FOREWIND

DOGGER BANK
TEESSIDE A & B

March 2014

Environmental Statement Chapter 14 Appendix A Seal Telemetry Report

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1. Introduction

The aim of this study was to use existing seal telemetry data to quantify seal activity at the proposed Dogger Bank Zone (including a 10km buffer around it) and each of the proposed Dogger Bank Tranche sites B, C and D (including a 10km buffer around each). The analysis was to provide basic quantification of the connectivity between seals using each of the areas likely to be affected by wind farm construction and haulouts at designated Special Areas of Conservation (SACs) for seals.

2. Methods

2.1. Definition of areas for examining overlap

Wind farm boundary

For the purposes of this study, the development area was supplied by Forewind and consists of the Dogger Bank Zone plus a 10km buffer and the Dogger Bank Tranche B, C and D boundaries plus a 10km buffer zone for each (Figure 1).

2.2. Telemetry data

In the UK, the Sea Mammal Research Unit (SMRU) has deployed telemetry tags on grey seals (*Halichoerus grypus*) and harbour seals (*Phoca vitulina*) since 1988 and 2001, respectively. These tags transmit data on seal locations with the tag duration (number of days) varying between individual deployments. There are two types of telemetry tag which are associated with two types of data transmission. Data transmission can be through the Argos satellite system (Argos tags) or mobile phone network (phone tags). Both types of transmission result in location fixes, but data from phone tags comprise better quality and more frequent locations. All telemetry data used in this report have been cleaned according to SMRU protocol (Russell *et al.* 2011). Location data resulting from Argos tags were then corrected for positional error using a linear Gaussian state space Kalman filter (Royer & Lutcavage, 2008; Jones *et al*. 2011).

Any seals which had any degree of overlap with the Dogger Bank Zone were identified (from SMRU's database of 235 grey seals and 246 harbor seals) and the locations at which they

were tagged identified. Grey seals have been tagged at haul-outs at a total of three SAC's relevant to the Dogger Bank site; the Berwickshire and North Northumberland Coast (Farnes Island haul out and breeding colony), the Humber Estuary (Donna Nook haul out and breeding colony), and the Isle of May (Figure 1). Grey seals have also been tagged within the Firth of Tay and Eden Estuary SAC (Abertay haul out region) although this site is designated for its breeding population of harbour seals, large numbers of grey seals also haul out there. Connectivity was also examined with the Faray and Holm of Faray SAC. No seals which had locations within the Dogger Bank Zone also had locations at this SAC therefore it was scoped out of the study.

Harbour seals have also been tagged within the Wash and North Norfolk SAC – the tracks from these animals were included here because one tagged seal entered the region of interest. Harbour seals have also been tagged at the Firth of Tay and Eden Estuary SAC, however none of these animals travelled close to the Dogger Bank Zone.

For each of the haul-outs described above, the number of seals which have location fixes within or tracks crossing the Dogger Bank Zone plus buffer area, plus Tranche's B, C and D (plus their respective buffers) is described.

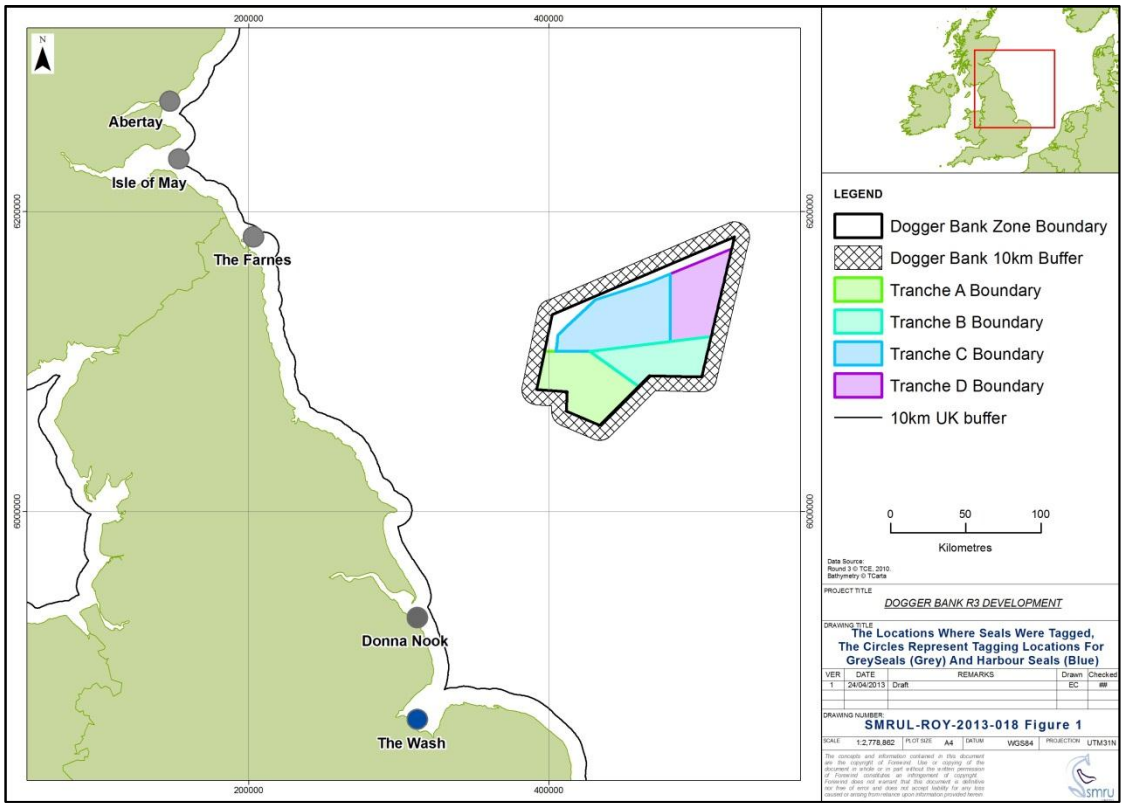


Figure 1. The locations where seals were tagged, by species (grey circle = grey seals, blue circle = harbour seals). The Dogger Bank Zone plus 10km buffer is also shown as well as individual tranche boundaries and the

10 km land buffer used to define at-sea locations. NB: The 10km buffer for each of the individual tranches is not shown.

At-sea locations

For all tagged animals which had locations within the Dogger Bank Zone plus buffer polygon, the percentage of at-sea locations within were calculated. To do this, locations had to be defined as on-land (hauled-out) or at-sea. Two datasets were used to define locations: activity data and a land mask.

Activity data

The tags record haul-out events. A haul-out event is recorded when the tag, which is located on the back of the neck, has been dry for 10 minutes. Not all haul-out events are transmitted, but the data transmitted allowed an activity status to be attributed to all locations: hauled-out, not hauled-out or unknown.

It should be noted that tags can record haul-outs associated with at-sea locations. This can occur if an animal's head is above the surface of the water for a prolonged period of time. Thus the activity status of locations cannot be used, alone, to attribute locations to on-land or at-sea. In addition, for some tags there is no haul-out data available.

Land mask

A land mask can be used to define locations as being on-land/at-sea. However, this mask must have a buffer associated with it, for three reasons. First, despite filtering there will be some error in the tag locations and thus using a land mask without a buffer may result in locations being wrongly defined. Second, despite the use of a high resolution map, some details including small islets would not be on such maps and thus not defined as land. Third, animals typically haul-out at low tide, on tidal rocks and sand banks, which would not be defined as land on maps. The third reason is particularly apparent when using data from the Wash. This area is very tidal, with some sandbanks up to 8 km off the coast being used as haul-outs at low tide. Thus a buffer was generated which included the Wash as land. For the rest of the coast, a buffer which extended 10 km from land was generated. The extent of the buffer was decided based on the frequency of known haul-out locations (from the activity data) which were near land and thus likely to be on land.

Definition

Using an activity and land mask, two scenarios were defined to generate the number of at-sea locations. The locations within the proposed wind farm development area plus buffer were then calculated as a percentage of these totals, incorporating uncertainty in the status

of locations. This resulted in minimum and maximum percentages of locations which were within the site.

Minimum percentage overlap (maximum number of at-sea locations)

This was based on the largest number of potential at-sea locations. Locations were defined as at-sea if they were

1) Outside the 10 km land buffer irrespective of activity status

2) Within the 10 km land buffer with a status of not hauled-out or unknown.

In other words, only locations within the buffer, which had an activity status of hauled-out, were defined as on-land locations.

For tags which had no activity data the minimum percentage calculated in this way is unrealistic as this would result in all locations being defined as at-sea – some unknown proportion of locations would be hauled out in reality.

Maximum percentage overlap (minimum number of at-sea locations)

This was based on the smallest number of potential at-sea locations. Locations were defined as at-sea if they were

1) Outside the 10 km land buffer irrespective of activity status

2) Within the 10 km land buffer with a status of not hauled-out.

In other words, locations within the buffer which had an activity status of hauled-out or unknown were defined as on-land locations.

It should also be noted that these estimates of overlap are of at-sea locations rather than time at-sea. Although there is likely to be a good relationship between the time an animal spends in an area and the number of location fixes, there are a number of other factors which can affect the rate at which location fixes are obtained and these are not controlled for here. As such there may be unquantifiable biases in these metrics.

3. Results

3.1. Grey seals

Pups

A total of nine pups have been tagged (Argos) on the Farne Islands in 1993 (n = 5) and 1994 (n = 4). One of these animals, tagged in 1993, entered the area defined by the Dogger Bank Zone boundary buffer and entered the Dogger Bank Tranche C boundary plus buffer (Figure 2).

A total of 22 pups have been tagged (Argos) at the Isle of May in 2001 (n=9) and 2002 (n=12). Seven of these animals entered the Dogger Bank zone plus buffer (Figure 2) of these seven, four animals entered the Dogger Bank Tranche B boundary plus buffer, three animals entered the Dogger Bank Tranche C boundary plus buffer and five animals entered the Dogger Bank Tranche D boundary plus buffer.

Adults

Farnes

There have been 29 Argos tags deployed on grey seals aged one year and over on the Farne islands. These animals were tagged in 1991 (n = 6), 1992 (n = 7), 1997 (n = 2), 2000 (n = 4) and 2008 (n = 10). The tags had a median duration of 106 days (range: 2 - 214).

Four animals (13%), one tagged in 1993 and three in 2008 entered the Dogger Bank site; (Figure 3). The animal tagged in 1993 entered Dogger Bank Tranche B, C and D boundaries plus their corresponding buffer. Of the three tagged in 2008, all entered the Dogger Bank Tranche C boundary plus buffer and one entered each of the Dogger Bank Tranche B and D boundaries plus buffer.

Donna Nook

There have been 12 grey seals, aged one and over, tagged at Donna Nook. Most of these animals (n = 10) were tagged in 2005 with the remainder tagged in 1988 (n = 1) and 1989 (n = 1). These animals had a median tag duration of 153 days (range: 12 - 257 days).

Two of these animals (17%) entered the Dogger Bank Zone plus buffer, as defined by the presence of locations or tracks within the area. Both of these animals entered the Dogger Bank Tranche C boundary plus buffer and one animal entered the Dogger Bank Tranche B boundary plus buffer, neither animal entered the Dogger Bank Tranche D boundary plus buffer.

Abertay

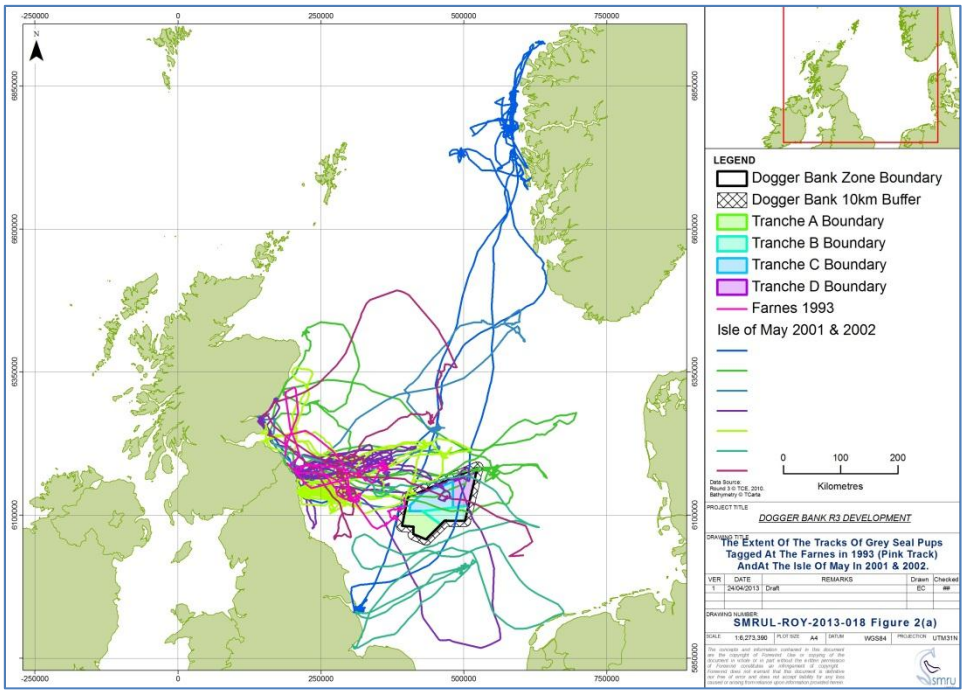
There have been 38 grey seals, aged one and over, tagged at Abertay (24 Argos tags and 14 GPS phone tags). Argos tagged animals were tagged in 1993 (n=2), 1997 (n=8), 1998 (n=10) and 2003 (n=4). GPS phone tagged animals were tagged in 2005 (n=4) and 2008 (n=10). These animals had a median tag duration of 147 days (range: 2 - 250 days).

Five of these 38 animals (13%) entered the Dogger Bank Zone, as defined by the presence of locations or interpolated tracks between locations within the area. All five animals entered the Dogger Bank Tranche C boundary plus buffer, four animals (13%) entered the Dogger Bank Tranche B boundary plus buffer and three animals (8%) entered the Dogger Bank Tranche D boundary plus buffer.

Isle of May SAC

11 adult grey seals have been tagged at the Isle of May SAC (grey seal breeding site), none of these entered the Dogger Bank Zone plus buffer. However, 2 of the tagged seals that entered the Dogger Bank Zone plus buffer polygon also had locations within 5km of the Isle of May. For context, a total of 33 out of 188 tagged grey seals had locations within 5km of the IOM. These 33 seals had been tagged at Abertay (15), The Isle of May (11), the Farnes (7) and Donna Nook (1).

(a)



(b)

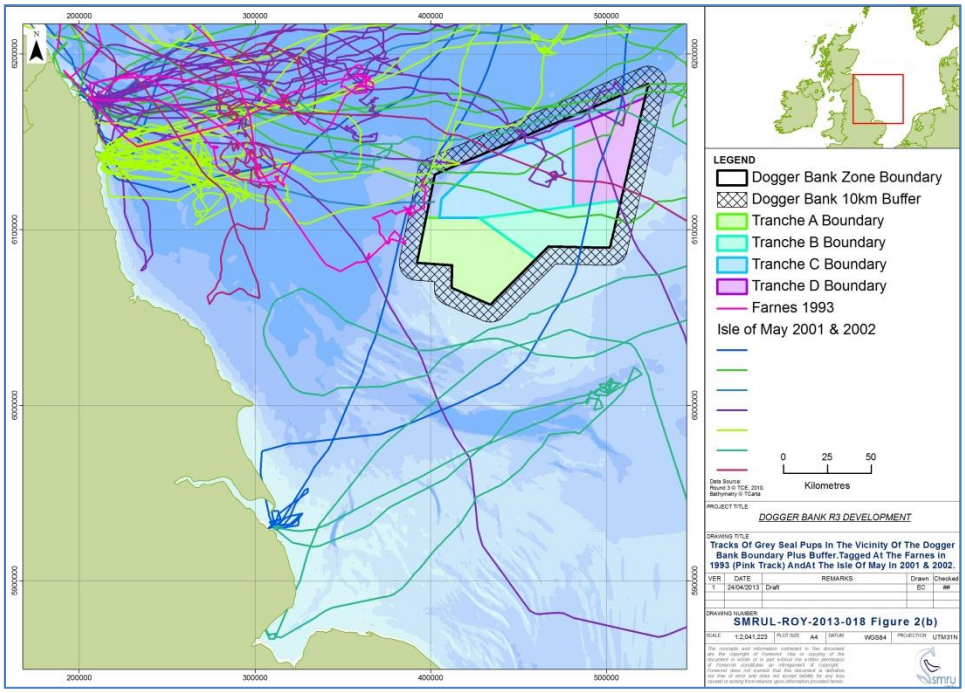
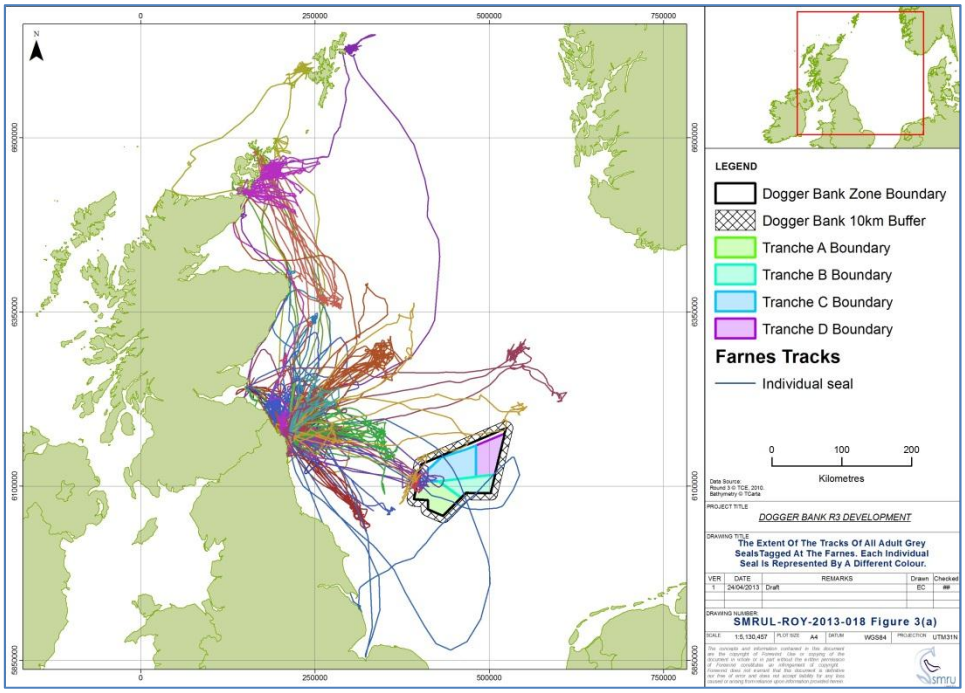


Figure 2. The tracks of grey seal pups, tagged at the Farnes in 1993 (red track) and at the Isle of May 2001 and 2002 which entered the Dogger Bank Zone plus buffer. The figures show (a) the extent of tracks, and (b) tracks in the vicinity of the Dogger Bank Zone plus buffer.

(a)



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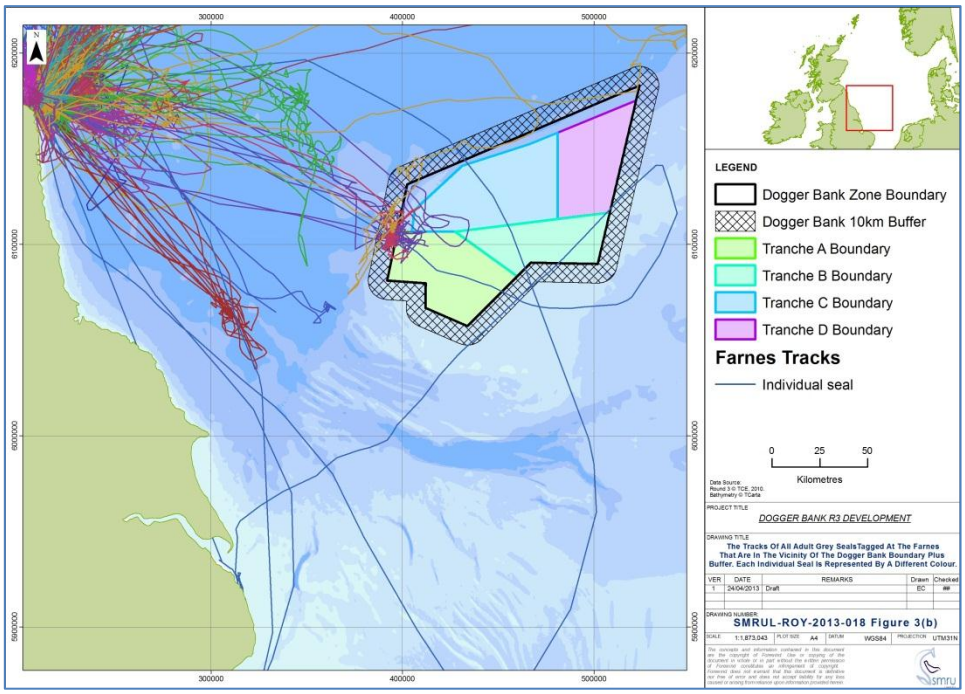
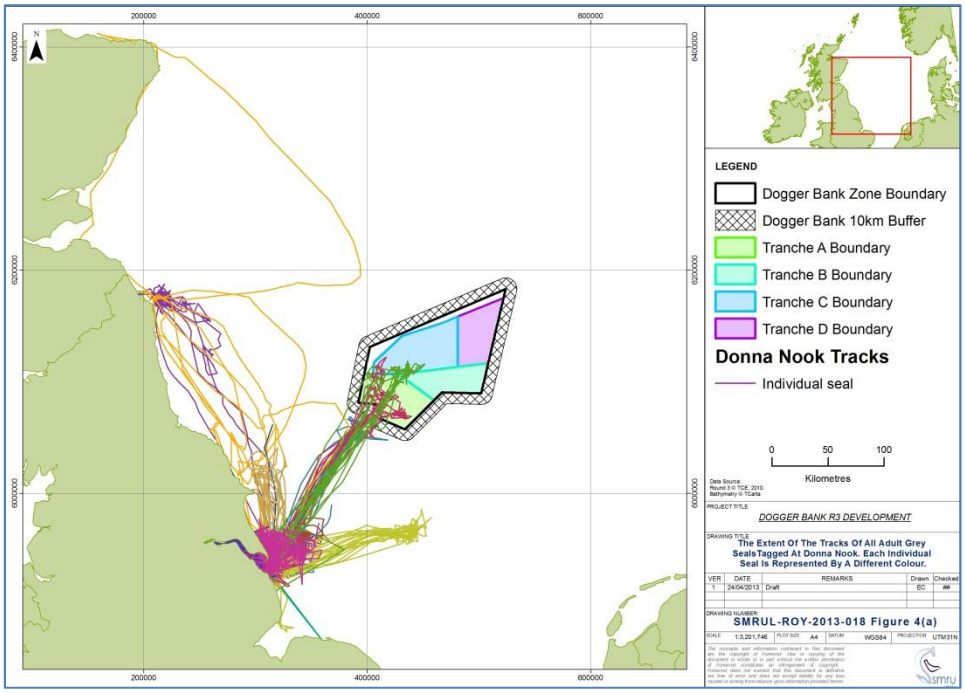


Figure 3. Tracks of all grey seals tagged at the Farnes. Each seal is represented by a different colour. The figures show (a) the extent of tracks, and (b) tracks in the vicinity of the Dogger Bank Zone plus buffer.

(a)



(b)

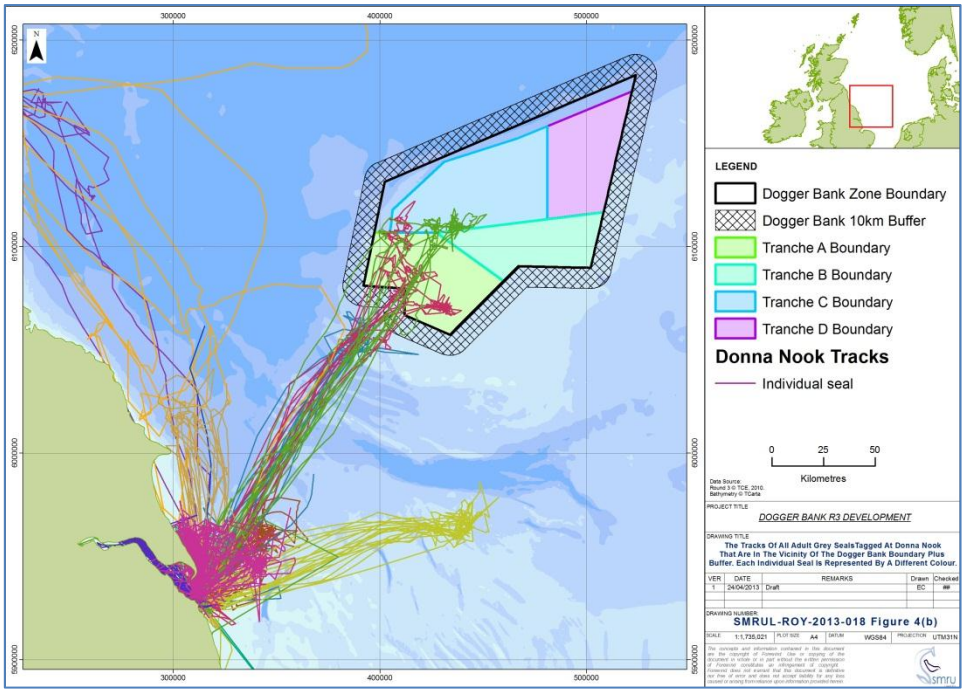
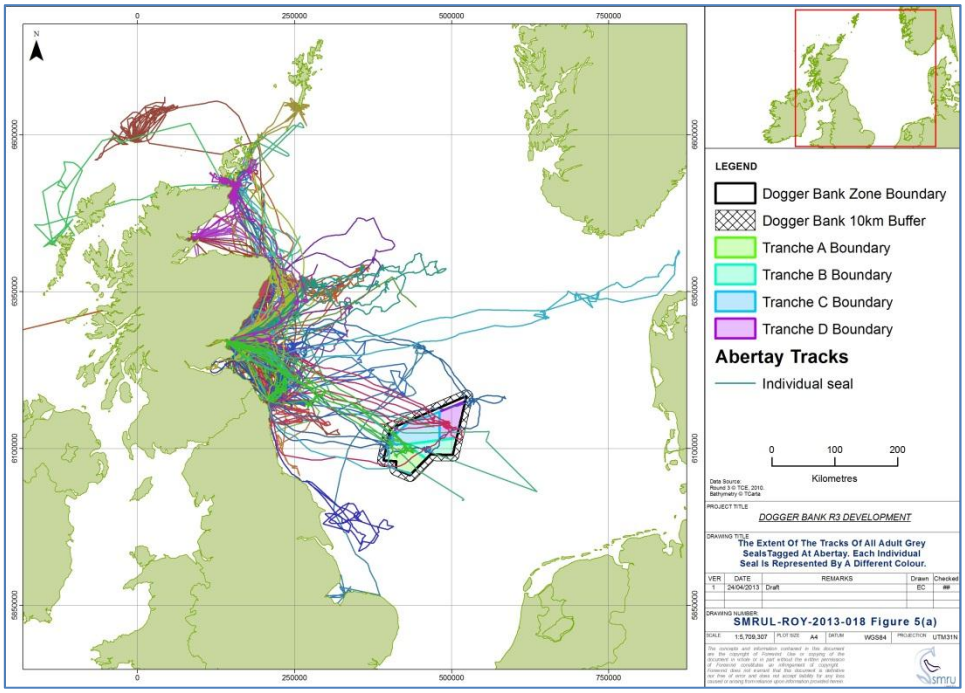


Figure 4. Tracks of all grey seals tagged at Donna Nook. Each seal is represented by a different colour. The figures show (a) the extent of tracks, and (b) tracks in the vicinity of the Dogger Bank Zone boundary buffer.

(a)



(b)

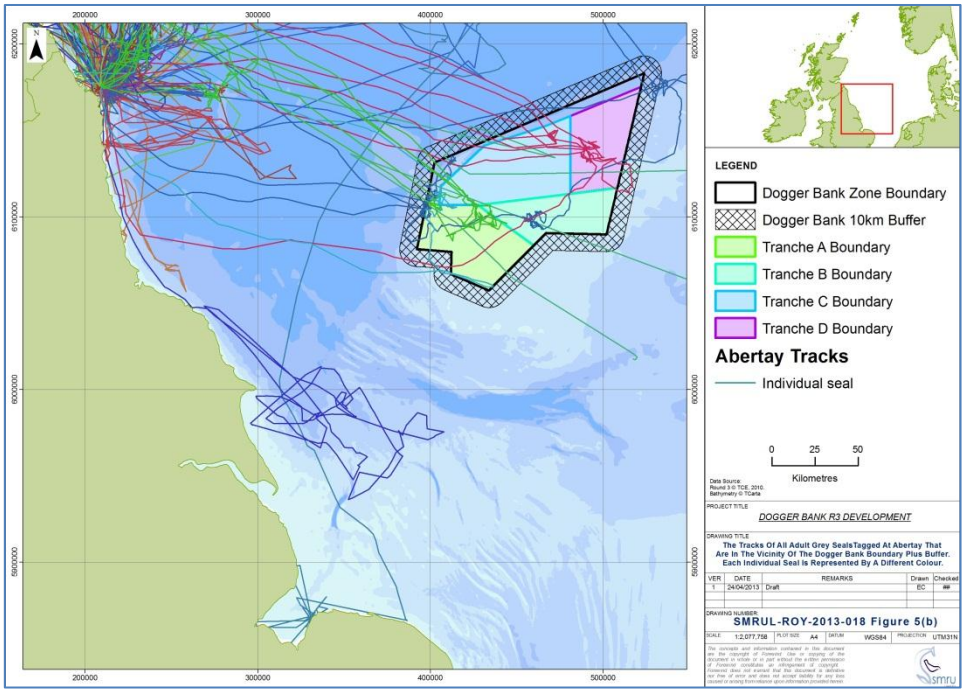


Figure 5. Tracks of all grey seals tagged at Abertay. Each seal is represented by a different colour. The figures show (a) the extent of tracks, and (b) tracks in the vicinity of the Dogger Bank Zone boundary buffer.

Grey seals: at-sea locations

Nineteen animals; eight pups (one from the Farnes and seven from the Isle of May) and eleven seals aged 1+ (four from the Farnes, two from Donna Nook and five from the Abertay region), had locations within the Dogger Bank Zone plus 10km buffer (Table 1 and Table 5).

Ten animals; four pups from the Isle of May and six seals aged 1+ (two from the Farnes, one from Donna Nook and three from the Abertay region) had locations within the Dogger Bank Tranche B boundary plus 10km buffer (Table 2 and Table 6).

Fifteen animals; four pups (one from the Farnes and three from the Isle of May) and eleven seals aged 1+ (four from the Farnes, two from Donna Nook and five from the Abertay region), had locations within the Dogger Bank Tranche C boundary plus 10km buffer (Table 3 and Table 7).

Ten animals; five pups from the Isle of May and five seals aged 1+ (two from the Farnes and three from the Abertay Region), had locations within the Dogger Bank Tranche D boundary plus 10km buffer (Table 4 and Table 8).

Pups

For the pups whose tracks overlapped, the extent of overlap was relatively low, approximately 9% of locations for the pup tagged at the Farnes and between 1 and 10% of locations for the pups tagged at the Isle of May were within the Dogger Bank Zone 10km buffer (Table 1).

For the Dogger Bank Tranche B boundary 10km buffer the extent of overlap is very low and is between 0.1 and 1.2% of locations for the pups whose tracks overlapped (Table 2). For the Dogger Bank Tranche C boundary 10km buffer the extent of overlap was 1% of locations for the pup tagged at the Farnes and between 1 and 8% of locations for the pups tagged at the Isle of May (Table 3). For the Dogger Bank Tranche D boundary 10km buffer the extent of overlap is between 0.5 and 4% of locations for the pups whose tracks overlapped (Table 4).

Farnes

For the four seals aged 1+ tagged at the Farnes, the percentage locations within the Dogger Bank Zone plus buffer ranged from 3 to 38% (Table 5). The average across all seals was 16% or 17% depending on how at-sea locations were defined.

The percentage locations for the two seals tagged at the Farnes aged 1+ that entered the Dogger Bank Tranche B boundary plus 10km buffer ranged from 1 to 2.7% and the average was 1.4% or 2.2% depending on how at-sea locations were defined (Table 6).

The percentage locations for the four seals tagged at the Farnes aged 1+ that entered the Dogger Bank Tranche C boundary plus 10km buffer ranged from 0.5% to 25% and the average was 8.1% or 8.5% depending on how at-sea locations were defined (Table 7).

The percentage locations for the two seals tagged at the Farnes aged 1+ that entered the Dogger Bank Tranche D boundary plus 10km buffer ranged from 0.2% to 0.7% and the average was 0.25% or 0.45% depending on how at-sea locations were defined (Table 8).

Donna Nook

For the two seals aged 1+ tagged at Donna Nook which entered the Dogger Bank Zone plus 10km buffer area, the average percentage overlap was 57 or 59% depending on how at sea locations were defined (Table 5).

The percentage locations for the individual seal tagged at Donna Nook aged 1+ that entered the Dogger Bank Tranche B boundary plus 10km buffer ranged from 33 to 34% (Table 6).

The percentage locations for the two seals aged 1+ tagged at Donna Nook that entered the Dogger Bank Tranche C boundary plus 10km buffer ranged from 15 to 43% and the average was 28.5% or 29.5% depending on how at-sea locations were defined, which is approximately half of the percentage overlap found for these seals in the Dogger Bank Zone plus 10km buffer zone (Table 7).

Abertay

For the seals aged 1+ tagged at Abertay, the degree of overlap in the Dogger Bank Zone plus 10km buffer was lower, ranging from 2-45% across the five individual seals (Table 5). The average across the five seals was approximately 21% or 22% depending on how at-sea locations were defined.

The percentage locations for the three seals aged 1+ tagged at Abertay that entered the Dogger Bank Tranche B boundary plus 10km buffer ranged from 3 to 21% and the average was approximately 11% or 12% depending on how at-sea locations were defined (Table 6).

The percentage locations for the five seals aged 1+ tagged at Abertay that entered the Dogger Bank Tranche C boundary plus 10km buffer ranged from 1.5 to 32 % and the average was approximately 14% or 15% depending on how at-sea locations were defined (Table 7).

The percentage locations for the three seals aged 1+ tagged at Abertay that entered the Dogger Bank Tranche D boundary plus 10km buffer ranged from 0.4 to 32% and the average was 11.5% (Table 8).

It should be noted that these percentages are of at-sea locations rather than time at-sea. Locations are transmitted at irregular intervals, with between 1 to 21 locations transmitted per day for these animals. The median number of location fixes per day, for these tags, was between 5 and 12.

Isle of May – Adults

For the seals which had both locations within 5km of The Isle of May, and within the Dogger Bank Zone plus buffer, the degree of overlap with the Isle of May was low – the seal that had 25% of it's at-sea locations in the Dogger site (ref 8 in Table 5), had only 0.2% of locations within 5km of the Isle of May. The seal that had 5% of at-sea locations in the Dogger site (ref 10 in Table 5) had 2.5% of locations within 5km of the Isle of May.

Table 1. This table includes tagged grey seal pups which had locations within the Dogger Bank Zone boundary 10km buffer. The tagging location, number of locations within the polygon, and the total number of location fixes are shown. The maximum and minimum numbers of at-sea locations are shown along with the resulting minimum and maximum percentage of at-sea locations which were within the polygon.

reference	tagging location	number of locations				percentage of at-sea locations within polygon (%)	
		Within polygon	total	minimum at-sea	maximum at-sea	minimum	maximum
1	Farnes	18	207	192	207	8.7%	9.4%
2	Isle of May	20	1788	1677	1677	1.2%	1.2%
3	Isle of May	53	844	748	748	7.1%	7.1%
4	Isle of May	2	553	471	547	3.7%	4.2%
5	Isle of May	103	1203	983	983	10.5%	10.5%
6	Isle of May	20	1156	1036	1036	1.9%	1.9%
7	Isle of May	18	469	447	447	4.0%	4.0%
8	Isle of May	9	709	697	697	1.3%	1.3%

Table 2. This table includes tagged grey seal pups which had locations within the Dogger Bank Tranche B boundary 10km buffer. The tagging location, number of locations within the polygon, and the total number of location fixes are shown. The maximum and minimum numbers of at-sea locations are shown along with the resulting minimum and maximum percentage of at-sea locations which were within the polygon.

reference	tagging location	number of locations				percentage of at-sea locations within polygon (%)	
		Within polygon	total	minimum at-sea	maximum at-sea	minimum	maximum
2	Isle of May	5	1788	1677	1677	0.3%	0.3%
3	Isle of May	9	844	748	748	1.2%	1.2%
5	Isle of May	3	1203	983	983	0.3%	0.3%
8	Isle of May	1	709	697	697	0.1%	0.1%

Table 3. This table includes tagged grey seal pups which had locations within the Dogger Bank Tranche C boundary 10km buffer. The tagging location, number of locations within the polygon, and the total number of location fixes are shown. The maximum and minimum numbers of at-sea locations are shown along with the resulting minimum and maximum percentage of at-sea locations which were within the polygon.

reference	tagging location	number of locations				percentage of at-sea locations within polygon (%)	
		Within polygon	total	minimum at-sea	maximum at-sea	minimum	maximum
1	Farnes	2	207	192	207	1.0%	1.0%
3	Isle of May	22	844	748	748	2.9%	2.9%
5	Isle of May	76	1203	983	983	7.7%	7.7%
8	Isle of May	7	709	697	697	1.0%	1.0%

Table 4. This table includes tagged grey seal pups which had locations within the Dogger Bank Tranche D boundary 10km buffer. The tagging location, number of locations within the polygon, and the total number of location fixes are shown. The maximum and minimum numbers of at-sea locations are shown along with the resulting minimum and maximum percentage of at-sea locations which were within the polygon.

reference	tagging location	number of locations				percentage of at-sea locations within polygon (%)	
		Within polygon	total	minimum at-sea	maximum at-sea	minimum	maximum
2	Isle of May	13	1788	1677	1677	0.8%	0.8%
3	Isle of May	30	844	748	748	4.0%	4.0%
5	Isle of May	34	1203	983	983	3.5%	3.5%
7	Isle of May	11	469	447	447	2.5%	2.5%
8	Isle of May	4	709	697	697	0.6%	0.6%

Table 5. This table includes tagged grey seals aged 1+ which had locations within the Dogger Bank Zone boundary 10km buffer. The tagging location, number of locations within the polygon, and total number of location fixes are shown. The maximum and minimum numbers of at-sea locations are shown along with the resulting minimum and maximum percentage of at-sea locations which were within the polygon. Mean values per region are also given. The seals in italics are those which also had locations within 5km of the Isle of May and the figure in brackets is the percentage of all locations that these represent.

ref	tagging location	number of locations				percentage of at-sea locations within Polygon (%)	
		Within polygon	total	min at-sea	max at-sea	Min	Max
1	Farnes	24	854	291	794	3.0%	8.2%
2	Farnes	548	1634	1408	1438	38.1%	38.9%
3	Farnes	146	1539	1350	1370	10.7%	10.8%
4	Farnes	151	1566	1418	1444	10.5%	10.6%
	Farnes Mean					**15.6**	**17.2**
5	Donna Nook	587	1079	909	939	62.5%	64.6%
6	Donna Nook	504	1141	942	977	51.6%	53.5%
	Donna Nook Mean					**57.0**	**59.0**
7	Abertay	15	683	273	683	2.2%	5.5%
8	*Abertay (0.2%)*	*577*	*2607*	*2252*	*2350*	24.6%	25.6%
9	Abertay	390	1036	860	864	45.1%	45.3%
10	*Abertay (2.5%)*	*87*	*1820*	*1663*	*1678*	5.2%	5.2%
11	Abertay	158	636	523	555	28.5%	30.2%
	Abertay Mean					**21.1**	**22.4**

Table 6. This table includes tagged grey seals aged 1+ which had locations within the Dogger Bank Tranche B boundary 10km buffer. The tagging location, number of locations within the polygon, and total number of location fixes are shown. The maximum and minimum numbers of at-sea locations are shown along with the resulting minimum and maximum percentage of at-sea locations which were within the polygon. Mean values per region are also given. The seals in italics are those which also had locations within 5km of the Isle of May and the figure in brackets is the percentage of all locations that these represent.

ref	tagging location	number of locations				percentage of at-sea locations within Polygon (%)	
		Within polygon	total	min at-sea	max at-sea	Min	Max
1	Farnes	8	854	291	794	1.0%	2.7%
2	Farnes	24	1634	1408	1438	1.7%	1.7%
	Farnes Mean					**1.4**	**2.2**
6	Donna Nook	322	1141	942	977	33.0%	34.2%
	Donna Nook Mean					**33.0**	**34.2**
8	*Abertay (0.2%)*	*263*	*2607*	*2252*	*2350*	11.2%	11.7%
9	Abertay	25	1036	860	864	2.9%	2.9%
11	Abertay	112	636	523	555	20.2%	21.4%
	Abertay Mean					**11.4**	**12.0**

Table 7. This table includes tagged grey seals aged 1+ which had locations within the Dogger Bank Tranche C boundary 10km buffer. The tagging location, number of locations within the polygon, and total number of location fixes are shown. The maximum and minimum numbers of at-sea locations are shown along with the resulting minimum and maximum percentage of at-sea locations which were within the polygon. Mean values per region are also given. The seals in italics are those which also had locations within 5km of the Isle of May and the figure in brackets is the percentage of all locations that these represent.

ref	tagging location	number of locations				percentage of at-sea locations within Polygon (%)	
		Within polygon	total	min at-sea	max at-sea	Min	Max
1	Farnes	5	854	291	794	0.6%	1.7%
2	Farnes	348	1634	1408	1438	24.2%	24.7%
3	Farnes	47	1539	1350	1370	3.4%	3.5%
4	Farnes	60	1566	1418	1444	4.2%	4.2%
	Farnes Mean					**8.1**	**8.5**
5	Donna Nook	144	1079	909	939	15.3%	15.8%
6	Donna Nook	406	1141	942	977	41.6%	43.1%
	Donna Nook Mean					**28.5**	**29.5**
7	Abertay	11	683	273	683	1.6%	4.0%
8	*Abertay (0.2%)*	*245*	*2607*	*2252*	*2350*	10.4%	10.9%
9	Abertay	273	1036	860	864	31.6%	31.7%
10	*Abertay (2.5%)*	*55*	*1820*	*1663*	*1678*	3.3%	3.3%
11	Abertay	126	636	523	555	22.7%	24.1%
	Abertay Mean					**13.9**	**14.8**

Table 8. This table includes tagged grey seals aged 1+ which had locations within the Dogger Bank Tranche D boundary 10km buffer. The tagging location, number of locations within the polygon, and total number of location fixes are shown. The maximum and minimum numbers of at-sea locations are shown along with the resulting minimum and maximum percentage of at-sea locations which were within the polygon. Mean values per region are also given. The seals in italics are those which also had locations within 5km of the Isle of May and the figure in brackets is the percentage of all locations that these represent.

ref	tagging location	number of locations				percentage of at-sea locations within Polygon (%)	
		Within polygon	total	min at-sea	max at-sea	Min	Max
1	Farnes	2	854	291	794	0.3%	0.7%
4	Farnes	3	1566	1418	1444	0.2%	0.2%
	Farnes Mean					**0.25**	**0.45**
7	Abertay	1	683	273	683	0.4%	0.1%
8	*Abertay (0.2%)*	*49*	*2607*	*2252*	*2350*	2.1%	2.2%
9	Abertay	278	1036	860	864	32.2%	32.3%
	Abertay Mean					**11.5**	**11.5**

3.2. Harbour Seals

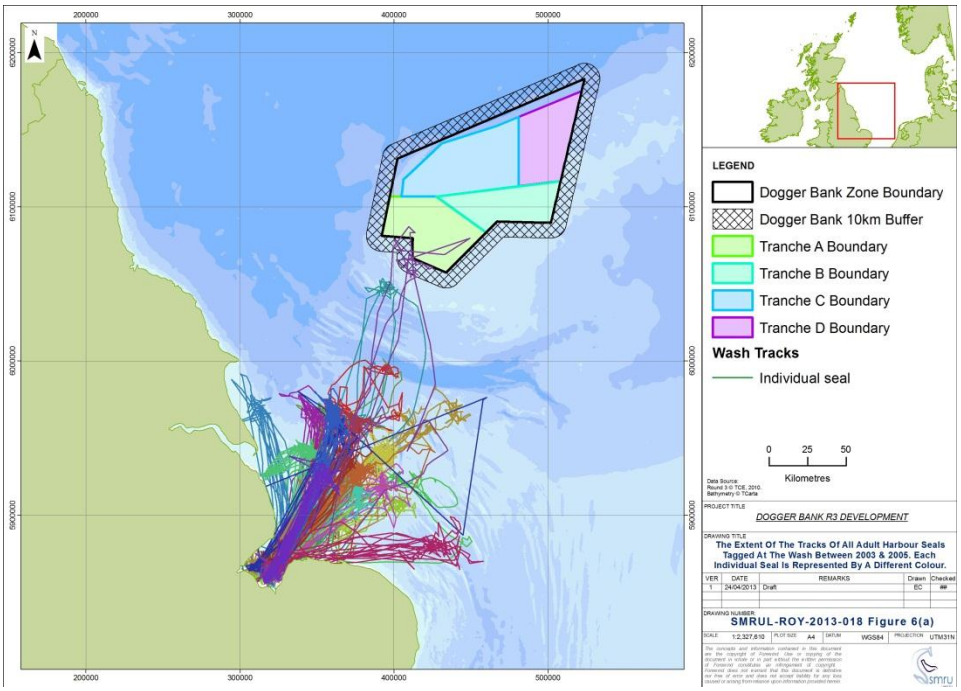
The Wash

There were 24 harbour seals, aged one year and above, tagged (Argos) in the Wash between 2003 and 2005. These animals had a median tag duration of 137 days (range: 77 – 226). There were locations or tracks recorded inside the Dogger Bank Zone boundary 10km buffer for one (4%) of these 24 seals (Figure 6).

Of the single seal that overlapped with the polygon, between 20% and 35% of at sea locations were within the windfarm depending how at sea locations were defined. These locations were in the Tranche A site which was reported on in an earlier report.

There has been a more recent deployment of tags on harbour seals in the Wash – in January 2012 25 seals aged 1+ were tagged with GPS phone tags by the Sea Mammal Research Unit as part of a DECC funded study into the impact of pile driving on seal behaviour. These data are currently being analysed by the Sea Mammal Research Unit but were not available at for inclusion in this report.

(a)



(b)

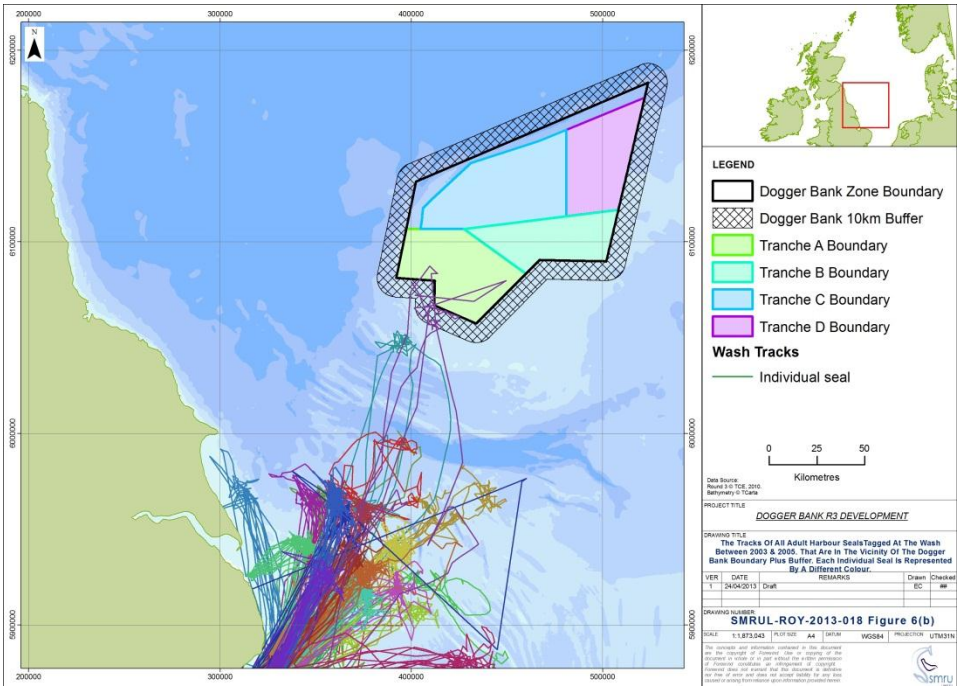


Figure 6. Tracks of all harbour seals tagged at the Wash. Each seal is represented by a different colour. The figures show (a) the extent of tracks, and (b) tracks in the vicinity of the Dogger Bank Zone boundary buffer.

Table 9. This table includes tagged harbour seals aged 1+ which had locations within the Dogger Bank Zone boundary plus 10km buffer. The tagging location, number of locations within the polygon, and total number of location fixes are shown. The maximum and minimum numbers of at-sea locations are shown along with the resulting minimum and maximum percentage of at-sea locations within the polygon.

reference	tagging location	number of locations				percentage of at-sea locations within Polygon (%)	
		Within polygon	total	minimum at-sea	maximum at-sea	minimum	maximum
1	The Wash	59	388	220	168	20.1	35.1

4. Software

All data filtering and analyses were carried out using the statistical software R (R Development Core Team, 2008). A number of packages were used within R and are listed below. The maps were generated using ArcGIS 9.3.

5. Projection

All figures are in the projection Universal Transverse Mercator (UTM) - zone 31 North. Datum WGS 1984.

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