Harbour seals, *Phoca vitulina*, in relation to the wind farm site OWEZ, in the Netherlands.
-Interim rapport

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Rapport **OWEZ_R_252_T1_200800303**

Institute for Marine Resources and Ecosystem Studies

Wageningen *IMARES*

Location Texel

Client: **NoordzeeWind**

Publication Date: 3-3-2008

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Introduction

Dutch government policy aims at realising sustainable energy production in the Netherlands. One possibility explored is offshore wind power. As an initiative, the government has given permission for the construction of a Wind Farm (formerly called NSW, now OWEZ: Offshore Wind farm Egmond aan Zee) as a demonstration project, used for assessing both technological and environmental challenges in relation to construction and operation. In order to evaluate environmental impacts from an offshore wind farm it is necessary to carry out a baseline or T0 study, which provides a thorough description of the ecological reference (present) situation.

The Nuon-Shell consortium "NoordzeeWind" exploiting the wind farm has procured a baseline study on the North Sea situation for the seals. The study was carried out in the autumn and winter of 2005/2006 and reported (OWEZ_R_252_T0_20061010 marine mammals.pdf). The wind farm was built between April 2006 and December 2006. Now that the wind farm is operational, a T_1 study on the seals has been conducted in 2007. This interim report presents an overview of the procured results of the work executed in 2007. Analysis will continue in 2008. The final report will include a final habitat model for harbour seals in the Dutch coastal waters.

This study includes a description of the spatial distribution, activity and migration of harbour seals that haul out both north of the OWEZ area (Wadden Sea) and south of it (Delta area). Seal activity and habitat use is measured by tagging harbour seals enabling to follow the animals on their trips at sea and measure diving activity.

Figure 1. Scheme of the proposed seal study in relation to the building and use of the OWEZ. This paper reports on the T1 phase (in green).

Distribution of harbour seals in the Dutch coastal area

In contrast to the conspicuous birds, marine mammals exhibit a mostly cryptic behaviour in open oceans, as most of their time is spent under water. The mammals that also show a terrestrial phase such as seals, otters, polar bears can be counted on land and so enable a reliable population estimate. However, these animals are seldom seen in open water and therefore the function of that system is difficult to assess.

In Dutch waters two sympatric seal species are observed: the harbour seal and grey seal (Phoca vitulina and Halichoerus grypus). In this study we concentrate on the former in the same way as the harbour porpoise, as a proxy for the cetaceans, was studied in that baseline study (Brasseur *et al.* 2004; Scheidat *et al.* 2008).

It is tempting to conclude that the habitat of seals is limited to only the haulout sites (areas where seals aggregate outside the water, in the Wadden Sea and in the Delta area mostly sandbanks). The animals are counted there during their breeding and moulting season at low tide when they tend to be most numerous (Reijnders 1978). Relative recent use of telemetry devices allowed to actually follow the animals into the water. This has opened our horizon and provided very different insights (Bowen *et al.* 1999, Brasseur *et al.* 2004, Brasseur & Reijnders 2001a, Härkönen *et al.,* 1999, Reijnders *et al.* 2000, Thompson *et al.* 1996). In the Netherlands, harbour seals generally forage some tens of kilometres away from the haulout sites. They also travel to other haulout sites from which they forage offshore, and consequently ranging up to a few hundred kilometres in all. The larger species, grey seal, may even range hundreds of kilometres away to feed offshore. Their range could amount up to almost 1000 km.

These migration and feeding ranges obviously are of importance to the seal population and should not be neglected when assessing possible impacts of human activities in coastal or offshore areas. Unfortunately, the necessity to acquire knowledge of these habitats does not correspond with the difficulty to actually measure their function and relative importance. The probability of observing a seal or following an individually tracked animal to the exact study area is slim. This is further aggravated by the fact that seals seem to be solitary and show very individualistic behaviour (Brasseur et al 2007). Variation in haul out pattern, distances travelled to feeding grounds and migration to other areas have been demonstrated both in harbour and grey seals in the Netherlands (Brasseur & Reijnders 2004, Brasseur et al. 2001, Reijnders & Brasseur 2000). Seals at sea are most often alone, which makes them even harder to spot.

The Dutch harbour seals are part of the international Wadden Sea population. Most seals in Dutch coastal waters are observed to haul out in the Wadden Sea, but a small colony persists in the so called Delta area, the Scheldt estuary. Historically the relative proportion of seals observed in the Delta was much greater, consisting of one third of the seals in the Netherlands.

A combination of excessive hunting in the past, which almost eradicated the population, followed by habitat loss, disturbance and pollution, prevented or slowed down the growth of the local Delta population (Reijnders 1984). The number of harbour seals in the Delta remains low, this emphasizes the urge to protect these colonies. IMARES (formerly Alterra) has over 10 years of experience in tracking harbour seals in both areas (Brasseur & Reijnders 2001a, Brasseur et al. 2004). In these studies a number of seals were shown to migrate from the southern Delta area north to the Wadden Sea and back. All tagged pregnant females left the Delta Area to give birth in the Wadden Sea (Brasseur & Reijnders 2001b). Due to the lack of births in the Delta area, growth of the colony is almost entirely dependent on immigration from other areas. The Wadden Sea is the most likely source population.

Existing data on seal movement indicates that the harbour seals are likely to travel along the coast, within a few tens of kilometres off the coast. These are the areas targeted for wind farms. One should take into consideration that besides affecting seal feeding habitat, wind farms could influence migration between the colonies. In the case of the Delta area a negative effect on migration could prevent this colony to persist.

Modelling seal movements and habitat use based on actual knowledge of seasonal and regional differences seem to be a sensible approach to define, and to some extent quantify, probable use of a specific area. An adequate habitat model will enable us to estimate the relative importance of areas in the North Sea. Also including the current human use in the model, could elucidate the general effect this has on the seals, specifically the study of the OWEZ Wind Farm will depend on the value of the direct results in the area.

Aim of the study

In this study data on migration and (diving) behaviour of harbour seals was collected and how this relates to the wind farm. As there are no haulout sites directly present in the vicinity of the site, seals were tagged north and south of the area. Quantifying changes in the use of the area in relation to the farm is the first aim of the study. However a more general aim is to model the seals habitat use in the North Sea in order to estimate the relative importance of the specific locations in the North Sea. This will in hindsight help evaluate the location choice of the studied wind farm but will also of great value when defining new wind farm areas in the future.
In this interim rapport the collected data is presented. Detailed analysis of possible effects and modelling is expected to be finalized in the final rapport in Q1 2009.

Material and methods

The OWEZ is intended to be a demonstration project, and therefore the assessment of possible effects will have a greater scope than only this area. Results should also yield a more general insight on the interaction between the seals and intended wind farms. Therefore the ultimate goal of the complete project (T0 and T1) includes, in addition to the impact study, the modelling of the use of the Dutch coast by seals, providing information on the relative importance of specific areas for the species. These results will be presented in the final report (Q1 2009). The Dutch North Sea coastal zone is known to play a role as foraging area, but also as a migration route between the Wadden Sea and the Delta area, and vice versa. Therefore knowledge on individual seal behaviour (tracking) will be combined with population surveys (aerial counts). Using these methods we will establish migration, dispersal and density of the seals in the study area (wind farm location) and beyond. It is realistic to say that the latter will only be obtained through modelling. Data on actual presence of seals will remain limited.

Study Area

The OWEZ area is located offshore at 8 - 18 km from the North Sea coast of Egmond aan Zee. It consists of about 40 km2, holding a total of 36 windmills with a hub height of 70 meters above MSL, each producing 3 MW. Although seals are occasionally seen hauled out on the beach near Egmond, the area is relatively far from their major haul out sites (figure 2). The construction and operation of the wind farm could, however, still intervene with the migration or feeding of the seals.

Aerial Surveys

Seals are usually counted during aerial surveys at low tide, when the maximum number of haulout sites is available. Harbour seals were counted in the Wadden Sea during pupping and moult (June, respectively August) since the mid-1970 by the authors (IMARES), contracted by the Ministry of Agriculture, Nature and Food Quality. Multiple counts (5-8 counts a year) in this period provide the necessary accuracy for long term monitoring and population studies (Reijnders 1978; Reijnders 1997: Meesters *et al.* 2007). The data also provides information on the spatial distribution of the seals and their pups, on land. In the southern Netherlands (Delta) seals are counted during a monthly count (Biologisch Monitoring Programma Zoute Rijkswateren van het RIKZ, Rijksinstituut voor Kust en Zee, now Waterdienst). Latest survey data will be procured from these monitoring programs and used in the final model.

Tracking of individual seals

Former studies showed that seals easily migrate up to several hundreds of km to other colonies or swim tens of km, apparently to feed (Brasseur & Reijnders 2001a, Brasseur et al., 2004, Brasseur et al., in press). In order to define the use of the area by the seals, 2 x 6 seals were tagged with satellite tags. As there are no haulout sites in the immediate vicinity of the study area, six animals were tagged in the north (near Texel, the Steenplaat) and 6 in the south (in the western Scheldt, at Hansweert). Seals are caught on the haul out areas with a large seine net, and tagged directly on location. The tags are glued to the fur of the neck using two component quick setting epoxy. Captured seals are weighed and measured before release usually within 1:30 hour after capture.
The resulting data will be used to model the behaviour and movement of the harbour seals in the Netherlands. In addition, existing data will be used to define the temporal and spatial changes in the use of the area by the individuals (Reijnders et al. 2000, Brasseur & Reijnders 2001a, Brasseur et al. 2004, and Brasseur et al., in press). This new data together with the data collected during T1, will make it possible to define year variation and specific use of the North Sea coast. This project was scrutinised and approved by the Dutch animal ethics committee of the Royal Netherlands Academy of Sciences.

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Table 1 Overview of the seals tagged during the project, in the western Scheldt, Hansweert and north of Texel, Steenplaat.

		F		M		Total
	age group	adult	sub-ad	adult	sub-ad	
	location					
T0 (autum 2005)	Hansweert	2	3		1	6
	Steenplaat		1	4	1	6
T1-a (spring 2007)	Hansweert				6	6
	Steenplaat		2	2	2	6
T1-b (autum 2007)	Hansweert			4		4
	Steenplaat	1		2	3	6
Total		3	6	14	11	34

Telemetry System

Two types of tags were used during T1. During the first series of T1 in spring, satellite relayed data recorders (SRDLs) were used. During the second series, the tags were equipped with Fastloc (GPS) and data was relayed through GSM. Both were constructed by the Sea Mammal Research Unit and consisted of a data logger. Detailed dive behaviour information is collected and transmitted via Argos satellite or GSM, respectively. The average daily uplink rate was of the SDRL is 7 per day (ranging between 12 and 2). This includes also poor quality locations In order to prolong battery life, the SRDLs switched to an energy saving mode after 5 hrs when transmissions were continuous (haulout).
The Fastloc tag is set to collect and store a location every 20 min. whenever in contact with a phone base, it sends the data as a text message. Data can be stored up to 3 months before being sent and received.
Both tags weighed 0.3 kg and can resist pressure to a depth of 1000m. Data from a depth sensor (0.5 m resolution) and a submergence sensor were used to determine the activity of the seal: "diving" (deeper than 0 m for at least 4 s), "at surface" (no dives for 180 s) or "hauled out" (continuously dry for at least 600 s, stops when wet for 40 s). Individual dive records included maximum dive depth, duration and previous surface interval durations. Dives were divided into shallow dives (<10m) and deep dives. From the latter dive shape was additionally recorded: four points per dive using dive characterisation algorithm, i.e. depth and time was recorded on four most significant flexing points in the dive.

Six hourly summary records, including the percentages of time spent diving and at the surface, were also calculated. Dive, haulout, and summary records were stored in memory and selected for transmission so that times of day when the Argos satellites were not available were adequately represented.

Data Processing

Animal tracking filtering procedure for ARGOS data
Many animal tracking devices rely on the Argos satellite system. In contrast to GPS locations, the Argos locations cannot estimate the exact location of the animal, i.e. the Argos estimates are known to have considerable errors. Consequently, in heterogeneous environments, such as coastal regions, some locations at-sea will appear to be on land. Traditionally, those locations that do fall on land were excluded from further analysis. This implies that locations close to shore, are more likely to fall on land and thus being removed, compared to those that are far offshore. This can lead to strong biases in estimates of spatial distribution of the species and their habitat preference. This is more dramatic in coastal species such as the harbour seal.
In this project we developed a method that overcomes this problem by repositioning the Argos telemetry observations. The framework not only includes information on land-features, it also incorporates information on

the magnitude of Argos error associated with each telemetry observation, and speed with which animals travel. We applied the algorithm to data from harbour seal (*phoca vitulina*) in the Dutch Wadden Sea, an area with a complex topography. Below we outline how this filtering algorithm works.

Every transmitter on the seal emits a UHF signal, known as an uplink, which can be received by Argos stations on board two orbiting satellites. Based on the Doppler shift in frequency for all uplinks, Argos can estimate the animals' position. The accuracy at which the location is estimated depends on many factors such as the geometry of the satellite relative to transmitter, the number of uplinks received and the stability of the frequency. To indicate the level of accuracy, Argos supplements each location with a so called Location Quality (LQ). LQ can take values of Z, B, A, 0, 1, 2, 3. In the past, studies have been conducted to get estimates of the magnitude of the error for each location class (e.g. Vincent et al. 2002). Given these error estimates it is now possible to generate any random location in space relative to the inaccurate Argos location, and calculate how likely it is that the animal was actually at that random location. When this random location falls on land, we know with some certainty this is not correct. Finally, if the distance to the previous and next Argos location would imply a travel speed beyond the animals' physiological capabilities, we also know this random location can't be the animals' true position. By repeatedly generating random locations it is possible to eventually find that location which is most likely to be the true animal position. The final product of this algorithm is a new set of animal positions that are always at-sea and within the individuals' travel speed capabilities. All ARGOS tracks presented this report were subjected to this treatment, even though the ARGOS filter is still being ameliorated.

Analysis of trips

Distance to known haul out areas was determined and two states were defined: "at sea"= more than 1000m away from any haul out, "haul out"= within 1000 m of a haul out site. A trip was defined as a number of consecutive locations "at sea". The trip or haul out period was estimated to start on the midpoint between the previous location within 1000m of a haul out site and the next location outside this haulout region. The distance from each acquired location to the last visited haulout site and the distance to the site where the seals were tagged were determined. This was also done with the gps data, where filtering was not necessary.

For comparison between areas (north and south), Season (autumn-winter and spring) and "treatment" (the effect of the wind farm) individual trips were defined and maximum duration and distance were calculated.

Behavioural data

In this report, summary statistics on diving behaviour is presented. These will be used in the final report to define foraging areas. Behavioural data is presented as daily percentage of time spend haul-out, at the surface and diving, for each seal. Number of dives (shallow and deep) and daily maximum depths are shown for each seal. Dive shapes were compared by calculating the similarity between single dives based on (normalised) time and depth data. This technique is known as Second-stage Multidimensional Scaling (Clarke et al 2006). The dive shapes are compared and the resemblance between the separate dives is determined by the Spearman rank order correlation coefficient. This results in a matrix of correlations that can be further analysed. In order to determine the function of the dives, which is needed in the final habitat use model, the Second-stage matrix was clustered by agglomerative hierarchical clustering (Legendre & Legendre 1998). This way, different groups of dives could be distinguished. Finally for each cluster the average dive profile was calculated. This was done using data from one seal as a test for the method. The dive depth and duration at the 4 points in the dive (see 2.3.1.) were used for the characterisation of the individual dives

Computations

All calculations use options available in the PRIMER software package (Plymouth Routines In Multivariate Ecological Research, version 6), Clarke and Gorley (2006).

Habitat Modelling

The available data realised through the T_0 and T_1 project, provides a detailed description of the spatial distribution and diving behaviour of the tagged individuals. Quantifying the importance of the wind farm area (for which no seal haul-out sites are available in close proximity), can be challenging when only few individuals are tagged. Secondly, the wildlife telemetry data alone, may not represent the entire harbour seal population.

The spatial distribution of animals will to a very large extend be influenced by local environmental conditions, such as food availability, but also abiotic conditions such as temperature and depth. In the final report we will investigate how the spatial distribution of harbour seals relates to environmental conditions, such as sediment type, fish distribution, depth, sea surface temperature (SST), etc. In this report we will present some initial habitat analysis, in which we tested the influence of depth and sediment type on their distribution using also historic data. Next we use this model and population counts at the haulout sites to predict the spatial distribution in the Waddenzee.

Results

Aerial Surveys

In both areas, the Wadden Sea and the Dutch Delta area, the number harbour seals continue to grow, recovering from the 2002 PDV epizootic (Figure 2).
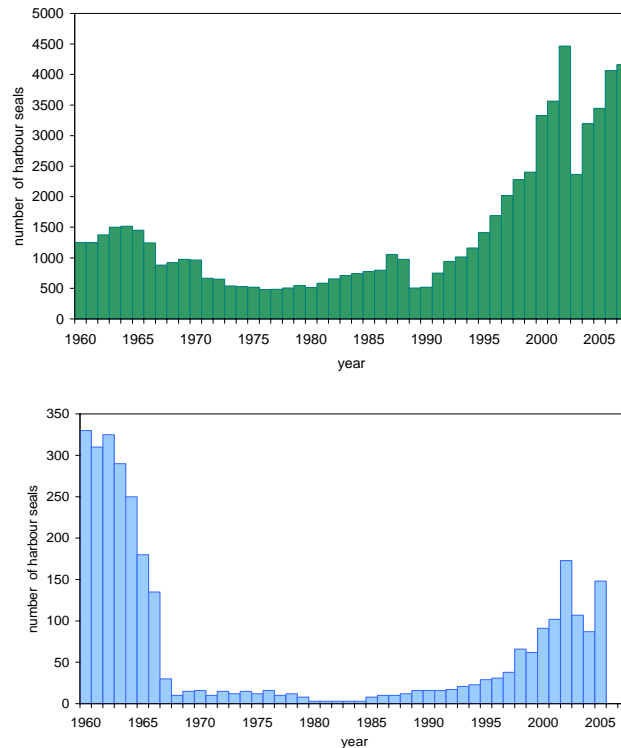

Figure 2. Results of the August surveys of the harbour seals in the Netherlands. Above: the Dutch part of the Wadden sea, below the Dutch Delta area (Strucker et al 2007).

Tracking of individual seals

During the T1 project in 2007, a total of 22 seals were equipped with a transmitter. In total animals were followed for 1939 days. On average the tags functioned for shorter duration than during T0, when the tags worked for 157 days on average (vs 88 days in T1). This lower average is mostly due to two tags deployed in autumn 2007 that only worked for a few days.

Results of the tracking is impressively variable in time and between individuals, especially in the southern Netherlands where seals travel to the French coast in autumn-winter 2005/6, while in spring 2007 two tagged seals travel to the English coast and a third one to the Wadden Sea. In autumn-winter 2007/8 the seals remain within the Western Scheldt (Figure 3).

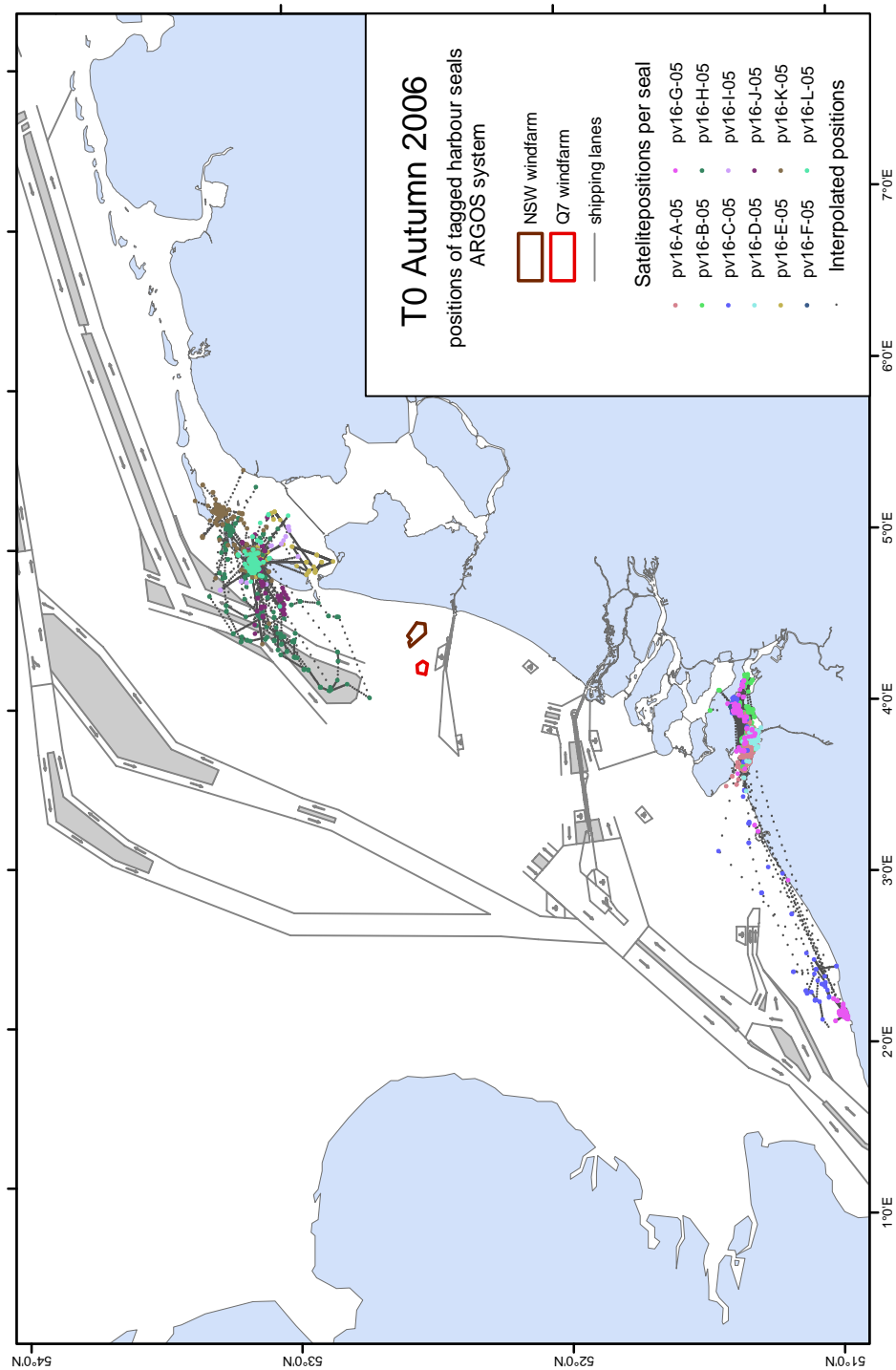Report Number **OWEZ_R_252_T1_200800303**

Figure 3a. Maps showing the distribution of the tagged seals during T0 (top), T1a (bottom). Location data collected using Argos.
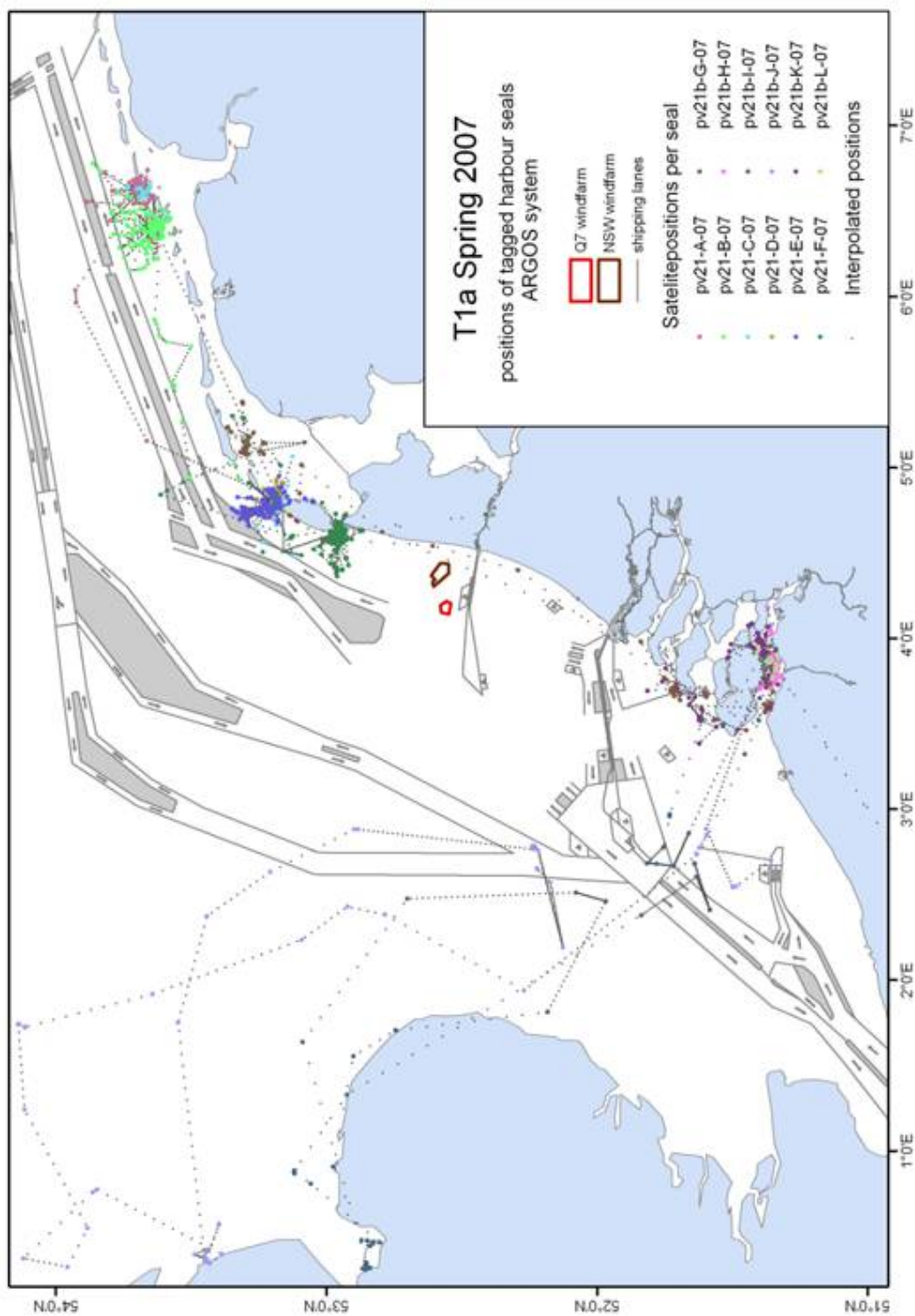
Figure 4b.continued Maps showing the distribution of the tagged seals during T0 (top), T1a (bottom). Location data collected using Argos.
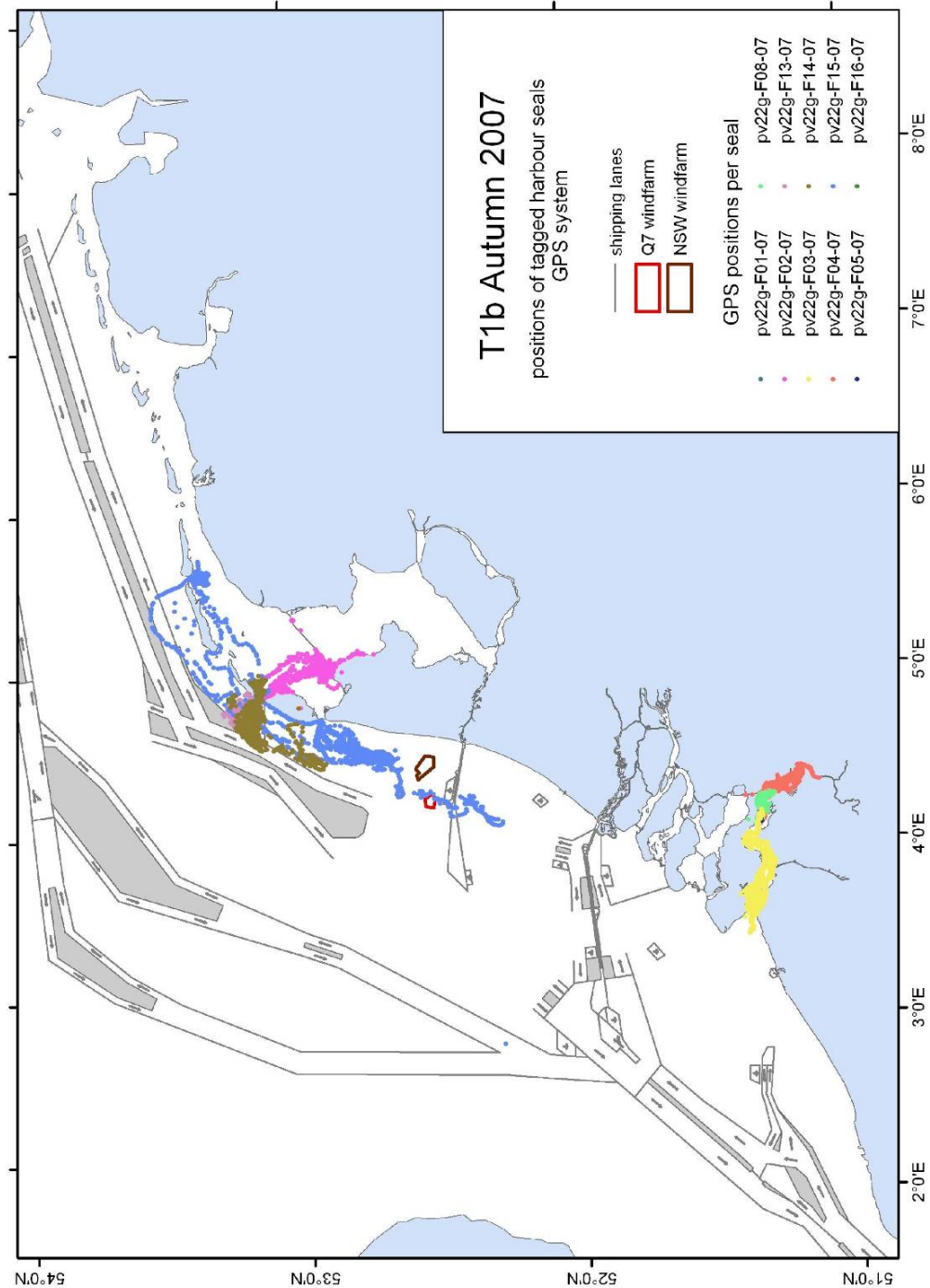
Figure 5a. Maps showing the distribution of the tagged seals during T1b (top) and detail of the Scheldt. Location data collected using GPS.

The maps also show the successful filtering of the data for T0 and T1, defining the actual trips of the seals much more accurately than other filters have shown. **Fout! Verwijzingsbron niet gevonden.**a and b shows the results obtained with the GPS tags (T1b), which give a much higher resolution. Here we see that one seal (blue) seems to avoid the wind farm. Further analysis will be used to put this observation in the correct context, as this seems to be the only case of crossing using the tags with high resolution.

Typically, trips are defined as leaving a haul out site for a period of time and then hauling out again, possibly, but not necessarily at the same site.
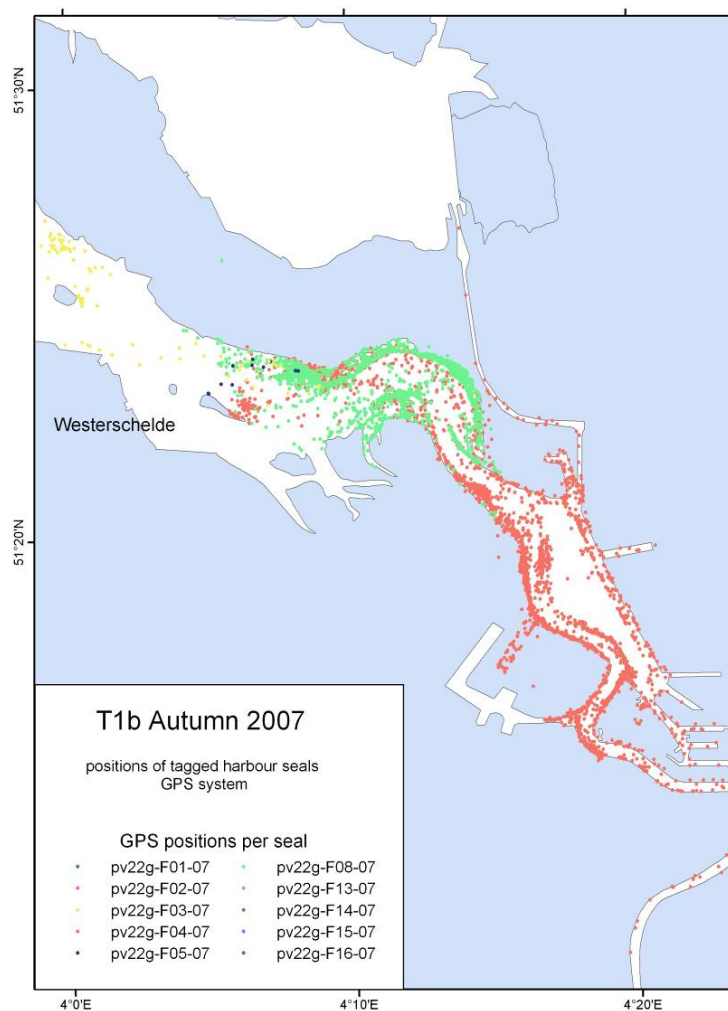

Figure 6b. continued. Maps showing the distribution of the tagged seals during T1b (top) and detail of the Scheldt. Location data collected using GPS.
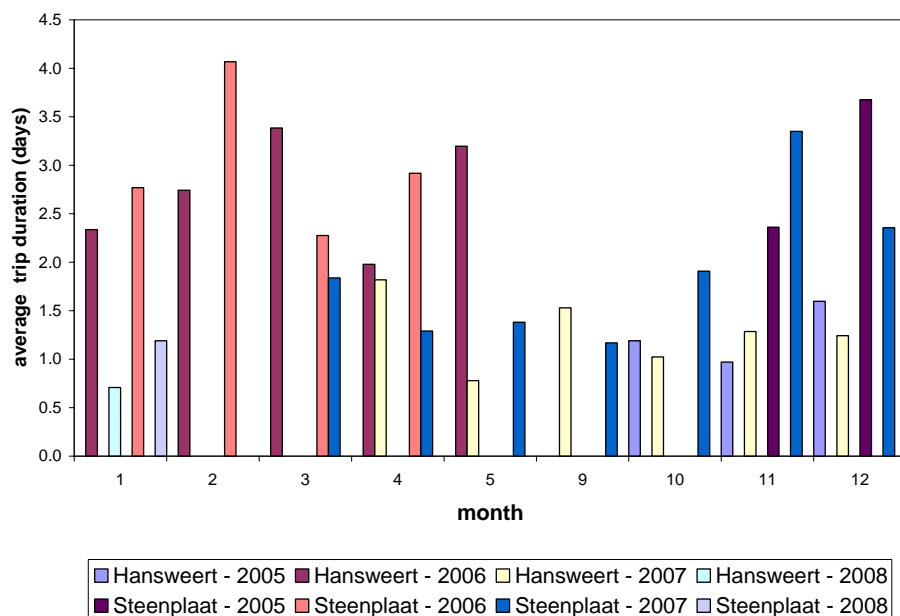
Figure 7. Average trip duration (days) per month, study years and sites are distinguished (see legend).

Figure 7 provides an overview of the duration of the trips carried out by the seals during the project (2005-2008). Although large variation exists, trips would typically last for 2 days (48 hrs) on average. Striking is that some seals travel much less on average whilst others travel 5-10 days before coming ashore. A first analysis shows that this behaviour does not clearly relate to the sex of the animals or their size. The travel distance is relatively low in average <20km, however many seals show seasonal patterns, travelling further (and longer) in winter months. Average trip distance is also limited though Table 2 shows that the maximum trips can extend beyond tens of km away from any known haul out site.

Table 2. Overview of average (top), maximum (middle) distance data and number of trips included (bottom) for the trips measured during the projects T0 and T1. Distance here is defined as minimum distance to any haul out site.

Average						Total						
	Hansweert					Steenplaat						Grand Total
month	2005	2006	2007	2008	Total		2006	2007	2008			
1		6.2		6.3	6.2		11.7		4.5		10.9	8.2
2		4.1			4.1		13.7				13.7	8.1
3		7.5			7.5		10.4	10.4			10.4	9.5
4		4.0	7.8		6.9		6.4	9.9			9.4	8.3
5		3.6	8.7		6.8			8.7			8.7	7.7
9			7.2		7.2			10.2			10.2	9.5
10	5.5		7.5		6.9			11.2			11.2	8.3
11	4.4		7.7		6.3		10.7	14.5			12.3	7.5
12	6.5		8.7		7.6		13.0		5.3		10.0	8.2
Grand Total	5.5	5.5	7.9	6.3	6.8		12.0	11.0	10.2	4.5	10.5	8.3

Max		year

month	Hansweert				Total	Steenplaat				Total	Grand Total
	2005	2006	2007	2008		2005	2006	2007	2008		
1		46.6		7.7	46.6		28.6		6.5	28.6	46.6
2		8.0			8.0		45.7			45.7	45.7
3		46.0			46.0		37.4	46.3		46.3	46.3
4		5.8	78.5		78.5		24.4	56.6		56.6	78.5
5		5.3	54.5		54.5			20.1		20.1	54.5
9			22.7		22.7			32.1		32.1	32.1
10	51.5		17.3		51.5			32.2		32.2	51.5
11	58.4		17.3		58.4	29.5		64.1		64.1	64.1
12	63.1		16.3		63.1	33.9		13.0		33.9	63.1
Grand Total	63.1	46.6	78.5	7.7	78.5	33.9	45.7	64.1	6.5	64.1	78.5

Count	year										
	Hansweert				Total	Steenplaat				Total	Grand Total
month	2005	2006	2007	2008		2005	2006	2007	2008		
1		31		8	39		25		3	28	67
2		17			17		12			12	29
3		17			17		14	28		42	59
4		12	39		51		9	53		62	113
5		6	10		16			13		13	29
9			25		25			70		70	95
10	27		62		89			41		41	130
11	44		58		102	15		11		26	128
12	48		45		93	19		12		31	124
Grand Total	119	83	239	8	449	34	60	228	3	325	774

Diving behaviour

In the final habitat model, diving behaviour will be used to distinguish between the functionality of areas. Dive data will help define, for example, foraging areas. Then specifics of these areas, such as depth or sediment type, can be described, and discriminated from areas that might have different functions.
One of the parameters included in defining this functionality include diving intensity (number of dives/ time). Below (Figure 8) we demonstrate that this can vary as a result of seasonality, but also location (Steenplaat vs Hansweert animals). Also analysis of individual dives will be used. As an example, Figure 9 shows the maximum dive depth of 5 different seals during one day (23rd of October). Clustering of types of dives and relating these clusters to specific habitat use will add to the behavioural habitat model. During the study over 200.000 individual dives were recorded, 1/3 of which exceed 10 m depth, these will be used for the clustering as explained in the T0 –report (Brasseur et al 2006).
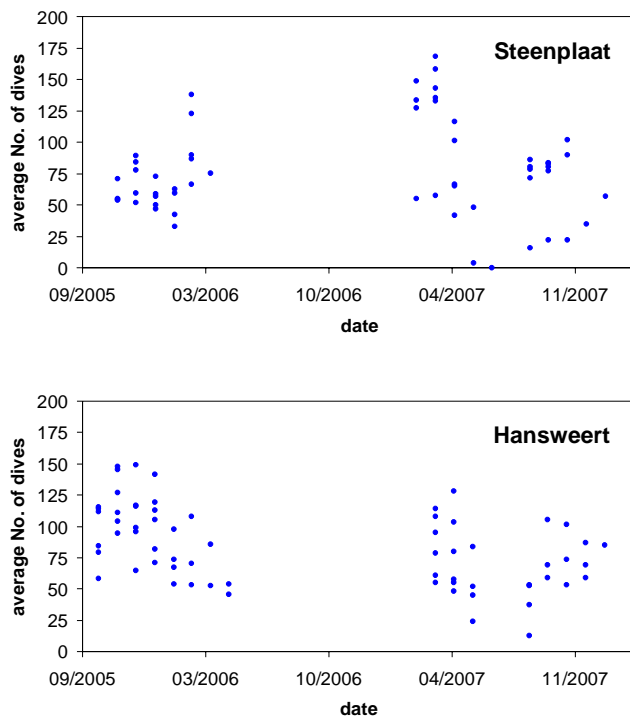
Figure 8. Average diving intensity (No. of dives/day) calculated for each individual animal for each month of tracking.
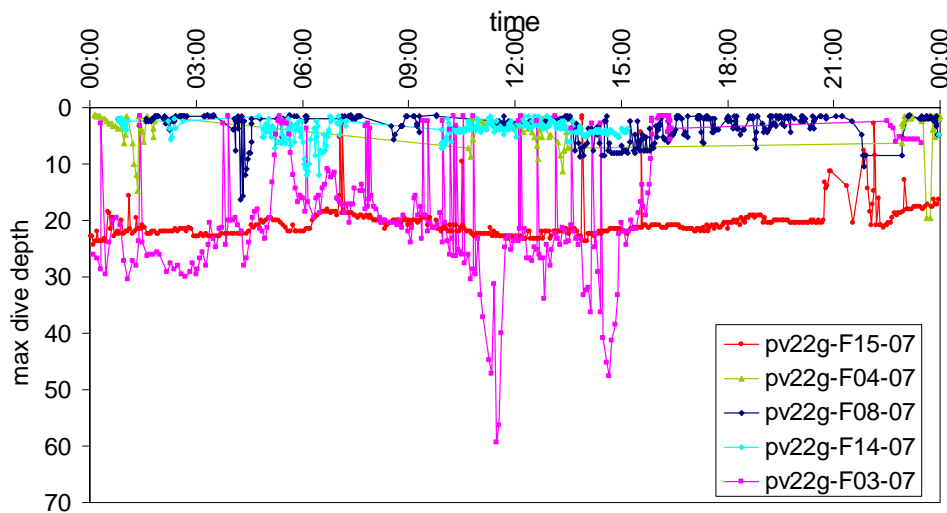

Figure 9. Example of data on dive depth, for 5 seals, on 23rd of October 2007. Different seals are given different colours

Habitat modelling

A preliminary analysis of the habitat preference (using only a limited set of environmental variables) shows that seals prefer areas close to their haul-out site (Fig 8a) and avoid deeper areas (Fig 8b).
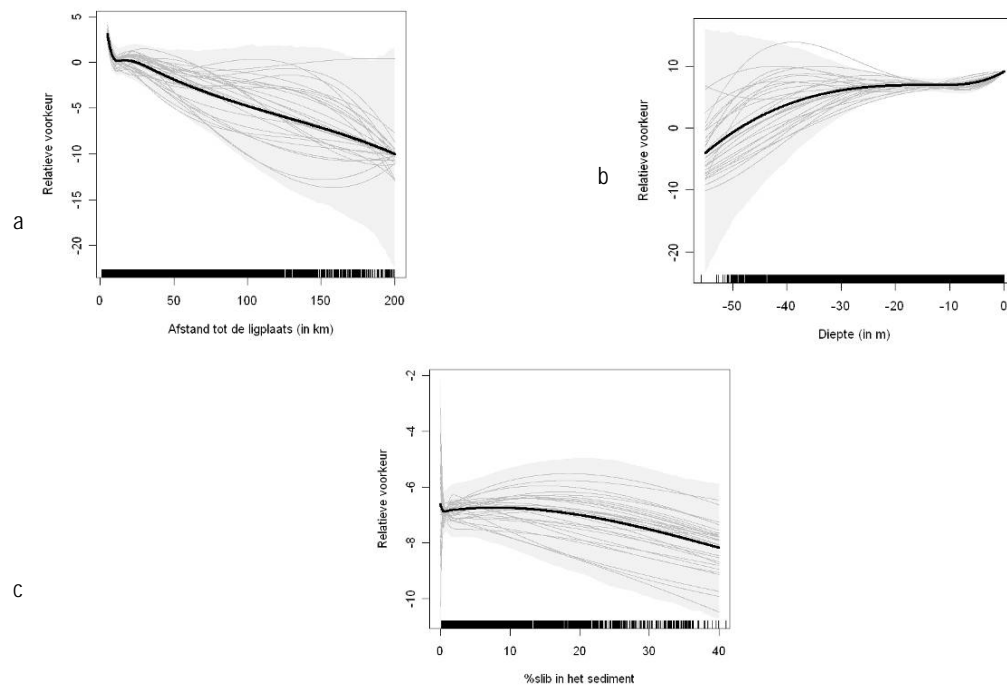
Figure 8. The relative preference for distance to the haulout (a), depth (b) and %mud in the sediment (c). The black line describes the mean population response, the grey line the individual estimates for each seal and the grey area represent the 95% confidence limits for the entire population.

Finally harbour seals seem to have a preference for areas with coarse sediment type, however this effect is very small compared to the large individual variability

The observed relations (Figure 8) can be used to estimate for every point in the North Sea (also those areas that were not used by the tagged animals) seal density. In this exercise, data from seal numbers at the haul-out sites have been used to estimate absolute abundance. The predictions are presented in Figure 9. Figure 9 is still a simplification because it does not incorporate the importance of different areas in terms of foraging behaviour, it merely quantifies absolute use. Also, it is uses relative few environmental variables (depth and sediment type) and other environmental characteristics not yet investigate may play an important role as well.
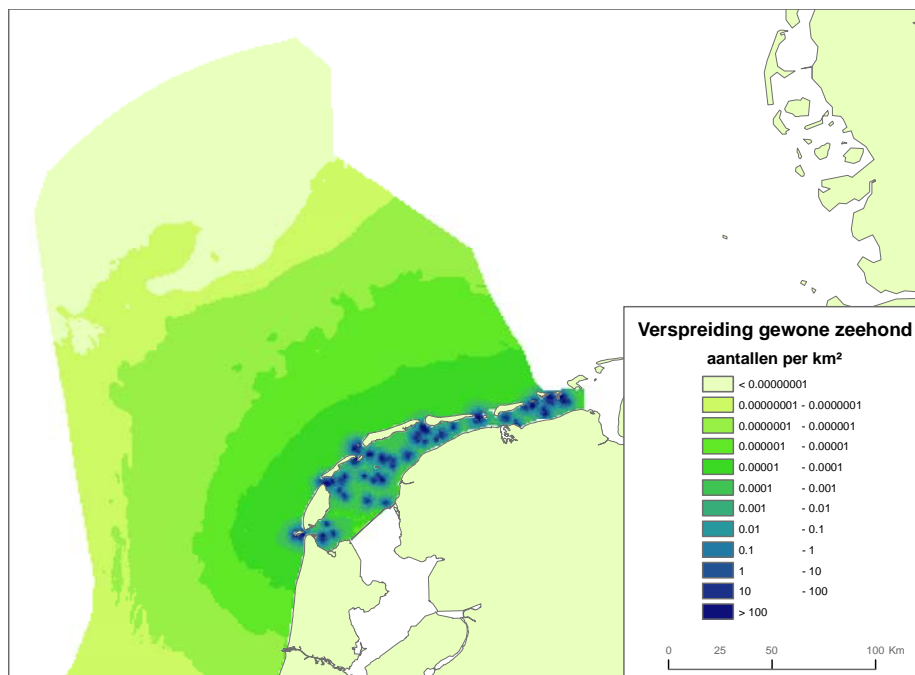
Figure 9. Predicted spatial distribution of harbour seal.

Conclusion

Data presented here comprises 3 field seasons, in total, 34 seals were tagged. This sums up to total of almost 4000 "seal days". Over 200.000 dives were recorded. Few studies have been as elaborate as this one, and successful.

Unsurprisingly, there are very few movement records of seals actually crossing the wind farm area, both before and after the construction. This does not make the study less valuable for the understanding of possible effects of wind farms, or human activity in general, on the seals. Data on the use of the aquatic environment by harbour seals largely lacked before this study, though enough knowledge is available to estimate, not to quantify possible effects. This study will certainly help to understand what the effects of wind farms are on seals, and as such, it may ultimately help to limit the effect of wind farms on the seals. In the last part of the project further analysis of the data will take place and a model defining the seals habitat use will be created. The final rapport is expected in Q1 2009.

Aerial surveys

In both areas the number of seals has grown compared to the numbers presented in 2006, when the T0 study was carried out. Effort should be put into obtaining the most recent data from the Delta area as these are usually published with some delay and were not available jet. Because the seal numbers in the Delta are not a consequence of local births, but a direct reflection of migration from the Wadden Sea, along the Dutch coast, changes in these numbers will be a strong indication on the possible effects of offshore developments. This data will also play an important role in the model as it will be used to generalise the findings of the tagged data.

Tracking of individual seals

The set collected is quite impressive as two very different areas were studied which will enable us eventually to determine the variety of behaviour of the seal's without having to correct for year effects. This will prove very valuable in the model proposed as final product. Like in other projects, seals are found to be extremely individualistic. Tracking data does not only vary as a result of seasonal, or location changes, even between two similar individuals from one area, large differences are found.
In general it seems that seals in the north undertake longer trips but also do this more frequently than the animals in the south. A thorough analysis of the behavioural differences between areas will take place.

Table 3. Overview of harbour seals tagged in the wild in the Netherlands between 1997 and 2007.

		Sex /Age group						
		F		F Total	M		M Total	Grand Total
month	area	a	Sa		a	sa		
autumn	Delta	3	5	8	6	3	9	17
	Eastern Wadden	1	1	2	3		3	5
	Western Wadden	2	3	5	11	3	14	19
autumn Total		6	9	15	20	6	26	41
spring	Delta	3	1	4	5	5	10	14
	Eastern Wadden	6		6	2	2	4	10

Western Wadden		5	5	3	5	8	**13**
spring Total	9	6	15	10	12	22	**37**
Grand Total	**15**	**15**	**30**	**30**	**18**	**48**	**78**

As stated before there are few records of seals migrating through the study area. During T1a a seal swam from the south and back, but locations at sea were not accurate enough to assess the pathway through the wind farm. During T1b however, the seal coming from the north seems to avoid the wind farm. Adequate filtering of the ARGOS data has made it possible to rely more on the locations. In the final rapport, further analysis should determine how realistic these finings are in relation to the total population.
Additional data collected in earlier years will help define the parameters of the model (Table 3).

Dive behaviour collected by the tags will be used to define the usage of the different areas by the seals (i.e. feeding grounds; migration routes etc.).

Acknowledgements

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To whom it may concern
Within the framework of the Off shore Wind farm Egmond aan Zee project, on the order of Dutch Government and with their financial support, an extensive environmental monitoring program is carried out. Research area's are birds, marine mammals, fish, benthos, solid substrate and public opinion.
The report at hand is written within the framework of the monitoring program and reports the work done in 2007 on one of the research topics. Before publication, the reports were reviewed by Dutch energy agency SenterNovem and the Waterdienst, a department of the Dutch water authority Rijkswaterstaat. The questions raised and comments of the researchers can be found in this appendix, however the text is available only in Dutch.

Aan de lezer van dit rapport

In het kader van het project Off shore Windpark Egmond aan Zee wordt, in opdracht van en met financiële ondersteuning van de Nederlandse rijksoverheid, een milieu monitoring programma uitgevoerd. Onderwerpen van onderzoek zijn vogels, zeezoogdieren, vis, benthos, hard substraat en publieke opinie.
Het rapport dat voor u ligt is gemaakt in het kader van dat programma en doet verslag van het werk dat in 2007 aan één van deze onderwerpen is uitgevoerd. Voorafgaand aan publicatie is dit concept rapport voorgelegd aan SenterNovem en de Waterdienst van Rijkswaterstaat die namens de overheid het monitoringprogramma begeleiden. Hun vragen bij dit rapport en de reactie van de onderzoekers treft u aan in deze bijlage bij het rapport.

Vragen en opmerkingen van de overheid op dit rapport:
Het document werd met veel interesse gelezen. Wel is er in de vervolgrapportage(s) een uitgebreide inhoudelijke beschrijving vereist van het op basis van de verzamelde data (te ontwikkelen) model. Tevens moet daarbij duidelijk gemaakt worden hoe het uiteindelijke model is gecalibreerd en gevalideerd, zodat de relevantie van het model als beschrijvend en voorspellend instrument beter kan worden beoordeeld.

Reactie van de onderzoekers:
Het model is niet mechanistisch maar empirisch en daarom geheel gedreven door de data. De calibratie is impliciet gevangen in de likelyhood functie die aan het model ten grondslag ligt. Met cross validatie wordt het model gevalideerd.