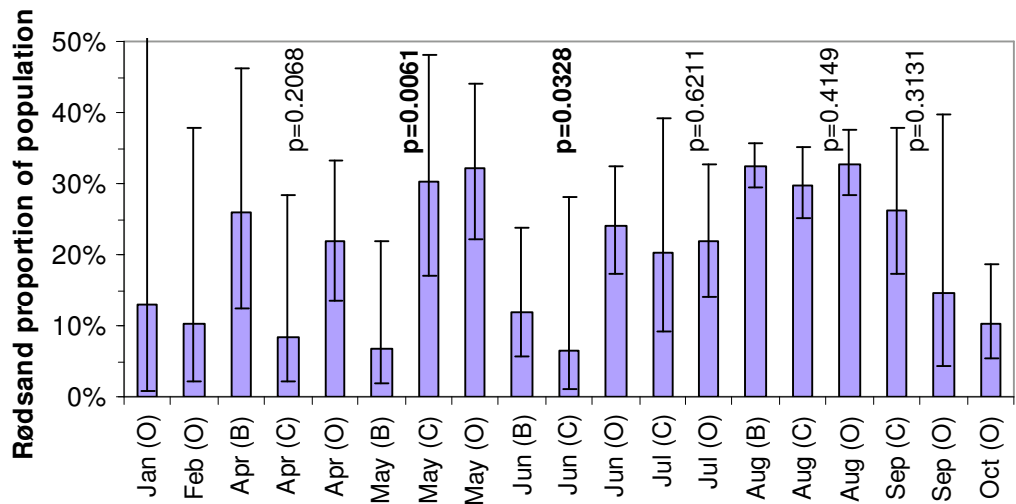


Figure 7. Estimated proportion of seals at Rødsand relative to all six localities for January-October (Rødsand, Vitten, Avnø, Bøgestrømmen, Saltholm, Falsterbo) by months for baseline (B), construction (C) and operation (O) periods. The error bars show the 95% confidence limits of the estimated proportions. Differences in proportions between the periods were tested for each month by calculating the contrast between estimates (*p*-values are given above the respective bars, significant tests are given in bold). Note that the test statistics are only given for April, May, June, July and August, and September where surveys were conducted in minimum two of the three periods (baseline, construction, operation).

6.5 Rødsand relative to the Vitten sub-population

The third analysis is similar to the prior analysis except that the proportion of seals at Rødsand is considered relative to the sub-population at Rødsand and Vitten combined. The telemetry analyses have shown that seals frequently move between these two localities (Dietz et al. 2003).

Table 3. Model data of the shift in seasonal proportion of seals between periods (baseline, construction, operation) at Rødsand compared to Vitten. Significant results are given in bold.

	Period	Year(period)	Month	Period*month
1. model	0.7422	0.3673	0.0388	0.7902
2. model	0.6092	0.3295	0.0338	
3. model	0.5297		0.0441	
Final model			0.0576	

The significant seasonal variation of this sub-population (Table 3) suggest that some seals move from Rødsand to Vitten in June and July, to return afterwards to Rødsand in August and September (Fig. 8). The estimates from January and February are highly uncertain as indicated by the confidence intervals.

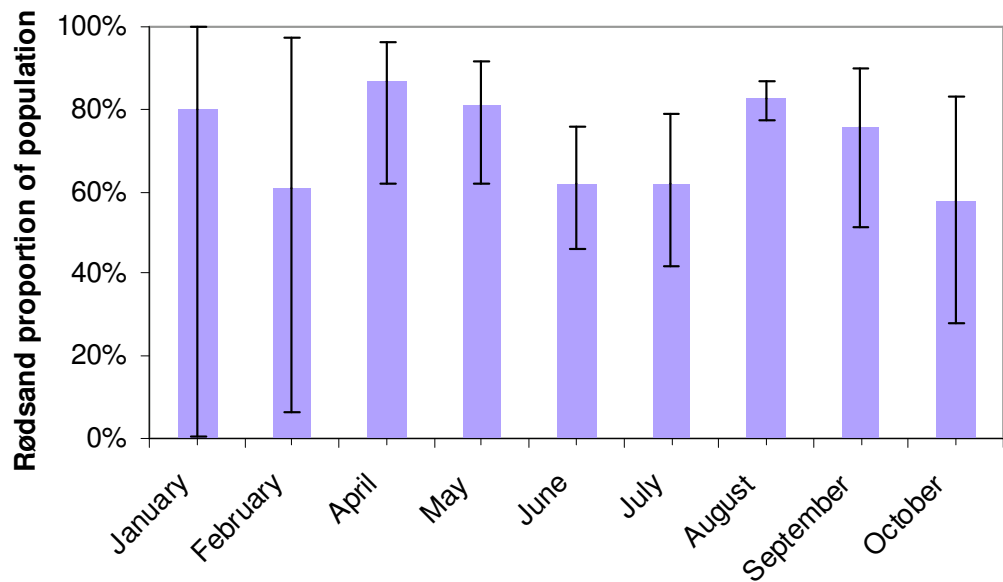


Figure 8. Estimated monthly proportions of seals at Rødsand relative to the sub-population comprised of Rødsand and Vitten. The error bars show the 95% confidence limits of the estimated proportions.

6.6 Number of seals at Rødsand

In the fourth analysis we investigated the variations in the number of seals counted at Rødsand only assuming the log-transform of the counts to be normal distributed. This distribution was preferred over the discrete Poisson distribution normally used for counts, since the latter had substantial overdispersion. The same four factors used in the binomial models above were tested for (Table 4).

Table 4. Model data of the variation in the number of seals at Rødsand. Significant results are given in bold.

	Period	Year(period)	Month	Period*month
Final model	<0.0001	0.0001	<0.0001	<0.0001

Significant differences between the periods were observed for May, June, August and September (Fig. 9). In May and August the Rødsand population increased significantly from baseline to the operation period. In June the construction period had significantly lower number of seals than the baseline ($p=0.0276$) and the operation period ($p=0.0008$), but there was no difference between baseline and construction ($p=0.4319$). Finally, in September there was a significant decrease from the construction to the operation period ($p=0.0271$).

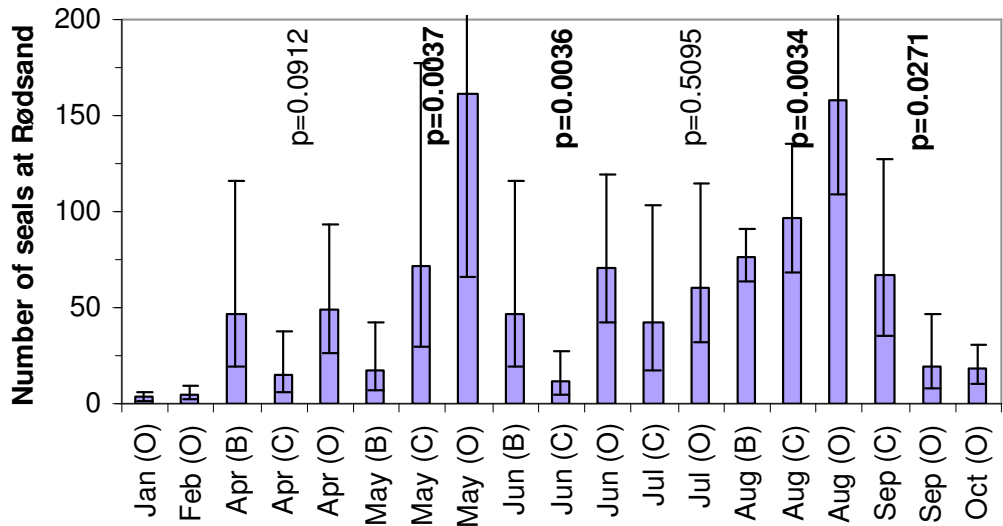


Figure 9. Estimated number of seals at Rødsand for the various months and periods. The error bars show the 95% confidence limits of the estimated proportions. Differences in proportions between the periods were tested for each month by calculating the contrast between estimates (p-values are given above the respective bars, significant tests are given in bold). Note that the test statistics are only given for April, May, June, July, August and September where surveys were conducted in minimum two of the three periods (baseline, construction, operation).

Comparing the August counts of seals across years showed a gradual increasing trend from 1990 to 2005 with minor declines in 1994 and 2002. In 2005 the highest number of seals so far was recorded (mean of 173) compared to a mean of 154 in 2004 and the level of 2002 and 2003 (construction period) when the number of seals was approximately 100 seals (Fig. 10). The average growth rate of the Rødsand population for the years (1990-2000) was around 8% and around 17% per year after 2002.

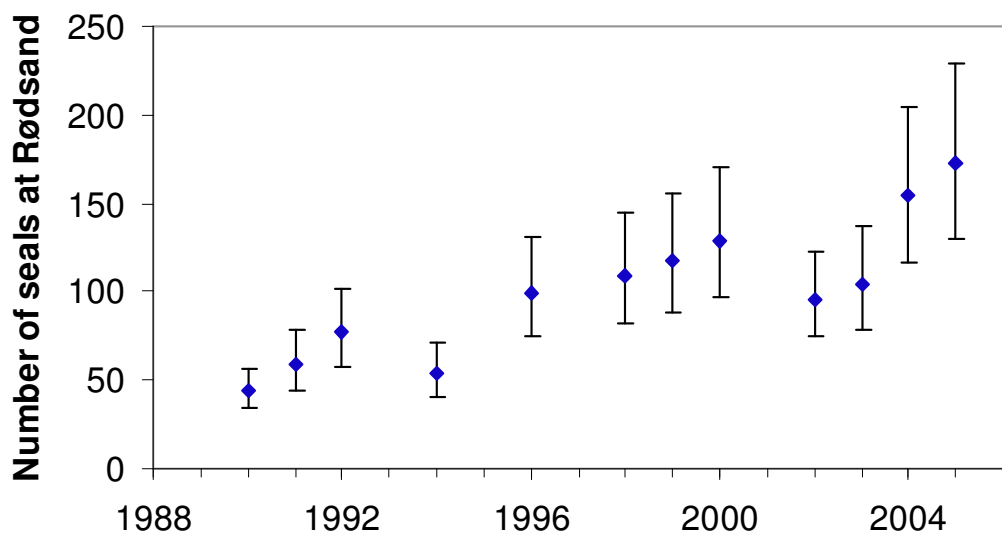


Figure 10. Mean number of seals at Rødsand during August. The error bars show the 95% confidence limits of the mean estimate.

6.7 Power considerations for seal surveys

To estimate the certainty of the results found in the present study, the statistical power of the method and available data was analysed.

Based on 28 surveys in the baseline, 14 during construction and 22 during operation a power analysis was conducted assuming the proportion of seals at Rødsand to be approximately normally distributed. A model similar to the analysis above with factors for month, period, and the interaction month*period was used. This resulted in a mean proportion of seals at Rødsand of 17.5% for the baseline, 17.2% for the construction, and 20.8% for the operation period with a common standard error of the residuals of 7.66%. The probability of observing a significant difference between baseline and construction, given that these estimates represent the true proportions, is no more than 5.2% (Fig. 11), whereas the probability of observing a significant difference between baseline and operation is higher (31.4%). Similarly, if the proportion of seals at Rødsand had changed more than 7% from baseline to construction, it would have been detected with a probability above 80%; similarly a change of more than 6% from baseline to operation would have been detected with a probability above 80%. Thus, if there has been a change in the proportion of seals at Rødsand relative to the other locations, this analysis suggests that the change was less than 6-7%.

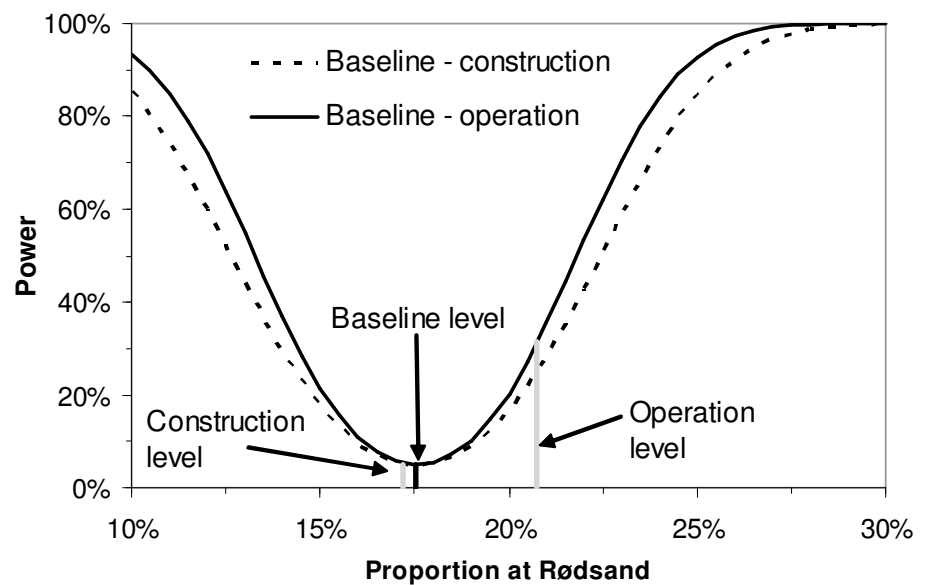


Figure 11. Power of detecting a change (baseline versus construction and baseline versus operation) in the proportion of seals at Rødsand relative to other locations. The estimated proportions for the three periods are shown by vertical lines.

7 Conclusion

Population increase from 2002 to 2005

The seal epidemic in 2002 killed about 20% of the harbour seals in management area 4 (Härkönen et al. 2006), but in August 2003 the number of harbour seals had almost recovered completely after one year. From 2003-2005 the number of harbour seals at Rødsand increased by almost 17%. This is more than the theoretical maximum rate of increase (about 12%/year) for harbour seals. This indicates an unusually high number of seals present on land during the survey days, emigration to Rødsand from the other seal sites, or that the epidemic killed more males than females (Härkönen et al. 2006).

Importance of Rødsand during the construction and operation periods

During the construction of the wind farm the relative importance of Rødsand seal sanctuary compared to the other five most important seal localities in the south-western Baltic sea (Vitten, Avnø, Bøgestrømmen, Saltholm, Falsterbo) decreased, although not significantly. This does not seem to be related to the seal epidemic as all localities seemed to be hit equally hard. During the operation of the wind farm in 2004 and 2005 the proportion of seals (harbour and grey seals combined) at Rødsand increased to 34 and 33% of the entire management 4 area, respectively, and this place thereby again became the most important seal site in south-western Baltic.

The seasonal proportion of seals at Rødsand

In June the proportion of seals (harbour and grey seals combined) at Rødsand compared to the other seals sites was significantly lower during the construction in 2003 compared to the baseline in 2002 and operation period in 2004-2005. However, in May 2003 a different picture was seen, as a significantly higher proportion was counted at Rødsand during construction and operation compared to the baseline. Except for an increasing importance of Rødsand during operation in May and June, no general shift in proportion of seals at Rødsand relative to the other localities was seen. Whether the increasing proportion of seals in May and June could be due to a positive effect from the wind farm is unknown.

The significant seasonal variation between Rødsand and Vitten suggests that some harbour seals move from Rødsand to Vitten in June and July, to return afterwards to Rødsand in August and September. Rødsand remains less important to the harbour seals during October-March.

Statistical power of method

Statistical power analysis based on the available data suggests that, if there has been a change in the proportion of seals at Rødsand relative to the other locations, it was less than 6-7%. This means that a change of about 40% of seals at Rødsand would have been detected with the method used.

Effect of the construction and operation periods

Based on this study no evidence was found that the construction activities and the first two years of operation of the wind farm have affected the local Rødsand population of harbour and grey seals differently from the other populations in the western Baltic Sea. The

Rødsand seal populations appears to thrive relative to the other areas and it has increased substantially in size, in 2004 and 2005, at least during August. Whether there are any positive effects from the wind farm, e.g. by creating an artificial reef that attracts more fishes, and thus seals, remains to be investigated.

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10 Appendix 1.

Details on surveys conducted in management area 4 (South-western Baltic) from January to October 2004 is shown below. Previous surveys are presented in Teilmann et al. 2003 and 2004.

Aerial survey of seals in Western Baltic							
Date: 01.02.05							
Take off: 09:20 Landed: 11:40							
Aircraft type: Cessna 206			Pilot: Jens Larsen				
Speed over locations (knob): 70-80			Observer front seat: Signe Andersen				
Hight over lokations (feet): 4-500			Observer back seat: Jonas Teilmann				
Wind, m/s: 6-10			Cloud cover (1/8): 0/8				
Wind direction: NV			Temperatur C⁰: 38474				
Locality	Time	Distur- bance (%)	Camera1 (Harbour/g rey)	Camera2 (Harbour/ grey)	Visuelle observation during survey	Total (harbour/ grey)	
Aunø	09:40	0	-	-	41 på+ spredte sten	41/0	
Dyrefod	09:49	-	-	-		0	
Falster NW	09:52	-	-	-		0	
Lolland NØ	09:54	-	-	-		0	
Flintehorne Odde	10:10	-	-	-		0	
Vitten/Skrollen	10:04	-	-	-	Få sten synlige	0	
Rødsand	10:10	-	-	-	10 i vandet (spæt/grå?)	10/0	
Bøgestrøm	10:33	-	-	-	Ingen synlige sten	0	
Jungshoved N	10:42	-	-	-	Ingen synli	0	
Falsterbo	11:03	-	-	-	8 sæler i vandet	8/0	
Saltholm	11:24	-	-	-	Højvande	0	
Amager SØ	11:30	-	-	-		0	
Total in area 4:							
Western Baltic harbour seals total:			59	Western Baltic grey seals total:			0
Notes:				Notes:			
Camera 1 (Front seat):				Film:			
Camera 2 (back seat):				Film:			

Aerial survey of seals in Western Baltic						
Date: 07.03.05						
Take off: 09:10 Landed: 11:46						
Aircraft type: Cessna 206				Pilot: Jens Larsen		
Speed over locations (knob): 70-80				Observer front seat: Susi Edrén		
Hight over lokations (feet): 4-500				Observer back seat: Signe May Andersen		
Wind, m/s: 6				Cloud cover (1/8): 8/8		
Wind direction: 310				Temperatur C°: 0		
Locality	Time	Distur- bance (%)	Camera1 (Harbour/g rey)	Camera2 (Harbour/ grey)	Visuelle observation during survey	Total (harbour/ grey)
Aunø	09:33	-	-	-	Fjorden total tilfrosset	0
Dyrefod	09:40	-	-	-		0
Falster NW	09:43	-	-	-		0
Lolland NØ	09:45	-	-	-		0
Flintehorne Odde	10:04	-	-	-		0
Vitten/Skrollen	09:55	-	-	-	Næsten helt frosset til	1
Rødsand	10:10	-		2/0	1 i vandet. Alle 3 ude for spidsen	3/0
Bøgestrøm	10:40	-	-	-	Næsten helt frosset til	0
Jungshoved N	10:42	-	-	-		0
Falsterbo	11:00	-	-	-	6 spættet i vandet	6/0
Saltholm	11:15	10%		-	51 på sten	51/0
Amager SØ	11:34	-	-	-		1/0
Total in area 4:						
Western Baltic harbour seals total: 62				Western Baltic grey seals total: 0		
Notes:				Notes:		
Camera 1 (Front seat):			Nikon D1	Film:		Digital 800 iso
Camera 2 (back seat):			Nikon F90	Film:		Fujichrome Provia 400

Aerial survey of seals in Western Baltic						
Date: 21.03.05						
Take off: 09:03 Landed: 11:21						
Aircraft type: Cessna 206				Pilot: Jens Larsen		
Speed over locations (knob): 60-70				Observer front seat: Signe May Andersen		
Hight over lokations (feet): 4-500				Observer back seat: Susi Edrén		
Wind, m/s: 1,5				Cloud cover (1/8): 5/8		
Wind direction: 130-190				Temperatur C°: 1		
Locality	Time	Distur- bance (%)	Camera1 (Harbour/g rey)	Camera2 (Harbour/ grey)	Visuelle observation during survey	Total (harbour/ grey)
Aunø	09:26	0	-	-	16 sæler på sten	16/0
Dyrefod	09:36	0	-	-	1 sæl på sten	1/0
Falster NW	09:40	-	-	-		0
Lolland NØ	09:43	-	-	-	Oversvømmet	0
Flintehorne Odde	10:04	-	-	-		0
Vitten/Skrollen	09:55	33%	-	-		39/0
Rødsand	10:09	0	-	-	2 sæler i vandet (spæt/grå?)	2/0
Bøgestrøm	10:25	6,25%	-	-		16/0
Jungshoved N	10:30	-	-	-		0
Falsterbo	10:45	0	23/0	23/0	14 sæler i vandet (ca. 21 på land)	37/0
Saltholm	10:55	0	-	-		57/0
Amager SØ	11:10	-	-	-		0
Total in area 4:						
Western Baltic harbour seals total: 166				Western Baltic grey seals total:		
Notes:				Notes:		
Camera 1 (Front seat):			Nicon D1		Film: Digital	
Camera 2 (back seat):			Nicon F90		Film: Fujichrome 400 asa	

Aerial survey of seals in Western Baltic						
Date: 20.04.05						
Take off: 09:17 Landed: 11:15						
Aircraft type: Cessna 172				Pilot: Jens larsen		
Speed over locations (knob): 60-70				Observer front seat: Signe May Andersen		
Hight over lokations (feet): 4-500				Observer back seat: Susi Edrén		
Wind, m/s: 3-4				Cloud cover (1/8): 0/8		
Wind direction: 110				Temperatur C ⁰ : 3		
Locality	Time	Distur- bance (%)	Camera1 (Harbour/g rey)	Camera2 (Harbour/ grey)	Visuelle observation during survey	Total (harbour/ grey)
Aunø	09:35	0	-	-	26 sæler på sten	26/0
Dyrefod	09:48	0	-	-	8 sæler på sten	8/0
Falster NW	09:52	-	-	-		0
Lolland NØ	09:55	-	-	-		0
Flinteorne Odde	10:20	-	-	-		0
Vitten/Skrollen	10:07	16%	-	-	25 sæler på sten	25/0
Rødsand	10:25	0	-	-	29 sæler i vandet	29/0
Bøgestrøm	10:47	0	-	-	14 sæler på sten	14/0
Jungshoved N	10:52	-	-	-		0
Falsterbo	11:12	0	103/93	103/93	2 gr. sp. sæl + 1 gr. gråsæl på land + 1 sæl i vandet. Overskyet 8/8	103/93
Saltholm	11:30	0	-	-	51 sæler på sten	51/0
Amager SØ	11:45	0	-	-	1 sæl på sten	1/0
Total in area 4:						
Western Baltic harbour seals total: 257				Western Baltic grey seals total: 93		
Notes:				Notes:		
Camera 1 (Front seat):			Nicon D1		Film: Digital	
Camera 2 (back seat):			Nicon F90		Film: Fujichrome 400 asa	

Aerial survey of seals in Western Baltic							
Date: 24.05.05							
Take off: 09:25 Landed: 12:01							
Aircraft type: Cessna 172				Pilot: Jens larsen			
Speed over locations (knot): 60-70				Observer front seat: Signe May Andersen			
Hight over lokations (feet): 4-500				Observer back seat: Nikolaj Ilsted Beck			
Wind, m/s: 5				Cloud cover (1/8): 0/8			
Wind direction: 230				Temperatur C ⁰ : 13			
Locality	Time	Distur- bance (%)	Camera1 (Harbour/g rey)	Camera2 (Harbour/ grey)	Visuelle observation during survey	Total (harbour/ grey)	
Aunø	09:50	17,5%	-	-	63 sæler på sten	63/0	
Dyrefod	10:02	-	-	-	34 sæler på sten	34/0	
Falster NW	10:06	-	-	-	Overskyet 6-7/8	0	
Lolland NØ	10:10	-	-	-	14 sæler på sten	14	
Flinteorne Odde	10:27	-	-	-		0	
Vitten/Skrollen	10:25	-	-	-	38 sæler på land	38	
Rødsand	10:32	100%			Alle sprang i vandet ved 900 fods højde	160	
Bøgestrøm	11:00	100%	-	-	6 sæler på sten	6	
Jungshoved N	11:05	-	-	-		0	
Falsterbo	11:18	-	117/131	-	1 stor gruppe gråsæler + 3 små grupper spættede sæler på land, og 4 stk. i vandet	117/131	
Saltholm	11:32	-	-	-	21 sæler på sten	21	
Amager SØ	11:45	-	-	-		0	
Total in area 4:							
Western Baltic harbour seals total:			453	Western Baltic grey seals total:			131
Notes:				Notes:			
Camera 1 (Front seat):			Nicon D1	Film: Digital			
Camera 2 (back seat):			Nicon F90	Film: Fujichrome 400 asa			

Aerial survey of seals in Western Baltic							
Date: 29.06.05			Piloten i venstre side og Pernille og Signe i højre side!!				
Take off: 09:12		Landed: 11:35					
Aircraft type: Cessna 177			Pilot: Jens Larsen				
Speed over locations (knob): 75-80			Observer front seat: Signe May Andersen				
Hight over lokations (feet): 4-500			Observer back seat: Pernille Bondo Harders				
Wind, m/s: 5			Cloud cover (1/8): 0/8, skyet over Lolland NØ (7/8)				
Wind direction: 290			Temperatur C°: 14				
Locality	Time	Distur- bance (%)	Camera1 (Harbour/g rey)	Camera2 (Harbour/ grey)	Visuelle observation during survey	Total (harbour/ grey)	
Aunø	09:30	-	-	-	76 på sten	76/0	
Dyrefod	09:40	-	-	-	2 på sten	2/0	
Falster NW	09:45	-	-	-	1 på sten	1/0	
Lolland NØ	09:48	-	4	-	4 på sten	4/0	
Flintehorne Odde	10:10	-	-	-	0	0	
Vitten/Skrollen	10:00	6,7%	-	-	23 på sten + 7 i vand	30/0	
Rødsand	10:15	-	27/23	-	3 grupper: 27 spættede, 19 gråsæler og 4 spættede sæler	31/23	
Bøgestrøm	10:35	72,7%	-	-	11 på sten	11/0	
Jungshoved N	10:40	-	-	-	0	0	
Falsterbo	10:52	-	34/14	-	2 grupper: 28 spættede + 6 unger og 14 gråsæler. 27 i vandet.	61/14	
Saltholm	11:05	5,3%	-	-		19/0	
Amager SØ	11:25	-	-	-	0	0	
Total in area 4:							
Western Baltic harbour seals total:			231	Western Baltic grey seals total:			37
Notes:			Notes:				
Camera 1 (Front seat):			Nicon D1	Film:			Digital
Camera 2 (back seat):			Nicon F90	Film:			Fujichrome 400 asa

Aerial survey of seals in Western Baltic						
Date: 11.07.05			Piloten i venstre side og Nikolaj og Signe i højre side!!			
Take off: 09:13		Landed: 11:30				
Aircraft type: Cessna 177			Pilot: Jens Larsen			
Speed over locations (knob): 75-80			Observer front seat: Signe May Andersen			
Hight over lokations (feet): 4-500			Observer back seat: Nikolaj Ilsted Beck			
Wind, m/s: 2			Cloud cover (1/8): 0			
Wind direction: 160			Temperatur C°: 21			
Locality	Time	Distur- bance (%)	Camera1 (Harbour/g rey)	Camera2 (Harbour/ grey)	Visuelle observation during survey	Total (harbour/ grey)
Aunø	09:35	29,7%	-	-	54 på sten og 10 (heraf én unge) i vand	64/0
Dyrefod	09:43	-	-	-	2 på sten	2/0
Falster NW	09:48	100%	-	-	2 på sten	2/0
Lolland NØ	09:52	11,8%	4	-	9 på sten og 4 i vand	17/0
Flintehorne Odde	10:08	-	-	-	4 i vandet 100 m væk	4/0
Vitten/Skrollen	10:02	4,5%	-	-	13 på sten (heraf 3 unger) + 9 i vand	22/0
Rødsand	10:15	-	33/15		3 grupper (7+22 spættede+15 grå)+ 4 i vandet	33/15
Bøgestrøm	10:40	-	-	-	6 på land (heraf 2 unger) + 2 i vandet	8/0
Jungshoved N	10:45	-	-	-		0
Falsterbo	11:00	-	91/12		4 grupper: 34+28+29 spættede sæler (heraf 10 unger)+ 12 grå	91/12
Saltholm	11:10	-	-	-	10 på sten + 4 i vand	14/0
Amager SØ	11:20	-	-	-		0
Total in area 4:						
Western Baltic harbour seals total:			257		Western Baltic grey seals total: 27	
Notes:			Notes:			
Camera 1 (Front seat):			Nicon D1		Film: Digital	
Camera 2 (back seat):			Nicon F90		Film: Fujichrome 400 asa	

Aerial survey of seals in Western Baltic						
Date: 19.08.05						
Take off: 09:15 Landed: 11:20						
Aircraft type:			Cessna 206		Pilot: Jens Larsen	
Speed over locations (knob):			90		Observer front seat Signe May Andersen	
Hight over lokations (feet):			500		Observer back seat Jonas Teilmann	
Wind, m/s:			4		Cloud cover (1/8) 1/8	
Wind direction:			SØ		Temperatur C ⁰ : 15	
Locality	Time	Distur- bance (%)	Camera1 (Harbour/g rey)	Camera2 (Harbour/ grey)	Visuelle observation during survey	Total (harbour/ grey)
Aunø	09:40	0%	-	-	Optalt under overflyvning: Jonas: 140, Signe: 119 sæler.	140/0
Dyrefod	09:50	0%	-	-	18 på sten + 2 i vadnet	20/0
Falster NW	09:57	0%	-	-	19 på sten + 2 i vandet	21/0
Lolland NØ	10:00	0%	-	-	11 på sten	11/0
Flinteorne Odde	10:20					0
Vitten/Skrollen	10:15	0%	-	-	38 på sten + 2 i vandet	40/0
Rødsand	10:25	0%	165	166	+ 14 i vandet	180/0
Bøgestrøm	10:45	0%	-	-	9 på sten + 3 i vandet	12/0
Jungshoved N	10:50					0
Falsterbo	11:10	5%	122/88	126/87	1 lille gruppe spættede + 1 stor gruppe grå+1 gråsæl i vandet	124/89
Saltholm	11:15	0%	-	-	Sdr. Flint er overskyttet	33/0
Amager SØ	11:30					0
Total in area 4:						
Western Baltic harbour seals total:			581		Western Baltic grey seals total: 89	
Notes:			Notes:			
Camera 1 (Front seat):			Nicon D1		Film: Digital	
Camera 2 (back seat):			Nicon F90		Film: Fujichrome 400 asa	

Aerial survey of seals in Western Baltic						
Date: 22.08.05						
Take off: 09:15 Landed: 11:40						
Aircraft type: Cessna 177				Pilot: Jens Larsen		
Speed over locations (knob): 70				Observer front seat: Signe May Andersen		
Hight over lokations (feet): 500				Observer back seat: Jonas Teilmann		
Wind, m/s: 5				Cloud cover (1/8): 0/8		
Wind direction: SV				Temperatur C ⁰ : 18		
Locality	Time	Distur- bance (%)	Camera1 (Harbour/g rey)	Camera2 (Harbour/ grey)	Visuelle observation during survey	Total (harbour/ grey)
Aunø	09:40	0%	-	-	Signe: 108, Jonas: 113	111/0
Dyrefod	09:45	0%	-	-	22 på sten	22/0
Falster NW	09:50	0%	-	-	12 på sten + 1 i vandet	13/0
Lolland NØ	09:55	0%	-	-	9 på spredte sten	9/0
Flinteorne Odde	10:15					0
Vitten/Skrollen	10:10	0%	-	-	15 på sten + 5 i vandet	20/0
Rødsand	10:25		181	178	4 græsæler på land + 8 sæler i vandet	188/4
Bøgestrøm	10:45	0%	-	-	8 på sten + 3 i vandet	11/0
Jungshoved N	10:46					0
Falsterbo	11:02	0%	128/76	125/75	1 gruppe ca. lige mange grå (tæt) og spættede (spredte)	127/76
Saltholm	11:20	0%	-	-	26 på spredte sten	26/0
Amager SØ	11:25					0
Total in area 4:						
Western Baltic harbour seals total: 527				Western Baltic grey seals total: 80		
Notes:				Notes:		
Camera 1 (Front seat):			Nicon D1		Film: Digital	
Camera 2 (back seat):			Nicon F90		Film: Fujichrome 400 asa	

Aerial survey of seals in Western Baltic						
Date: 24.08.05						
Take off: 09:15 Landed: 11:50						
Aircraft type:			Cessna 206		Pilot: Jens Larsen	
Speed over locations (knob):			90		Observer front seat Signe May Andersen	
Hight over lokations (feet):			500		Observer back seat Jonas Teilmann	
Wind, m/s:			2		Cloud cover (1/8) 8/8	
Wind direction:			N		Temperatur C°: 18	
Locality	Time	Distur- bance (%)	Camera1 (Harbour/g rey)	Camera2 (Harbour/ grey)	Visuelle observation during survey	Total (harbour/ grey)
Aunø	09:40	0%	-	-	Signe: 122, Jonas: 126	124/0
Dyrefod	09:47	0%	-	-	17 på sten	17/0
Falster NW	09:53	0%	-	-	24 på sten + 1 i vandet	25/0
Lolland NØ	09:57	0%	-	-	5 på spredte sten	5/0
Flintehorne Odde	10:15					0
Vitten/Skrollen	10:10	0%	-	-	50 på sten + 1 i vandet	51/0
Rødsand	10:20	10%	132	127	1. overflyvning: + 4 i vandet, overflyvning: + 25 i vandet	2. 134/0
Bøgestrøm	10:38	0%	-	-	18 på sten + 1 i vandet	19/0
Jungshoved N	10:40	0%	-	-	3 på samme sten	3
Falsterbo	10:57	2%	114/20 - en lille gruppe manglede	121/21	1 græsæl i vandet+3 grupper. Den midterste gruppe: halvt grå/halvt spættede, de to andre grupper var spættede	121/21
Saltholm	11:32	0%	-	-		40/0
Amager SØ	11:35					0
Total in area 4:						
Western Baltic harbour seals total:			539		Western Baltic grey seals total: 21	
Notes:			Notes:			
Camera 1 (Front seat):			Nicon D1		Film: Digital	
Camera 2 (back seat):			Nicon F90		Film: Fujichrome 400 asa	

Aerial survey of seals in Western Baltic						
Date: 30.09.05						
Take off: 09:20 Landed: 11:40						
Aircraft type:			Cessna 206		Pilot: Jens Larsen	
Speed over locations (knob):			80		Observer front seat Signe May Andersen	
Hight over lokations (feet):			500		Observer back seat Jonas Teilmann	
Wind, m/s:			3		Cloud cover (1/8) 8/8-0/8	
Wind direction:			Vest (270)		Temperatur C ⁰ : 12	
Locality	Time	Distur- bance (%)	Camera1 (Harbour/g rey)	Camera2 (Harbour/ grey)	Visuelle observation during survey	Total (harbour/ grey)
Aunø	09:45				Meget højevandet, få sten	0
Dyrefod	09:50				Meget højevandet, få sten	0
Falster NW	09:55				Meget højevandet, få sten	0
Lolland NØ	09:57				Meget højevandet, få sten	0
Flintehorne Odde	10:10					0
Vitten/Skrollen	10:07					0
Rødsand	10:22		-	-	Ingen på land, 18 i vandet	18/0
Bøgestrøm	10:45	0%	7 på sten	-	7 på sten	7/0
Jungshoved N	10:47					0
Falsterbo	11:05	0%	30 spættede	på vej	47 græsæler i vandet, 5 spættede i vandet	35/47
Saltholm	11:20	0%	-	-	16 på spredte sten	16/0
Amager SØ	11:30	0%			1 på sten	1/0
Total in area 4:						
Western Baltic harbour seals total:			77		Western Baltic grey seals total: 47	
Notes:			Notes:			
Camera 1 (Front seat):			Nicon D1		Film: Digital	
Camera 2 (back seat):			Nicon F90		Film: Fujichrome 400 asa	

Aerial survey of seals in Western Baltic						
Date: 24.10.05						
Take off: 09:15 Landed: 11:30						
Aircraft type:			Cessna 206		Pilot: Jens Larsen	
Speed over locations (knob):			90		Observer front seat Signe May Andersen	
Hight over lokations (feet):			500		Observer back seat Jonas Teilmann	
Wind, m/s:			2		Cloud cover (1/8) 1/8	
Wind direction:			Vest		Temperatur C ⁰ : 3	
Locality	Time	Distur- bance (%)	Camera1 (Harbour/g rey)	Camera2 (Harbour/ grey)	Visuelle observation during survey	Total (harbour/ grey)
Aunø	09:40	20%	-	-	55 spættede på spredte sten	55/0
Dyrefod	09:45		-	-		0
Falster NW	09:50		-	-		0
Lolland NØ	09:51	0%	-	-	på sten	1/0
Flinteorne Odde	10:10		-	-		0
Vitten/Skrollen	10:05	5%	-	-	Meget lavvandet. 2 i vandet	23/0
Rødsand	10:15	0%	+	-	7 sæler i vandet. 2 havørne på land	7/0
Bøgestrøm	10:40	30%	-	-	7 på sten + 3 i vandet	10/0
Jungshoved N	10:45		-	-		0
Falsterbo	11:00	-	-	-	6 spættede + 36 grå i vandet	6/36
Saltholm	11:15	-	-	-	Alle på sten, 1 i vandet	47/5
Amager SØ						0
Total in area 4:						
Western Baltic harbour seals total:			143		Western Baltic grey seals total: 41	
Notes:			Notes:			
Camera 1 (Front seat):			Nicon D1		Film: Digital	
Camera 2 (back seat):			Nicon F90		Film: Fujichrome provia 400	