

## APPENDIX 15-B SEAL TELEMETRY ANALYSIS





# SMRU Consulting

understand ♦ assess ♦ mitigate

## Provision of Seal Telemetry Data: Nigg Bay Data Request

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## Contents

Contents.....	2
Figures.....	2
Tables.....	3
1 Introduction .....	4
2 Methods.....	7
2.1 Telemetry data.....	7
2.2 Database .....	7
2.3 SACs.....	7
2.4 Quantifying connectivity.....	8
3 Results.....	8
3.1 Grey Seals.....	8
3.2 Harbour Seals.....	19
4 Conclusions .....	22
5 Software.....	22
6 Projection.....	22
7 SAC site accounts .....	22
7.1 Grey Seal SACs.....	22
7.2 SACs where grey seals are a qualifying feature .....	23
7.3 Harbour Seal SACs.....	23
8 Literature Cited .....	23
9 Glossary of Terms, Acronyms and Abbreviations .....	25

## Figures

FIGURE 1 THE FOUR SEAL SACs LOCATED ON THE EAST COAST IDENTIFIED AS AREAS OF INTEREST. ....	5
FIGURE 2 LOCATION OF THE NIGG BAY STUDY AREA. ....	6
FIGURE 3 TRACKS OF ALL GREY SEALS THAT ENTERED THE NIGG BAY STUDY AREA. ....	9
FIGURE 4 GREY SEALS TAGGED AT GREY SEAL SACs THAT ENTERED THE NIGG BAY STUDY AREA. ....	10
FIGURE 5 ALL GREY SEAL TRACKS WITHIN THE NIGG BAY STUDY AREA (BLUE LINE = ADULT, RED LINE = PUP, PURPLE LINE = UNKNOWN AGE). ....	13
FIGURE 6 GREY SEALS TAGGED AT A GREY SEAL SAC THAT ENTERED THE NIGG BAY STUDY AREA (BLUE LINES = ADULT, RED/ORANGE LINES = PUP) .....	14
FIGURE 7 PERCENTAGE OF GREY SEAL LOCATIONS THAT WERE RECORDED IN THE NIGG BAY STUDY AREA. ....	17



FIGURE 8 CONNECTIVITY BETWEEN HARBOUR SEALS IN THE NIGG BAY STUDY AREA AND HARBOUR SEAL SACs. .... 20

FIGURE 9 TRACK AND LOCATIONS OF THE SINGLE TAGGED HARBOUR SEAL THAT ENTERED THE NIGG BAY STUDY AREA. 21

## Tables

TABLE 1 DETAILS OF ALL GREY SEALS TAGGED AT GREY SEAL SACs THAT ENTERED THE NIGG BAY STUDY AREA. .... 11

TABLE 2 DETAILS OF ALL GREY SEALS NOT TAGGED AT GREY SEAL SACs THAT ENTERED THE NIGG BAY STUDY AREA.

WHETHER THEY ALSO VISITED A GREY SEAL SAC DURING THEIR DEPLOYMENT IS ALSO NOTED. PF = PRIMARY

FEATURE. .... 16

TABLE 3 MINIMUM, AVERAGE AND MAXIMUM NUMBER OF LOCATIONS RECORDED IN THE NIGG BAY STUDY AREA

ACROSS SEALS, PRESENTED BY SEAL TAGGING LOCATION. .... 18

TABLE 4 DETAILS OF THE SINGLE HARBOUR SEAL THAT ENTERED THE NIGG BAY STUDY AREA. .... 19



## 1 Introduction

SMRU Consulting was contracted by Furgro EMU Limited for the provision of baseline seal data in and around the proposed development at Nigg Bay. This included seal data from the two harbour seal Special Areas of Conservation (SACs) and the two grey seal SACs identified by Fugro Emu Ltd as areas of interest (Figure 1).

This report provides the results of the following tasks:

- Provision of seal satellite tracking data from tagged harbour and grey seals (either animals tagged at the SACs and visiting the site, or visiting the site and also hauling out at the SACs).
- Provision of seal satellite tracking data from all harbour or grey seals which cross the development site regardless of where tagged, if not already included in the datasets specified above.
- A basic quantification of the degree of connectivity between the development site and important haul out sites.

The 'site' for which seal data was analysed in this report was the Nigg Bay study area ( Figure 2) as defined by Fugro Emu Ltd.

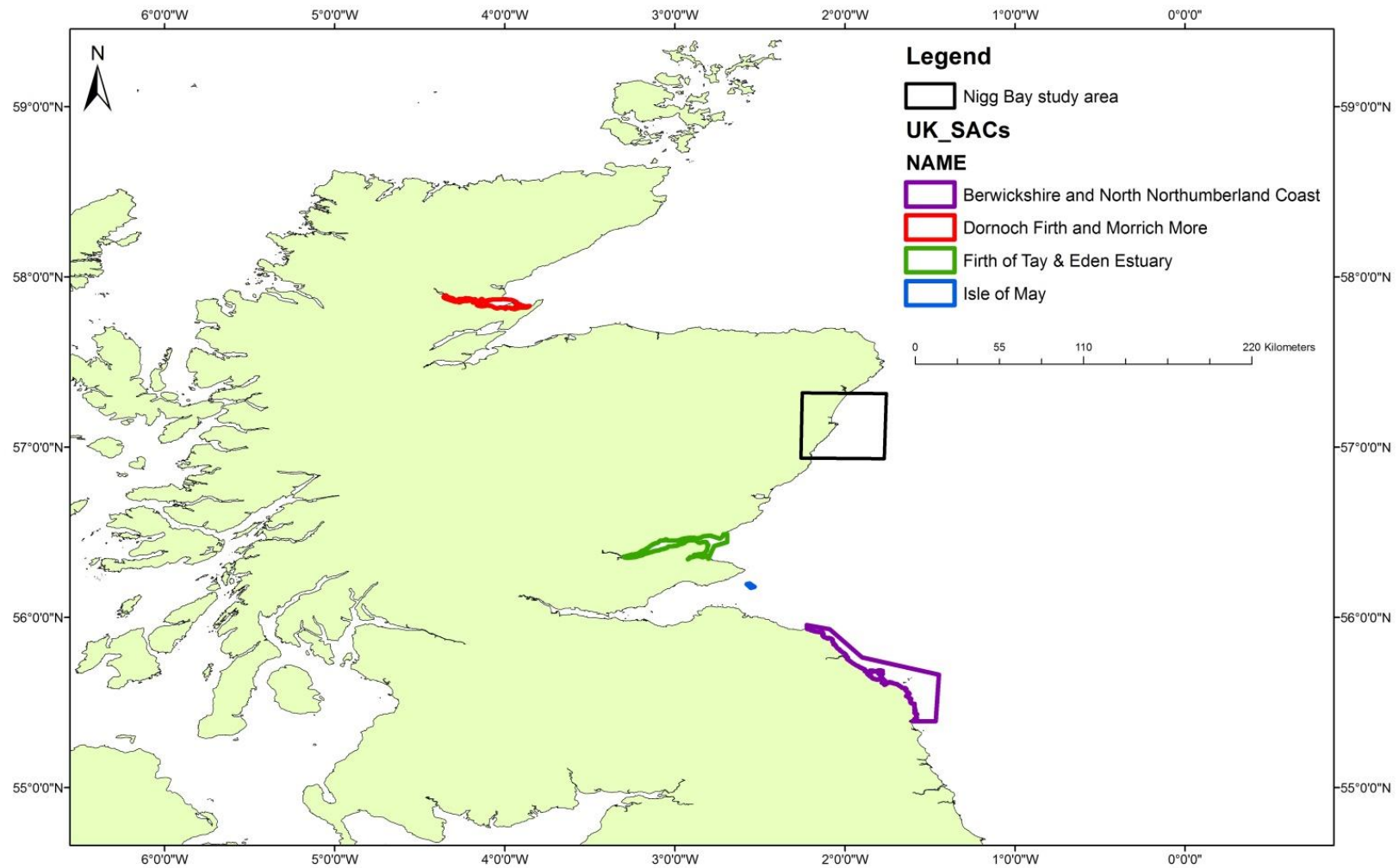


Figure 1 The four seal SACs located on the East Coast identified as areas of interest.

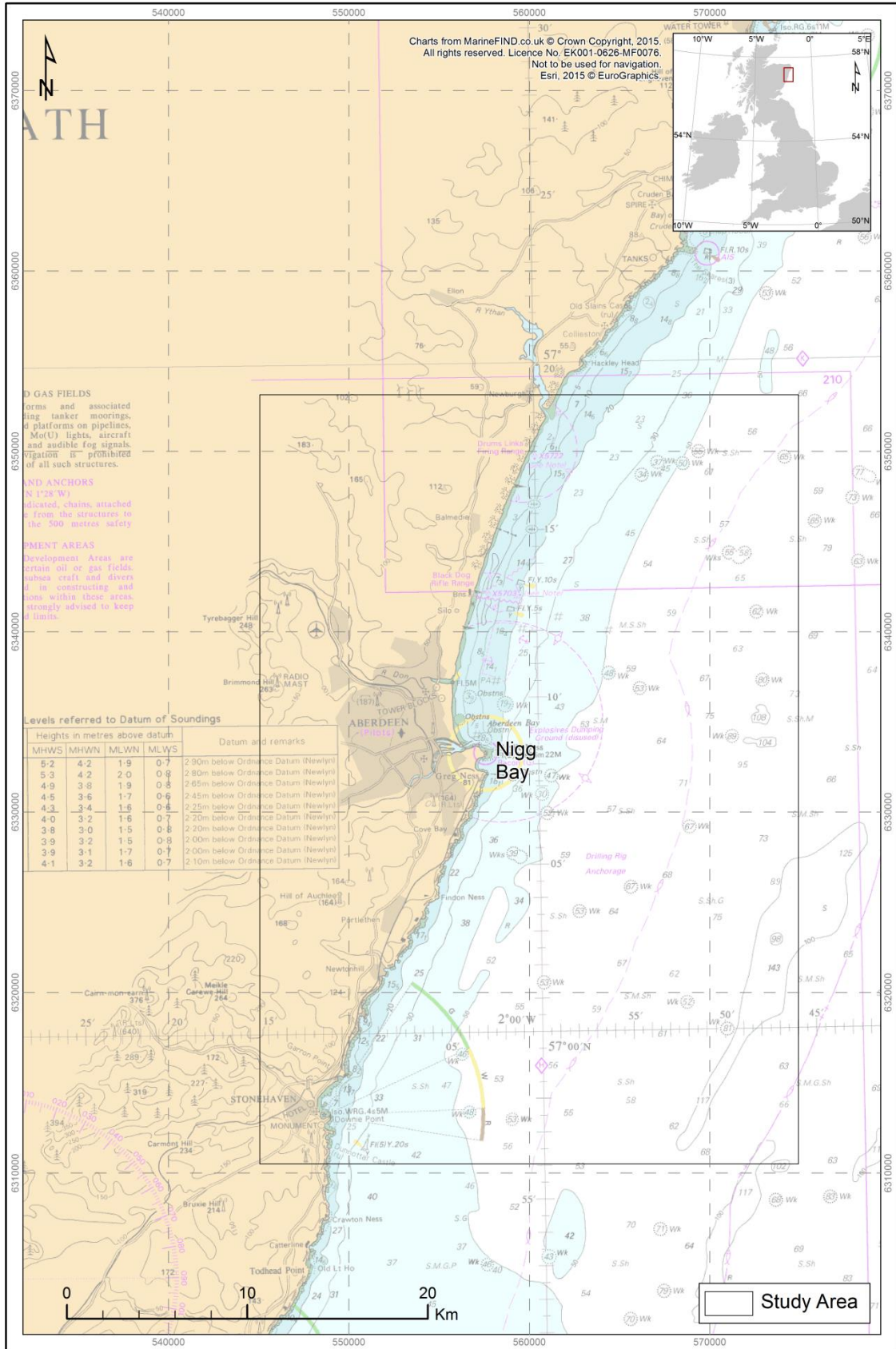


Figure 2 Location of the Nigg Bay study area.





## 2 Methods

### 2.1 Telemetry data

The Sea Mammal Research Unit (SMRU) has deployed telemetry tags on grey seals (*Halichoerus grypus*) and harbour seals (*Phoca vitulina*) in the UK since 1988. 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 differ by their data transmission methods. 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).

### 2.2 Database

The telemetry database was queried to determine whether any seals had any degree of overlap with the Nigg Bay study area provided by Fugro Emu Ltd (Figure 2). This was conducted by plotting all seal tracks and locations in ArcGIS and selecting only those that crossed into the Nigg Bay study area polygon. These selected tracks and locations that crossed into the Nigg Bay study area were then divided using the database into those that were tagged at seal SACs, those that visited SACs and those that did not visit any SACs throughout the tagging duration.

### 2.3 SACs

There are four seal SACs identified by Fugro Emu Ltd located on the East Coast that they identified as areas of interest (Figure 1). These include two grey seal SACs where grey seals have been tagged: adult seals tagged at the Berwickshire & North Northumberland Coast (Farnes Island haul out and breeding colony), and pups have been tagged at the Isle of May (haul out and breeding colony). There are also two harbour seal SACs within the East Coast area of interest where harbour seals have been tagged: the Dornoch Firth & Morrich More (haul out and breeding colony) and the Firth of Tay and Eden Estuary (Abertay haul out region).

Grey seals have been tagged at SACs where they are listed as a qualifying feature such as the Humber Estuary SAC. 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.

#### **2.4 Quantifying connectivity**

For all tagged animals which had locations within the Nigg Bay study area, the percentage of locations within the area was calculated as a proportion of the total number of locations from each track. Although there is likely to be a good relationship between the time an animal spends in an area and the number of location fixes, it is important to note that 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, these include such things as satellite availability and the duration animals spend at the surface between dives. As such there may be unquantifiable biases in these metrics.

## **3 Results**

### **3.1 Grey Seals**

Of the 265 grey seals tagged by SMRU between 1988 and 2012, a total of 35 entered the Nigg Bay study area between 1997 and 2010 (Table 1, Figure 3). Of these, 13 were tagged at grey seal SACs – with eight pups tagged at the Isle of May SAC (grey seal primary feature), four adults tagged at the Berwickshire & North Northumberland Coast SAC (grey seal primary feature) and one at the Humber Estuary SAC (grey seal qualifying feature) (Table 1, Figure 4).

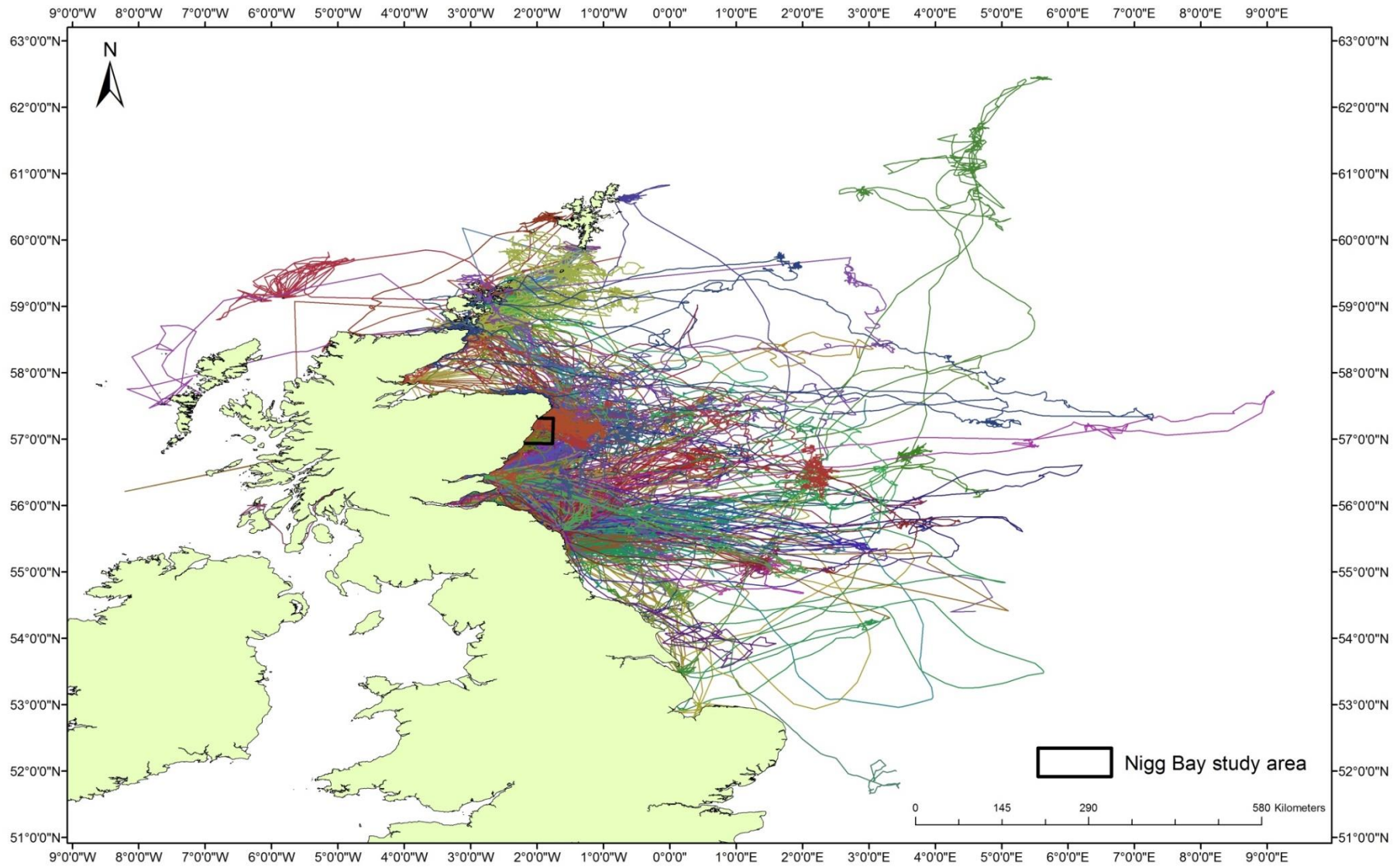


Figure 3 Tracks of all grey seals that entered the Nigg Bay study area.

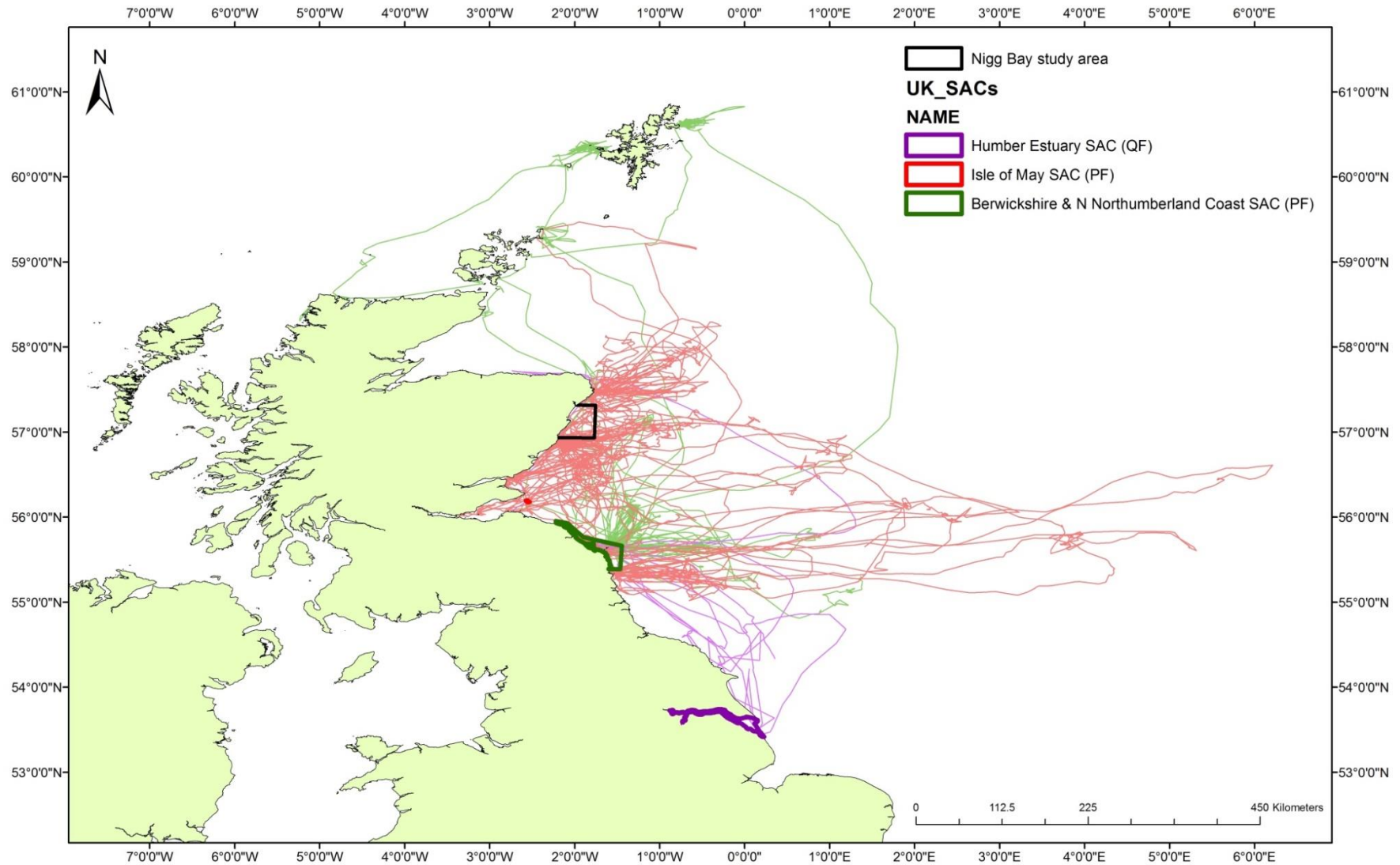


Figure 4 Grey seals tagged at grey seal SACs that entered the Nigg Bay study area.

**Table 1 Details of all grey seals tagged at grey seal SACs that entered the Nigg Bay study area.**

Tagging Location	Seal ID	Tagging Date	Tag Type	Tag Sub-type	Age	Sex	# Locations	# Locations in Nigg Bay study area	% locations in Nigg Bay study area	SAC Primary Feature	Qualifying Feature
Donna Nook	hg11-Earl-05	16/07/2005	ARGOS	SRDL	1+	M	325	4	1.2	No	Humber Estuary SAC
Farnes	fa3-1546-93	15/12/1993	ARGOS	SRDL	pup	F	207	2	1.0	Berwickshire & North Northumberland Coast SAC	-
	ab2-2849-97	16/07/1997	ARGOS	WLC_neck	1+	M	956	1	0.1		
	ab2-28503-97	16/07/1997	ARGOS	SRDL	1+	M	419	4	1.0		
	gp13b-480-08	26/04/2008	ARGOS	SRDL	1+	F	2175	6	0.3		
Isle of May	im4-Hubble-01	03/12/2001	ARGOS	SRDL	pup	M	1781	306	17.2	Isle of May SAC	-
	im4-Ikea-01	01/12/2001	ARGOS	SRDL	pup	F	509	52	10.2		
	im4-Pascal-01	14/12/2001	ARGOS	SRDL	pup	F	844	12	1.4		
	im4-Queenie-01	18/12/2001	ARGOS	SRDL	pup	F	2284	55	2.4		
	im5-Caveman-02	09/12/2002	ARGOS	SRDL	pup	M	1284	34	2.6		
	im5-Lassie-02	28/11/2002	ARGOS	SRDL	pup	F	345	25	7.2		
	im5-OliveOil-02	29/11/2002	ARGOS	SRDL	pup	F	1156	6	0.5		
	im5-Woody-02	04/12/2002	ARGOS	SRDL	pup	M	332	16	4.8		



It is apparent from the inset in Figure 5 that the tracks of both adult and pup grey seals cross the Nigg Bay development area, however, it appears from Figure 5 that many adult grey seals transit along the coast, passing just offshore of the Nigg Bay development, while grey seal pups tend to spend most of their time off Newburgh to the north of the development at the top of the Nigg Bay study area (Figure 5 green circle) or just south of Stonehaven at the south of the Nigg Bay study area (Figure 5 green square).

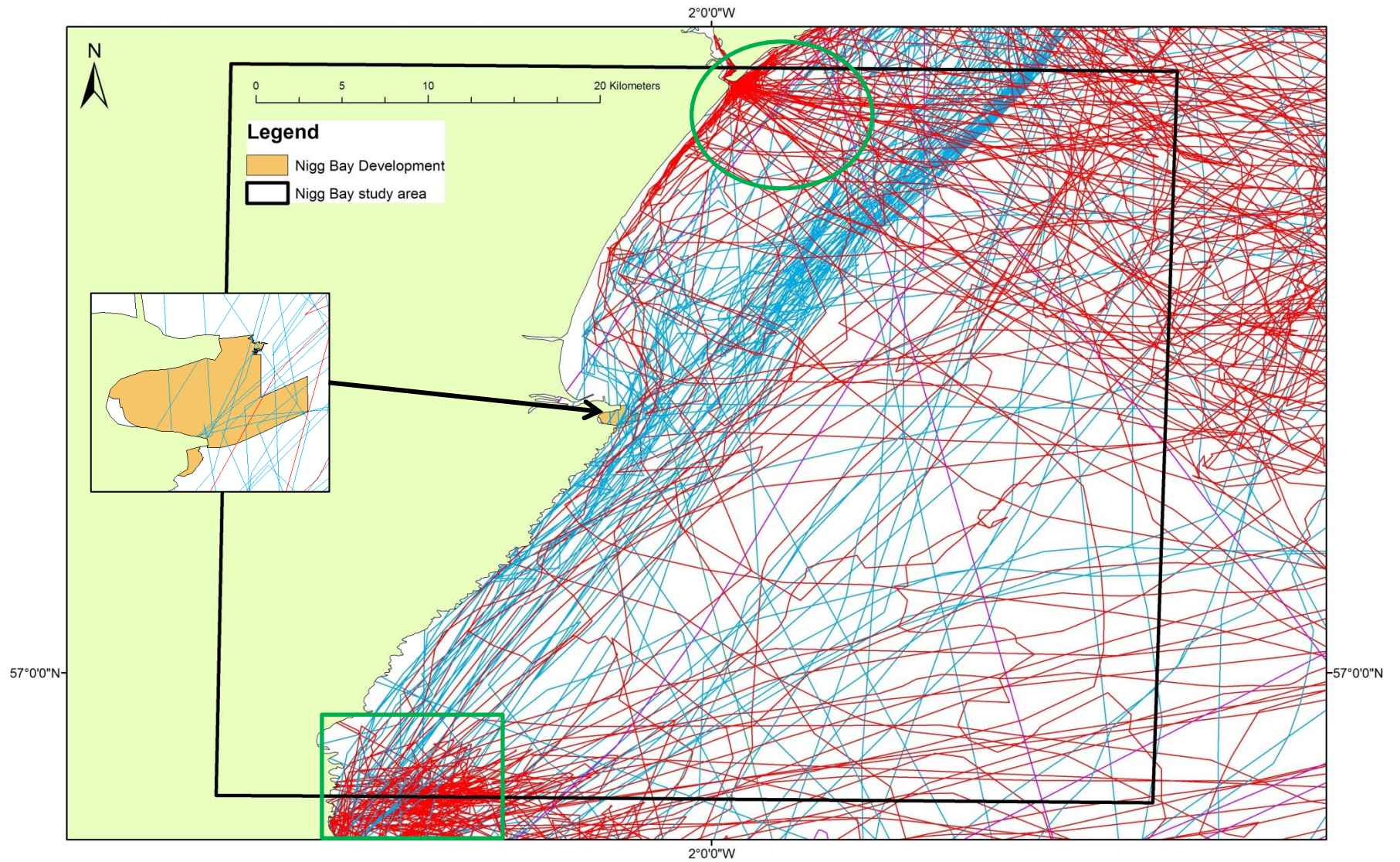


Figure 5 All grey seal tracks within the Nigg Bay study area (blue line = adult, red line = pup, purple line = unknown age).

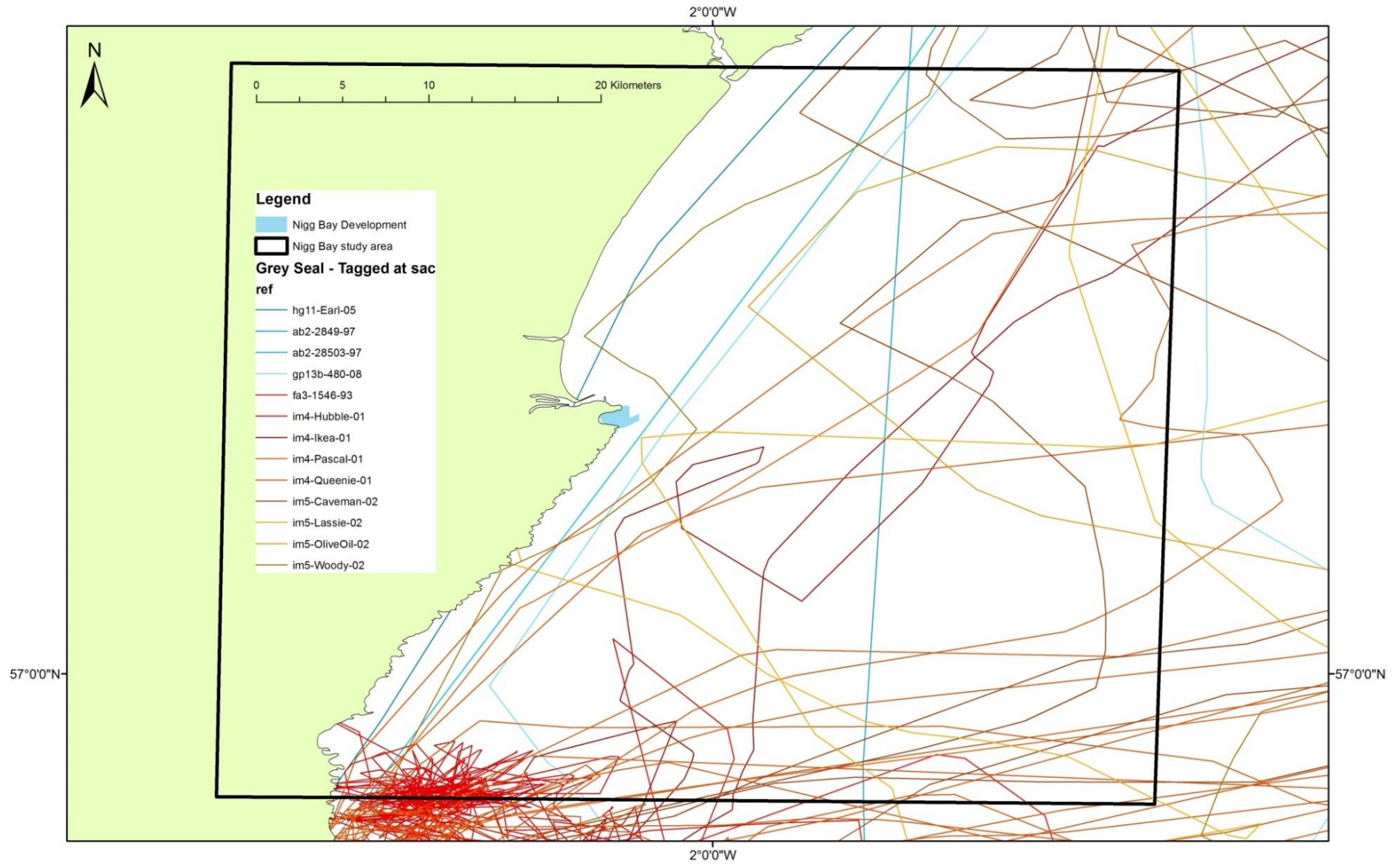


Figure 6 Grey seals tagged at a grey seal SAC that entered the Nigg Bay study area (blue lines = adult, red/orange lines = pup)





There were also nine grey seals which entered the Nigg Bay study area, that were not tagged at a grey seal SAC, but that visited grey seal SACs (Table 2). These included seals that were tagged at Abertay and also visited grey seal SACs including Berwickshire & North Northumberland Coast SAC, The Isle of May SAC, the Monach Islands SAC and the Faray & Holm of Faray SAC and one seal that was tagged at Sanday which visited the Faray & Holm of Faray SAC (Table 2). This shows that there is connectivity between seals that enter the Nigg Bay study area and grey seal SACs that are much further away from the development such as the Monarch Island SAC (Western Isles) and the Faray & Holm of Faray SAC (Orkney Islands).

A further 13 tagged grey seals never recorded any tracks or locations in a grey seal SAC throughout the tag duration, however, this does not mean they never visit grey seal SACs, only that they didn't during the tagging duration.

**Table 2 Details of all grey seals NOT tagged at grey seal SACs that entered the Nigg Bay study area. Whether they also visited a grey seal SAC during their deployment is also noted. PF = Primary feature.**

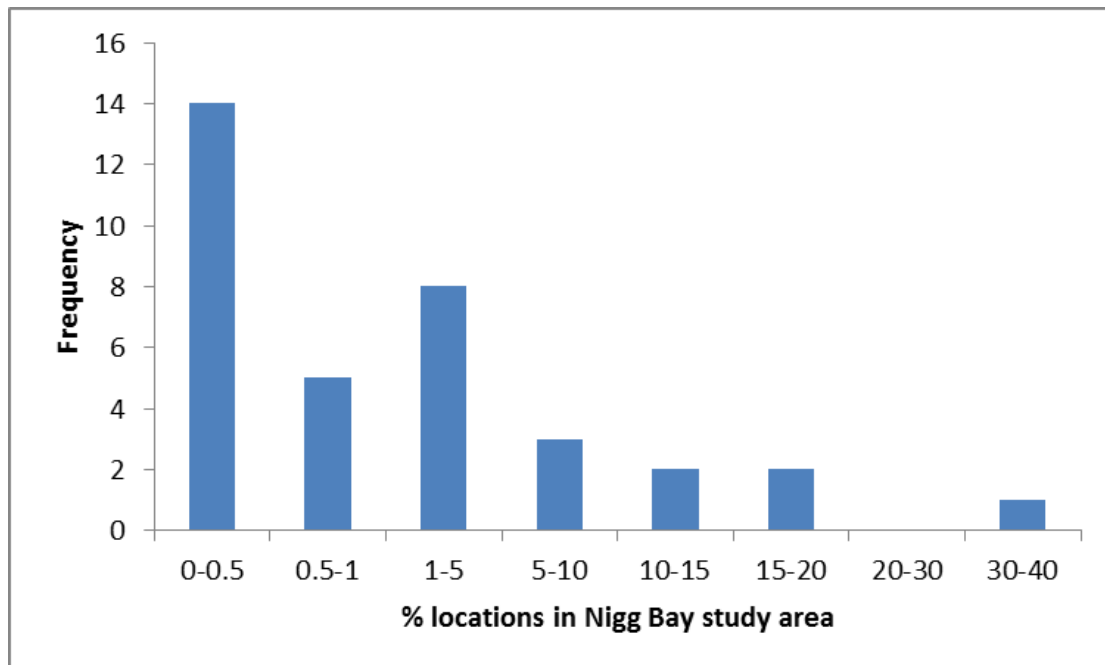
Tagging Location	Seal ID	Tagging Date	Tag Type	Tag Sub-type	Age	Sex	# Locations	# Locations in Nigg Bay study area	% locations in Nigg Bay study area	Visited grey seal SAC?
Abertay	ab2-28501-97	23/06/1997	ARGOS	SRDL	1+	M	161	0*	0.0	-
	ab3-20915-98	13/05/1998	ARGOS	SRDL	1+	F	344	0*	0.0	Berwickshire (PF)
	ab3-26625-98	16/05/1998	ARGOS	SRDL	1+	M	283	1	0.04	Berwickshire (PF)
	ab3-26629-98	16/05/1998	ARGOS	SRDL	1+	M	596	1	0.02	Isle of May (PF)
	ab3-28480-98	20/05/1998	ARGOS	SRDL	1+	M	483	18	3.7	-
	ab3-28495-98	13/05/1998	ARGOS	SRDL	1+	M	533	2	0.4	North Rona (PF)
	ab3-28507-98	18/05/1998	ARGOS	SRDL	1+	F	366	1	0.3	-
	ab3-28508-98	13/05/1998	ARGOS	SRDL	1+	M	284	2	0.7	Monarch Islands (PF), Berwickshire (PF)
	wc1-F1-03	11/05/2003	ARGOS	WLC_neck	unknown	unknown	685	8	1.2	Isle of May (PF)
	wc1-M2-03	11/05/2003	ARGOS	WLC_neck	unknown	unknown	549	0**	0.0	-
	hg15-POOL-06	10/11/2006	ARGOS	SRDL	1+	M	607	36	5.9	-
	gp13-888-08	09/04/2008	phone	phone	1+	M	2811	872	31.0	-
	gp13-902-08	09/04/2008	phone	phone	1+	M	2607	12	0.5	Isle of May (PF), Berwickshire (PF)
	gp13-916-08	09/04/2008	phone	phone	1+	F	3629	19	0.5	Isle of May (PF), Berwickshire (PF)
Eden	hg8-Vera-04	16/09/2004	ARGOS	SRDL	1+	F	1840	13	0.7	-
	hg13-Emma-05	15/10/2005	ARGOS	SRDL	1+	F	956	9	0.9	-
Green Holm	hg30-01-10	12/12/2010	phone	phone	pup	M	5270	470	8.9	-
Sanday	or3-1549-98	05/06/1998	ARGOS	SRDL	1+	M	382	2	0.5	-
	or3-1554-98	06/06/1998	ARGOS	SRDL	1+	F	347	0***	0	Faray & Holm of Fary SAC (PF)
Stroma	hg30-05-10	24/12/2010	phone	phone	pup	F	2550	438	17.2	-
	hg30-07-10	14/12/2010	phone	phone	pup	F	5345	711	13.3	-
	hg30-13-10	15/12/2010	phone	phone	pup	F	6752	221	3.3	-

\* Seal tracks passed through the Nigg Bay study area but no locations were recorded within the Nigg Bay study area.

\*\* Seal tracks passed through the Nigg Bay study area but no locations were recorded within the Nigg Bay study area. Note – the track that passed through Nigg Bay is likely an error

\*\*\* Seal tracks passed through the Nigg Bay study area but no locations were recorded within the Nigg Bay study area. Note – the track that passed through Nigg Bay is almost certainly an error due to the fact that it links to a location that is in land and therefore a location error.

The number of grey seal locations within in the Nigg Bay study area was generally low with the exception of five individual grey seals that recorded >10% of their locations in the area. One seal recorded 31% of its locations in the Nigg Bay study area, however, most tagged grey seals (77%) recorded less than 5% of their locations in the study area, with 40% only recording up to 0.5% of their locations in the area (Figure 7). The average percentage of locations recorded within the Nigg Bay area was highest for those seals tagged at Stroma (Pentland Firth, n=3) with an average of 11.3% of recorded locations being in the study area. This was followed by the one seal tagged at Green Holm (Orkney) with 8.9% of its recorded locations being in the study area and the eight grey seal pups tagged at the isle of May with an average of 2.8% of their recorded locations being in the study area.



**Figure 7 Percentage of grey seal locations that were recorded in the Nigg Bay study area.**



**Table 3 Minimum, average and maximum number of locations recorded in the Nigg Bay study area across seals, presented by seal tagging location.**

	Min	Max	Mean	St Dev	n
Donna Nook	1.2	1.2	1.2	-	1
Farnes	0.1	1.0	0.6	0.47	4
Isle of May	0.5	17.2	5.8	5.63	8
Abertay	0.0	31.0	3.2	8.19	14
Eden	0.7	0.9	0.8	0.14	2
Green Holm	8.9	8.9	8.9	-	1
Sanday	0.0	0.5	0.3	0.35	2
Stroma	3.3	17.2	11.3	7.17	3



### 3.2 Harbour Seals

Of the 229 harbour seals tagged by SMRU between 1988 and 2012, 121 were in Scottish waters (management areas East Scotland, Orkney and North Coast, Shetland and the Moray Firth). Of these, the only tagged harbour seal to enter the Nigg Bay study area was a single adult female harbour seal tagged at Eden with an ARGOS SRDL tag in 2002 (Table 4). The track of this seal in relation to the Firth of Tay and Eden Estuary SAC and the Nigg Bay marine mammal study area is shown in Figure 8.

Of the 714 locations associated with this tagged animal, 107 were within the Nigg Bay study area which equates to 15% of its recorded locations. As can be seen in Figure 8, the Nigg Bay study area represents the northern most locations at which this tagged seal was recorded. This individual appeared to concentrate some activity during the trip around the mouth of the Nigg Bay harbour area.

**Table 4 Details of the single harbour seal that entered the Nigg Bay study area.**

Tagging Location	Seal ID	Tagging Date	Tag Type	Tag Sub-type	Age	Sex	# Locations	# Locations in Nigg Bay study area	% locations in Nigg Bay study area	Primary Feature?
Eden	ab5-Georgia-01	16/01/2002	ARGOS	SRDL	1+	F	714	107	15.0	Firth of Tay and Eden Estuary SAC

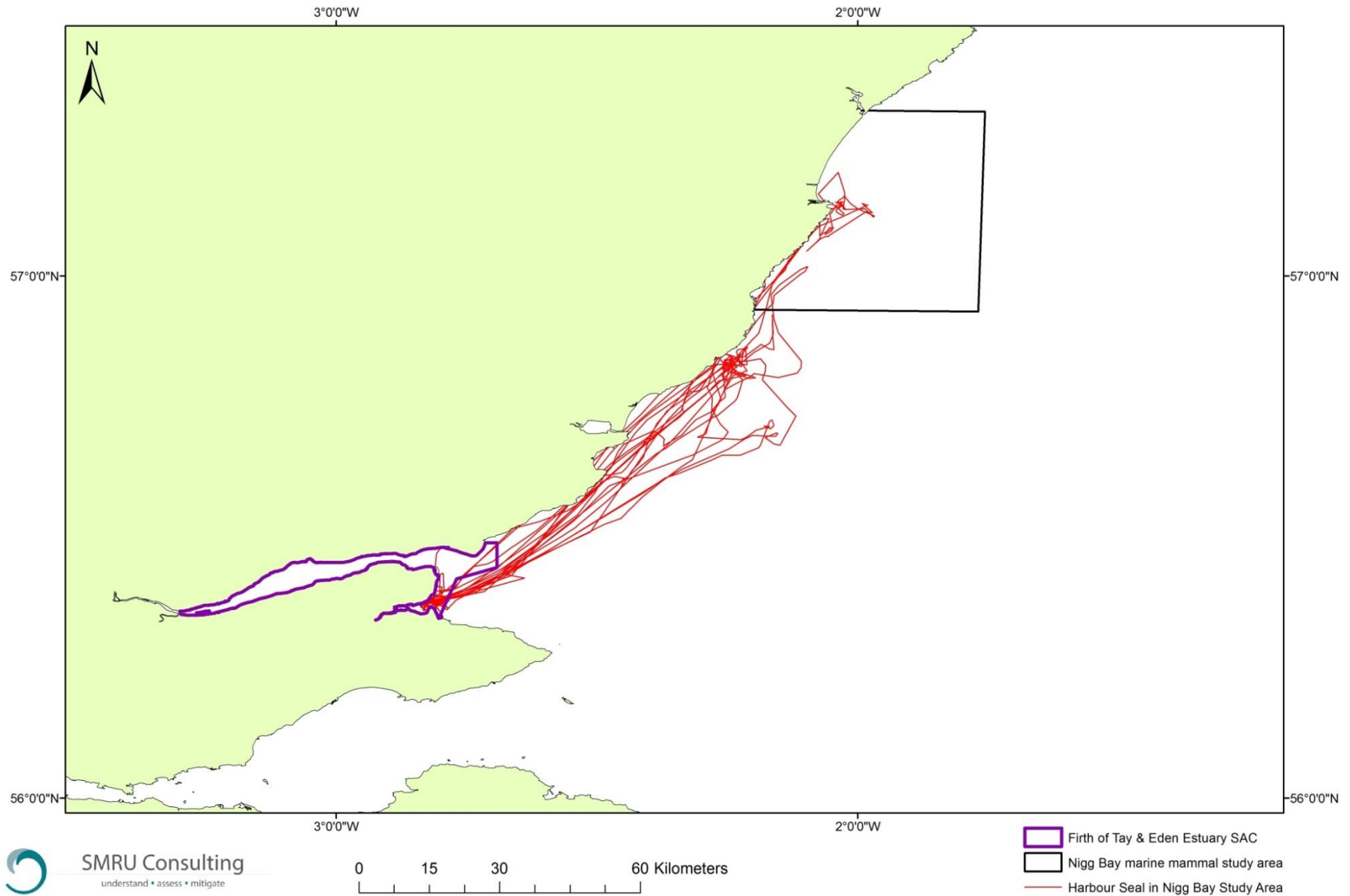


Figure 8 Connectivity between harbour seals in the Nigg Bay study area and harbour seal SACs.

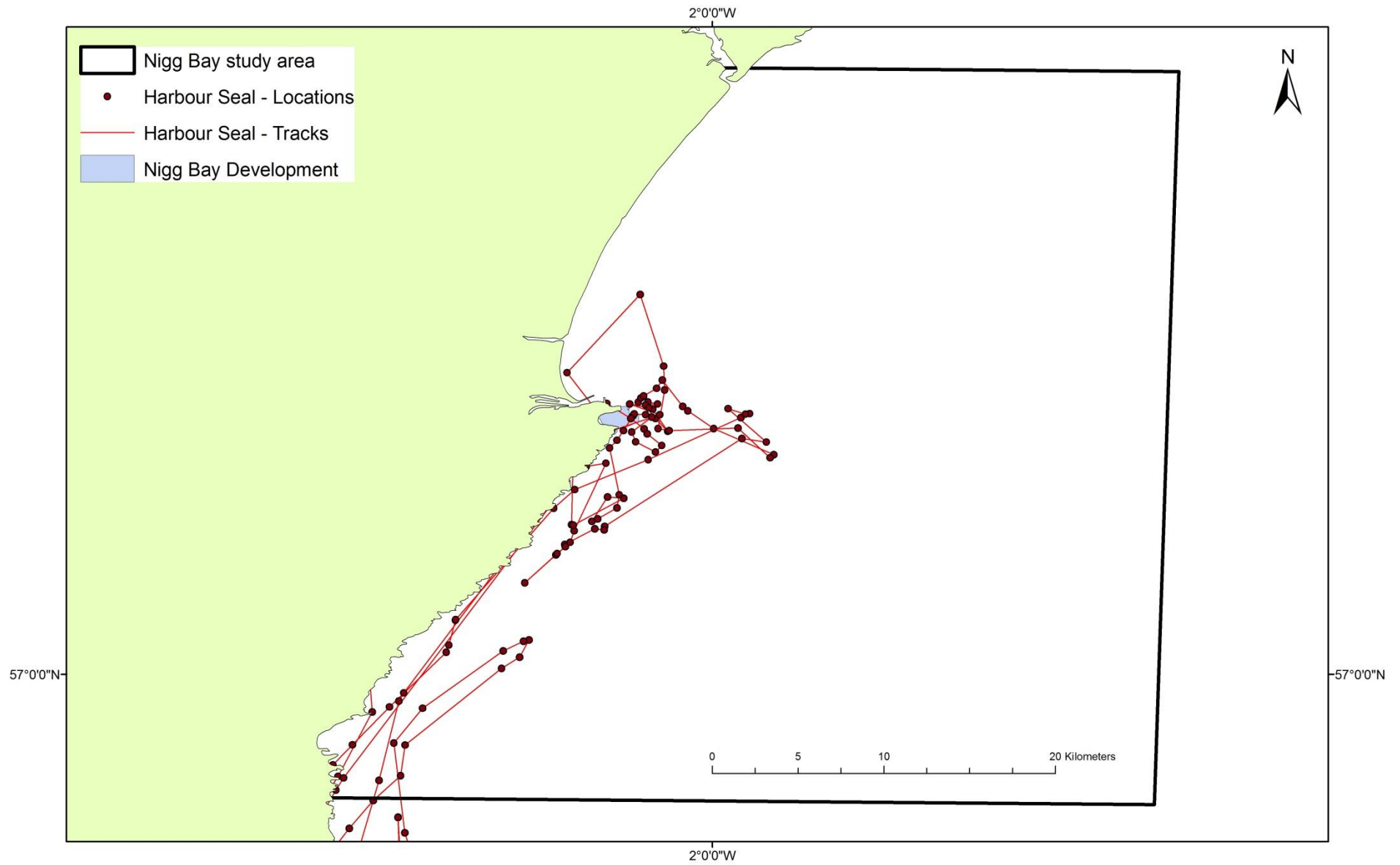


Figure 9 Track and locations of the single tagged harbour seal that entered the Nigg Bay study area.



## 4 Conclusions

The telemetry data show a lot of overlap between grey seal movements and the Nigg Bay study area, however, the degree of connectivity with grey seal SACs is low. A large proportion (69%) of the grey seals tagged at SACs that entered the Nigg Bay study area were pups (n=9 pups), mostly from the Isle of May SAC. Pups tend to disperse more after leaving the breeding site and have less 'settled' movement patterns than adult seals (SMRU Ltd, 2011). It is not certain that those pups tagged at the Isle of May SAC would return there to form part of the breeding population for which the SAC is designated. Most adult grey seal activity appears to be transiting along the coast rather than foraging (due to a lack of concentrated tracks in any one area), however, grey seal pups appear to be highly concentrated to the North and south of the Nigg Bay study area at Newburgh and south of Stonehaven which could potentially indicate foraging areas.

The data show limited connectivity between harbour seals and the Nigg Bay study area. A single seal tagged at the Firth of Tay and Eden Estuary SAC did enter the Nigg Bay study area. This one seal appeared to concentrate some activity during the trip around the mouth of the Nigg Bay harbour area.

## 5 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 10.0.

## 6 Projection

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

## 7 SAC site accounts

The following information is taken directly from the JNCC website:

<http://jncc.defra.gov.uk/protectedsites/sacselection/species.asp?FeatureIntCode=s1364>

<http://jncc.defra.gov.uk/protectedsites/sacselection/species.asp?FeatureIntCode=S1365>

Only those SACs mentioned in this report are listed below.

### 7.1 Grey Seal SACs

#### Berwickshire and North Northumberland Coast

#### Northumberland; Scottish Borders

This is an extensive and diverse stretch of coastline in north-east England and south-east Scotland. There is variation in the distribution of



features of interest along the coast. The north-east England coastal section is representative of **grey seal *Halichoerus grypus*** breeding colonies in the south-east of its breeding range in the UK. It is the most south-easterly site selected for this species, and supports around 2.5% of annual UK pup production.

#### **Faray and Holm of Faray**

#### **Orkney Islands**

These two uninhabited islands in the northern part of Orkney support a well-established **grey seal *Halichoerus grypus*** breeding colony. The seals tend to be found in areas where there is easy access from the shore, and freshwater pools on the islands appear to be particularly important. The islands support the second-largest breeding colony in the UK, contributing around 9% of annual UK pup production.

#### **Isle of May**

#### **Fife**

The Isle of May, lying at the entrance to the Firth of Forth on the east coast of Scotland, supports a breeding colony of **grey seals *Halichoerus grypus***. The site is the largest east coast breeding colony of grey seals in Scotland and the fourth-largest breeding colony in the UK, contributing approximately 4.5% of annual UK pup production.

#### **Monach Islands**

#### **Western Isles / Na h-Eileanan an Iar**

The Monach Islands, off the Outer Hebrides, offer a wide area of largely undisturbed habitat for breeding **grey seal *Halichoerus grypus***, and there is easy access to the grassy swards and dune systems of the islands. These islands hold the largest breeding colony in the UK, contributing over 20% of annual UK pup production.

#### **North Rona**

#### **Western Isles / Na h-Eileanan an Iar**

North Rona is a remote and very exposed island in the North Atlantic off the north-west tip of mainland Scotland. The islands are rarely disturbed by human activities in the breeding season. **Grey seal *Halichoerus grypus*** are found over much of the island and use many of the submerged sea caves that are found around the coast. North Rona supports the third-largest breeding colony in the UK, representing some 5% of annual UK pup production.

## **7.2 SACs where grey seals are a qualifying feature**

Humber Estuary

## **7.3 Harbour Seal SACs**

#### **Dornoch Firth and Morrich More**

#### **Highland**

The Dornoch Firth is the most northerly large estuary in Britain and supports a significant proportion of the inner Moray Firth population of the **Harbour seal *Phoca vitulina***. The seals, which utilise sand-bars and shores at the mouth of the estuary as haul-out and breeding sites, are the most northerly population to utilise sandbanks. Their numbers represent almost 2% of the UK population.

#### **Firth of Tay & Eden Estuary**

#### **Angus; City of Dundee; Fife; Perth & Kinross**

The Firth of Tay & Eden Estuary supports a nationally important breeding colony of **Harbour seal *Phoca vitulina***, part of the east coast population of common seals that typically utilise sandbanks. Around 600 adults haul-out at the site to rest, pup and moult, representing around 2% of the UK population of this species.

#### **Sanday**

#### **Orkney Islands**

Sanday is situated in the north-east of the Orkney archipelago and supports the largest group of **Harbour seal *Phoca vitulina*** at any discrete site in Scotland. The breeding groups, found on intertidal haul-out sites that are unevenly distributed around the Sanday coast, represent over 4% of the UK population. Nearshore kelp beds that surround Sanday are important foraging areas for the seals, and the colony is linked to a very large surrounding population in the Orkney archipelago.

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## 9 Glossary of Terms, Acronyms and Abbreviations

Term	Description
SMRU	Sea Mammal Research Unit
SAC	Special Area of Conservation
SCOS	Special Committee on Seals