CONTRACTOR DOCUMENT FRONT SHEET

NOT PROTECTIVELY MARKED

DOCUMENT DETAILS

PROJECT	CONTRACT CODE	ASSET ZONE	SYSTEM BUILDING	DOCUMENT TYPE	SEQUENTIAL NUMBER
SZC	SZ0200	XX	000	REP	100063

DOCUMENT TITLE	Sizewell SPA/SAC features and associated marine prey species			**EMPLOYER REVISION**	02
DOCUMENT STATUS	D3	**DOCUMENT PURPOSE**	D3 - FFD - FIT FOR CONTRACTOR, DESIGN, IMPLEMENTATION, EXECUTION	**TOTAL PAGES** (Including this page)	47

CONTRACTOR DETAILS

CONTRACTOR NAME	CEFAS		
CONTRACTOR DOCUMENT NUMBER	TR431	**CONTRACTOR REVISION**	03

ECS CODES

REVISION HISTORY

EMPLOYER REVISION	REVISION DATE	PREPARED BY	POSITION/TITLE	CHECKED BY	POSITION/TITLE	APPROVED BY	POSITION/TITLE
1	01/03/2019	B Robinson	Director	C Jenkins	Director	C Jenkins	Director
2	08/07/2019	D. Kirby	Marine Ecologist	M. Breckels	Marine Ecology Lead	B Robinson	Director

COPYRIGHT

Revision	Purpose	Amendment	By	Date
01	First release		BR	01/03/2019
02	Update	Added 4 additional species at a total of 3 sites	DK	08/07/2019

Sizewell SPA/SAC features and associated marine prey species

Sizewell SPA/SAC features and associated marine prey species

Holly Buckley, Damien Kirby, Berrit Bredemeier, Brian Robinson

Version and Quality Control

	Version	Author	Date
Draft	0.01	H. Buckley	25/08/2016
Revision	0.02	D Sheahan	03/11/2016
Executive QC	0.03	B Robinson	16/11/2016
Revision	0.04	B Robinson	25/05/2017
Internal QC	0.05	C. Jenkins	01/07/2017
Revision	0.06	H. Buckley	12/07/2017
Executive QC & Final Draft	0.07	C Jenkins	18/07/2017
Submission to EDFE as Prel A	1.00		20/07/2017
Revision (minor updating)	1.01	B Robinson	28/02/2019
Executive QC & Final Draft	1.02	C Jenkins	01/03/2019
Submission to EDFE as Prel B	2.00		01/03/2019
Revision	2.01	D Kirby	16/04/2019
Internal QC	2.02	M. Breckels	12/06/2019
Revision	2.03	D Kirby	08/07/2019
Executive QC & Final Draft	2.03	B. Robinson	08/07/2019
Submission to EDFE as Prel C	3.00		08/07/2019
Approved by NNB (to BPE)		S Roast	27/03/2020

Table of contents

List of Tables and Figures

Tables

Figures

Executive summary

NNB Generation Company Limited propose to construct a nuclear power station (Sizewell C, SZC) on a site adjacent to and to the north of the existing Sizewell B station. The development is likely to affect one or more ecological sites designated as being of European and/or international importance for nature conservation. A report (hereafter called a 'Shadow HRA Report') must, therefore, be provided to support the Development Consent Order application, as well as applications for Environmental Permits. This Shadow HRA Report must identify the designated site(s) that may be affected and contain sufficient information to enable decision-makers to undertake Habitats Regulations Assessment (HRA) in accordance with The Conservation of Habitats and Species Regulations 2010 (as amended) (the 'Habitats Regulations)

HRAs must consider potential effects upon:

- ornithological interests – designated species populations of SPAs, potential SPAs (pSPAs) if appropriate and Ramsar sites, including rare and vulnerable birds (as listed on Annex I of the Birds Directive), regularly occurring migratory species and species forming designated assemblages (including impacts on those species that are designated as a feature of an SPA/Ramsar, and that may be affected outside of the boundaries of designated sites);
- SACs and candidate SACs (cSACs), if appropriate, (as listed in Annex I of the Habitats Directive);
- SAC designated species populations (as listed in Annex II of the Habitats Directive);
- habitats and species populations of Ramsar sites not covered under SPA and SAC designations; and
- supporting species and habitats in those cases where there are potential impacts upon designated features through indirect effects (e.g. prey species).

The Sizewell C Habitat Regulations Assessment (HRA) Evidence Plan (EDF Energy, 2014) has scoped Likely Significant Effects during the Construction and Operation phases of the Sizewell C development. One of the identified potential effects was to the marine prey of designated species.

The purpose of this report is to synthesise the available evidence to identify for each designated SAC/SPA species, that has the potential to be impacted by the Sizewell C development:

a. those species that have marine prey as an important component of their diet;
b. the foraging range of each species (where applicable); and
c. what their marine prey species are likely to be in the Sizewell area.

BEEMS Technical Report TR483 considers the impacts of the Sizewell C development on the identified marine prey species for each designated SAC/SPA species.

Changes in this Version 2 Report

This Version 2 report includes evidence on the following features and sites that have been screened into the 2019 Sizewell C HRA LSE Screening report:

Feature	Site
Over wintering Avocet (*Recurvirostra avosetta)*	Deben Estuary SPA
Over wintering dark-bellied Brent goose *(Branta bernicla bernicla)*	Deben Estuary Ramsar
Harbour seal (*Phoca vitulina)*	Wash and North Norfolk coast SAC
Grey Seal *(Halichoerus grypus)*	Humber Estuary SAC

1 Introduction

The European 'Habitats Directive' on the Conservation of Natural Habitats and Wild Flora and Fauna (92/43/EEC) and the European 'Birds Directive' on the conservation of wilds birds (79/409/EEC – as amended by Directive 2009/147/EC) intend to protect biodiversity by requiring Member States to take measures to maintain or restore natural habitats and wild species listed in the Annexes to the Directive at a favourable conservation status. It provides robust protection for those habitats and species of European importance and provides a framework for the conservation and management of, and human interactions with, wild birds in Europe. This requirement has been transposed into UK law through 'The Conservation of Habitats and Species Regulations 2010' (as amended), referred to as the 'Habitats Regulations'.

Under this legislation, a network of protected areas (the Natura 2000 network) has been established. These are Special Areas of Conservation (SAC), for habitats and species, and Special Protection Areas (SPA), for birds. The Habitats Regulations require that, where the possibility of a likely significant effect on a Natura 2000 site cannot be excluded (either alone or in combination with another plan or project), a competent authority must undertake an Appropriate Assessment as part of the Habitats Regulations Assessment (HRA) process. The Habitats Regulations state that it is the developer's responsibility to provide sufficient information to the competent authority to enable them to assess whether there are likely to be any significant effects and to enable them to carry out the appropriate assessment, where necessary. In the context of Sizewell New Nuclear Build (NNB), the directive is relevant to the marine prey of protected birds, harbour porpoises, grey and harbour seals, and any marine habitats supporting the protected populations.

Figure 1 shows the location of statutory internationally and nationally designated sites within 20 km of the proposed Sizewell NNB main development site. Table 1 provides details on the protected features of the relevant designated sites and associated marine prey species.

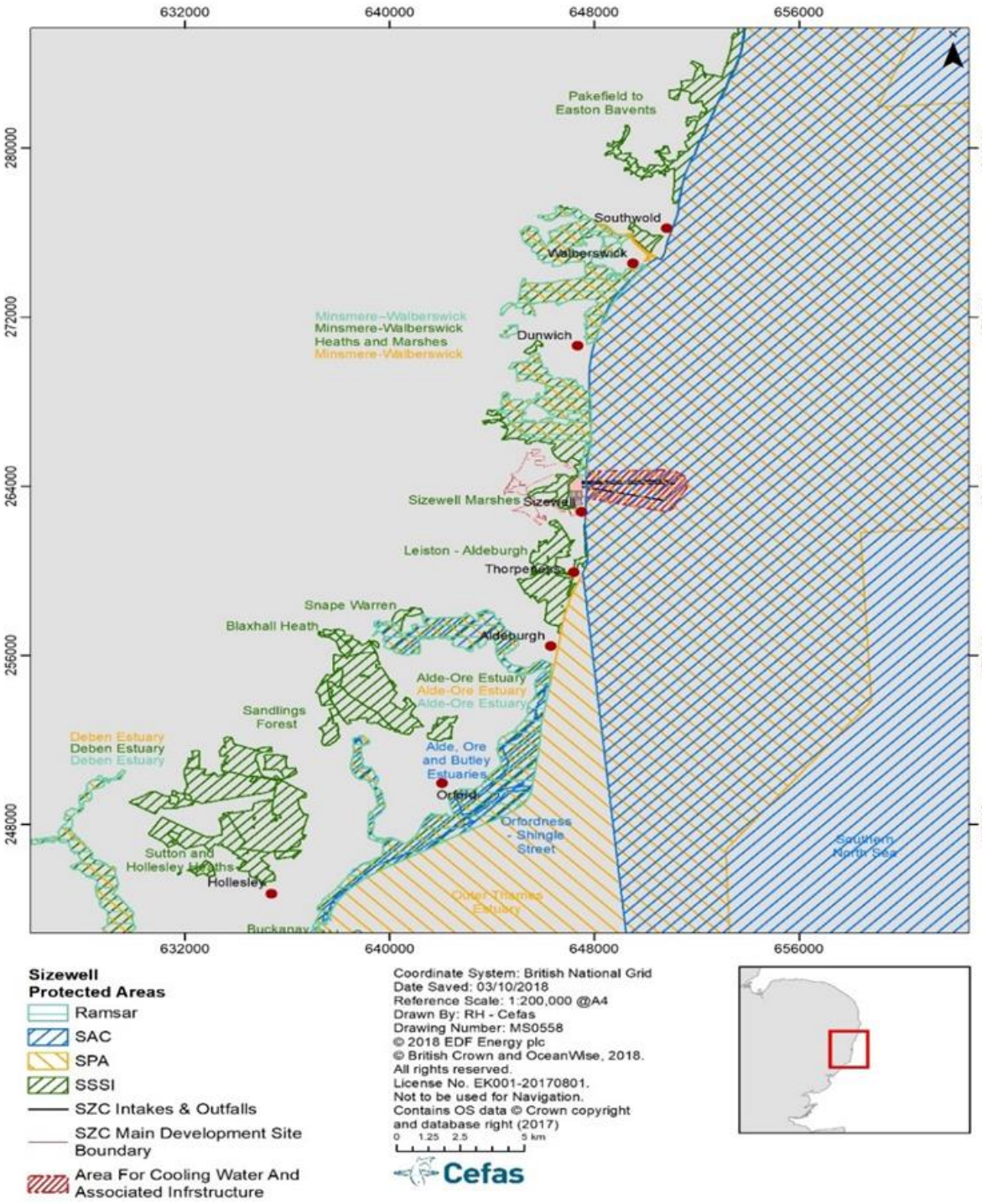

Figure 1: Internationally and nationally designated sites within 20 km of the main development site.

Table 1: Relevant statutory designated sites for birds and marine mammals and associated marine prey species. Bird prey species are informed by del Hoyo et al., 1996 marine mammal prey species are informed from the marine mammal characterisation and references therein (BEEMS Technical Report TR324).

Statutory designated site	Description of site features	Description of associated marine prey species
Minsmere to Walberswick SPA and Ramsar site (located adjacent to the north-east boundary of the Main Development Site)	Identified as a Ramsar site as it supports a diverse range of wetland bird species in nationally important numbers. The SPA supports breeding, wintering and passage bird populations of European importance, including breeding populations of marsh harrier (*Circus aeruginosus*), bittern (*Botaurus stellaris*), avocet (*Recurvirostra avosetta*) and little tern (*Sterna albifrons)*.	Breeding and over wintering Bittern – eels (*Anguilla anguilla*). Eels form part of the diet of this species (particularly of juvenile bitterns). Bitterns do not forage at sea. Juvenile eels (glass eels/elvers) migrate from the marine environment into freshwater where they remain for many years (up to 20 yrs) until they are ready to return to the Sargasso Sea as adult silver eels. Breeding Little Tern are present at Sizewell (May – August) and feed on schooling pelagic fish species during daylight hours including sprat, herring and anchovy.
Sandlings SPA (located approximately 0.7 km south of the Main Development Site)	Supports breeding populations of European importance of both nightjar (*Caprimulgus europaeus*) and woodlark (*Lullula arborea*).	No marine prey dependencies.
Alde-Ore Estuary SPA and Ramsar site (located approximately 5.5 km south of the Main Development Site)	Identified as a Ramsar site for its diverse and nationally important wetland bird species, and as an SPA because it supports bird populations of European importance, including breeding populations of avocet, little tern and sandwich tern (*Sterna sandvicensis)*, and over-wintering ruff (*Philomachus pugnax*). The site also supports important migratory populations of lesser black-backed gull (*Larus fuscus*) during the breeding season and redshank (*Tringa tetanus*) during the winter. The site also supports a seabird assemblage of international importance (including Little Tern, Sandwich Tern, Lesser black-backed gull, Black headed gull *Larus ridibundus* & Herring gull *Larus argentatus).*	Breeding Little Tern (May – August) – schooling pelagic fish species that are found near to the sea surface during daylight hours including sprat, herring and anchovy. Breeding Sandwich Tern (April to August) – schooling pelagic fish species that are found near to the sea surface during daylight hours including sprat, herring and anchovy. Breeding Lesser black-backed gull (April to August) - schooling pelagic fish and crustacea that are found near to the sea surface including sprat, herring, anchovy and swimming crabs together with the waste from fishing vessels.

Statutory designated site	Description of site features	Description of associated marine prey species
Benacre to Easton Bavents SPA (located approximately 15 km north of the Main Development Site)	The site qualifies by supporting the following species: Breeding and over wintering Bittern *Botaurus stellaris*, Breeding Little Tern *Sterna albifrons* and Breeding Marsh Harrier *Circus aeruginosus*. (Note: where available eels (*Anguilla anguilla*) form part of the diet of breeding and over wintering Bittern. There is no pathway for eels to migrate into this site from the marine environment and therefore there is no potential marine impact on Bitterns at this site).	Breeding Little Tern (May – August) – schooling pelagic fish species that are found near to the sea surface during daylight hours including sprat, herring and anchovy.
Outer Thames Estuary SPA (includes the area of open sea adjacent to the eastern boundary of the Main Development Site)	The Outer Thames Estuary SPA qualifies by supporting populations of European importance of wintering Red-throated diver (*Gavia stellata*). It also protects foraging areas for Little Tern (*Sterna albifrons)* and Common Tern (*Sterna hirundo)* during the breeding season enhancing the protection already afforded to their feeding and nesting areas in the adjacent coastal SPAs (including the Minsmere to Walberswick SPA).	Over wintering/passage Red-throated diver (September to March) – most commonly occurring benthopelagic species - sprat, herring, whiting and bass. Breeding Little Tern and Breeding Common Tern (May – August) – schooling pelagic fish species that are found near to the sea surface during daylight hours - sprat, herring and anchovy.
Deben Estuary SPA	The site qualifies by supporting overwintering populations of avocet (*Recurvirostra avosetta*)	Avocet feed non-selectively on aquatic invertebrates such as insects, crustaceans, worms, some molluscs, fish and plant matter.
Deben Estuary Ramsar site	The Deben Estuary supports: a population of the mollusc *Vertigo angustior*; and an overwintering population of Dark-bellied brent goose, *Branta bernicla bernicla*	The dark bellied brent goose feeds on intertidal vegetation such as *Enteromorpha*, *Ulva*, *Zostera* and salt marsh vegetation in addition to terrestrial grasses and cereals.
Southern North Sea SAC (includes the area of open sea adjacent to the eastern boundary of the Main Development Site)	The Southern North Sea site is designated for the Annex II species harbour porpoise (*Phocoena phocoena*) for both winter and summer seasons.	Harbour porpoise feed on a wide variety of fish and generally focus on the most abundant local species. The predominant prey type appears to be demersal fish, although shoaling fish such as mackerel and herring are also taken (JNCC, 2017).
Humber Estuary SAC. Approximately 220km north of the Main Development Site	The site is site is designated for the Annex II species Grey Seal, *Halichoerus grypus*	Grey seals are opportunistic foragers, eating a wide variety of prey types depending on location, season and the abundance of prey. Sandeel, cod, Dover sole, dab, flounder and plaice make up large components of the diet dependent upon availability.

Statutory designated site	Description of site features	Description of associated marine prey species
The Wash and North Norfolk Coast SAC. Approximately 120km north of the Main Development Site	The site is site is designated for the Annex II species harbour seal, *Phoca vitulina*	Harbour seals are opportunistic foragers, consuming a wide variety of prey species, dependant on the seasonality and local availability. Whiting, Dover sole and gobies form a large component of the diet in the southern North Sea together with flounder, sprat and sandeel dependent upon local availability.

2 SPA/SAC features at Sizewell with a marine prey component of their diet – distribution and feeding patterns

2.1.1 Little Tern (*Sterna albifrons)*

Wintering European Little Terns are found in tidal creeks and lagoons off the coast of western Africa (del Hoyo *et al.,* 1996). During the breeding season (May to August) they are found on sand/shingle beaches, islands and spits on British and Irish coasts. Little terns feed by fishing in the top few centimetres of water and can forage up to 6 km offshore (del Hoyo *et al.,* 1996).

In the breeding season:

- the Minsmere to Walberswick SPA supports 28 pairs of Little Tern, which constitutes 0.1 % of the biogeographical population and 1.2 % of the national population (JNCC, 2001).
- the Alde-Ore Estuary SPA supports 48 pairs of Little Tern, which constitutes 0.2 % of the biogeographical population and 2.0 % of the national population (JNCC, 2001).
- the Benacre to Easton Bavents SPA supports 53 pairs of Little Tern, which constitutes 0.3 % of the biogeographical population and 2.2 % of the national population (JNCC, 2001)

The foraging areas of Breeding Little Tern are also features of the Outer Thames Estuary SPA.

2.1.2 Sandwich Tern (*Sterna sandvicensis*)

Sandwich Terns winter off the coasts of western and south Africa (RSPB, n.d). During the breeding season (April to August) they are found on sandy islands, spits, dunes and shingle beaches (del Hoyo *et al.,* 1996). Sandwich Terns feed over inlets and at sea by fishing typically feeding within 1m of the surface, down to a maximum depth of 2m (Furness *et al.,* 2012)

In the breeding season, the Alde-Ore Estuary SPA supports 169 pairs of Sandwich Terns, which constitutes 0.1 % of the biogeographical population and 1.2 % of the national population (JNCC, 2001).

2.1.3 Common Tern (*Sterna hirundo)*

During the breeding season (May to August) Common Terns are found around most of the UK coast, apart from the south-west and they frequent shingle beaches and rocky islands (RSPB, n.d).

However, migrating birds can be seen offshore during Autumn (RSPB, n.d). Common Terns feed over freshwater and at sea by fishing in the top few centimetres of water (del Hoyo *et al.,* 1996) down to a maximum depth of 1 metre (Furness et al., 2012).

In the breeding season, the UK supports 12,000 pairs. The foraging areas of breeding Common Tern are also features of the Outer Thames Estuary SPA.

2.1.4 Lesser black-backed gull (*Larus fuscus*)

Lesser black-backed gulls wintering grounds are in Africa (RSPB, n.d). During the breeding season (April to August) they are found on coastal grassy slopes, sand-dunes, cliffs and saltmarshes. Lesser black-backed gulls forage on arable land, pasture land, refuse dumps and at sea (del Hoyo *et al.,* 1996). At sea they typically feed close to the sea surface, down to a maximum dive depth of 0.5 - 1m (Furness *et al.,* 2012)

In the breeding season, the Alde-Ore Estuary SPA supports 21,700 pairs of Lesser black-backed gull, which constitutes 17.5 % of the biogeographical population and 26.1 % of the national population (JNCC, 2001).

2.1.5 Red-throated diver (*Gavia stellata*)

During the breeding season (April to September) Red throated divers are found in British waters on Orkney, the Outer Hebrides and the north Scottish mainland (RSPB, n.d). Off the Suffolk coast, red throated divers winter between September and March and frequent inshore waters along sheltered coasts (RSPB, n.d). Red-throated divers are pursuit divers and forage in marine waters by diving from the surface to a typical mean depth of 2-8 m and maximum depth of 9 - 10 m (Furness *et al.,* 2012). In the non-breeding season, the UK supports 17,116 individuals, of which 1643 individuals are found off the Suffolk coast (RSPB, n.d). The Outer Thames Estuary SPA supports 38 % of the GB population during the non-breeding season.

2.1.6 Bittern (*Botaurus stellaris)*

Bittern were not identified in the Sizewell C Habitat Regulations Assessment Evidence Plan (EDF Energy, 2014) because they do not forage at sea. However, eels (*Anguilla anguilla*) are considered an important component of their diet, particularly for chicks, at sites where this species is available. Eels reproduce in the Sargasso Sea and the species migrates into estuaries and freshwater rivers draining into the UK and European continental shelf as recruiting glass eels/elvers, returning to sea many years later (up to 20 years later) as adult silver eels. As such the species is potentially vulnerable to impingement (as adults) and entrainment (as glass eels) by power stations and EDF Energy is required to evaluate the impacts of both stressors on local eel populations. Migratory species such as eels can also be sensitive to power station discharges if avoidance of the discharge plume impacts on their migratory pathways. Literature suggests that glass eels generally arrive in the North Sea in January to February. However, this is dependent on met-ocean conditions over Northern Europe and the relative strength of the Gulf Stream and associated currents around the British Isles. Oceanographic observations suggest that most glass eels probably enter the southern North Sea, south of the Wash, from the English Channel following residual currents that flow northwards into the southern North Sea (pers. comm. L. Fernand, Cefas and BEEMS Technical Report TR356). The potential impact pathway on Bitterns from Sizewell C is, therefore, on the number of eel recruits into the freshwater systems where Bitterns breed and over winter.

The Bittern's European population is estimated at 10,000-12,000 pairs. Bitterns are currently one of the rarest breeding birds in the UK, with the entire population (20 booming males) confined to England. In the UK, the species breeds regularly in reedbeds in the counties of Norfolk, Suffolk and Lancashire. (JNCC, 2001) The Bittern is a solitary, daytime feeder, feeding mainly in flooded marginal stands of emergent vegetation. Radio-tracking studies have suggested that most feeding activity occurs within the first 10 m of wet reedbed from the reed/water interface. Bitterns forage by sight, clambering through flooded reedbed (water depth ≤ 25 cm) by clutching clumps of reed with their feet or wading through shallow water (Noble *et al.,* 2004). Due to the rarity of the species in the UK and their secretive nature there have only been a few studies on bittern diet.

In the breeding season:

- the Benacre to Easton Bavents SPA supports 1 booming male representing at least 5.0 % of the breeding population in Great Britain.
- the Minsmere to Walberswick SPA supports 7 booming males representing 35 % of the national population (JNCC, 2001).

Over winter:

Bitterns are extremely secretive and silent outside the breeding season and they therefore tend to be under-recorded by birdwatchers and rarely figure amongst Wetland Bird Survey data. Hence, the estimated
total of 30 to 100 individuals wintering in Britain cannot be treated with confidence (JNCC, 2001).

- the Benacre to Easton Bavents SPA supports 2 individuals representing at least 2.0 % of the wintering population in Great Britain which constitutes <0.1 % of the biogeographical population.
- the Minsmere to Walberswick SPA supports 14 individuals representing at least 14 % of the wintering population in Great Britain which constitutes <0.1 % of the biogeographical population (JNCC, 2001).

2.1.7 Pied Avocet (*Recurvirostra avosetta*)

Global distribution of pied avocet is discontinuous, with a series of unconnected breeding areas distributed across western Europe, within the Mediterranean, southern and eastern Africa, and eastern and southern Asia (Cramp & Simmons 1983; del Hoyo et al. 1996). Ahead of breeding season, many birds from north-west Europe migrate to the coasts of western France, Spain and Portugal to breed. However, the pied avocet also breeds within areas of the UK, particularly on the coasts of East Anglia and along the north Kent coast. The pied avocet is typically found in shallow, brackish coastal lagoons with bare or sparsely vegetated low islands (Cleeves & Holden 2014), however at times of increased competition for nest sites they are known to extend their range into alternative habitats.

In the non-breeding season 2,225 individuals are present within UK SPAs (100 % of the UK population and 3.2 % of the biogeographic population). In the breeding season 549 pairs of avocets are found within UK SPAs (93 % of the UK breeding population and 2 % of the biogeographic population). The Deben Estuary SPA regularly supports 95 individuals over-winter, representing 7.5% of the UK wintering population.

2.1.8 Dark-bellied Brent Goose (*Branta bernicla bernicla*)

The dark-bellied Brent goose (*Branta bernicla bernicla*) breeds in the Russian high Arctic but migrate to winter on the coasts of North Sea countries in Europe. The main UK wintering areas are in England, along the North Sea and English Channel coasts, extending from The Wash south to Poole Harbour (JNCC 2001). The traditional wintering habitat is shallow coastal waters saltmarshes and intertidal mudflats within estuaries (Vickery et al 1995)

In the non-breeding season an average of 93,677 dark-bellied Brent geese (94 % of the British population and 31 % of biogeographic population) are found within UK SPAs (JNCC 2001). The Deben Estuary UK Ramsar site supports an over-winter population of 1,953 individuals, representing an average of 1.9% of the UK population.

2.1.9 SPA seabird assemblage

In addition to Little Tern, Sandwich Tern and Lesser black-backed gull the Alde-Ore SPA supports Black headed gull *Larus ridibundus*, Herring gull *Larus argentatus* and Common Tern as part of the seabird assemblage feature.

The Black headed gull is an opportunist feeder on earthworms, insects, household waste, fish and carrion
Its maximum foraging range from breeding colonies is 25.5 km with a mean range of 11.4 km (Thaxter *et al.,* 2012). It feeds in the intertidal zone and terrestrial habitats and is scarce at sea. Its marine diet is primarily bivalves and polychaetes (Kubetzki and Garthe, 2003). At sea, it is a surface feeder within the upper 10's of centimetres with a maximum dive depth of 1 m (Furness *et al.,* 2012).

The Herring Gull is an opportunist feeder and has a diverse diet of earthworms, household waste, freshwater and marine fish, marine invertebrates, bird chicks, eggs, carrion, grain and berries (Camphuysen, 1995). Its maximum foraging range from breeding colonies is 61.1 km with a mean range of 10.5 km (Thaxter *et al.,* 2012). At sea, it is a surface feeder within the upper 10's of centimetres with a maximum dive depth of 1 m (Furness *et al.,* 2012). The species scavenges bycatch and fish waste from fishing vessels but, unlike the Lesser black-backed gull which forages to >80 km from shore, the Herring gull is found much closer to shore and hardly ever >40 km from the shore. At the coast the species feeds primarily in the intertidal zone and its marine prey consists largely of bivalves and crustacea together with discarded fish waste from fishing vessels (Kubetzki and Garthe, 2003).

2.1.10 Harbour porpoise (*Phocoena phocoena*)

All cetaceans found in Northern European waters are listed under Annex IV of the EU Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (the Habitats Directive) as European Protected Species (EPS) of Community Interest and in need of strict protection. The harbour porpoise is a widely-distributed cetacean in European North Atlantic waters, and relatively little is known about its breeding behaviour. Harbour porpoises within the eastern North Atlantic are generally considered to behave as a 'continuous' biological population that extends from the French coasts of the Bay of Biscay northwards to the arctic waters of Norway and Iceland. However, for conservation and management purposes, the population in UK waters has been divided into smaller management units (MUs). These MUs reflect differences, to some extent, in the spatial preferences of individuals and the spatial variation in human activities. Three MUs (Figure 2) have been established by the UK Inter Agency Marine Mammals Working group (IAMMWG, 2015) for harbour porpoise:

1. North Sea (NS) (comprising ICES area IV, VIId and part of Division IIIa [Skagerrak and northern Kattegat]). Noting that the northern and western boundary with Division VIa is arbitrary (but the shelf is relatively narrow here) and that there will be an interchange of animals here with the 'West Scotland' MU. The eastern boundary has been defined by the ASCOBANS North Sea Conservation Plan for the species. The northern peak of the EEZ is treated as part of the NS MU and has been included in abundance estimates (see below).

2. West Scotland (WS) (comprising ICES area VIa and b). Noting that the boundary with the North Sea MU is arbitrary and that there will be an interchange of animals here and also with the Irish Sea and Celtic Sea MUs. It should also be noted that harbour porpoise are generally rare in waters >200 m depth.

3. Celtic and Irish Seas (CIS) (comprising ICES area VI and VII, except VIId).

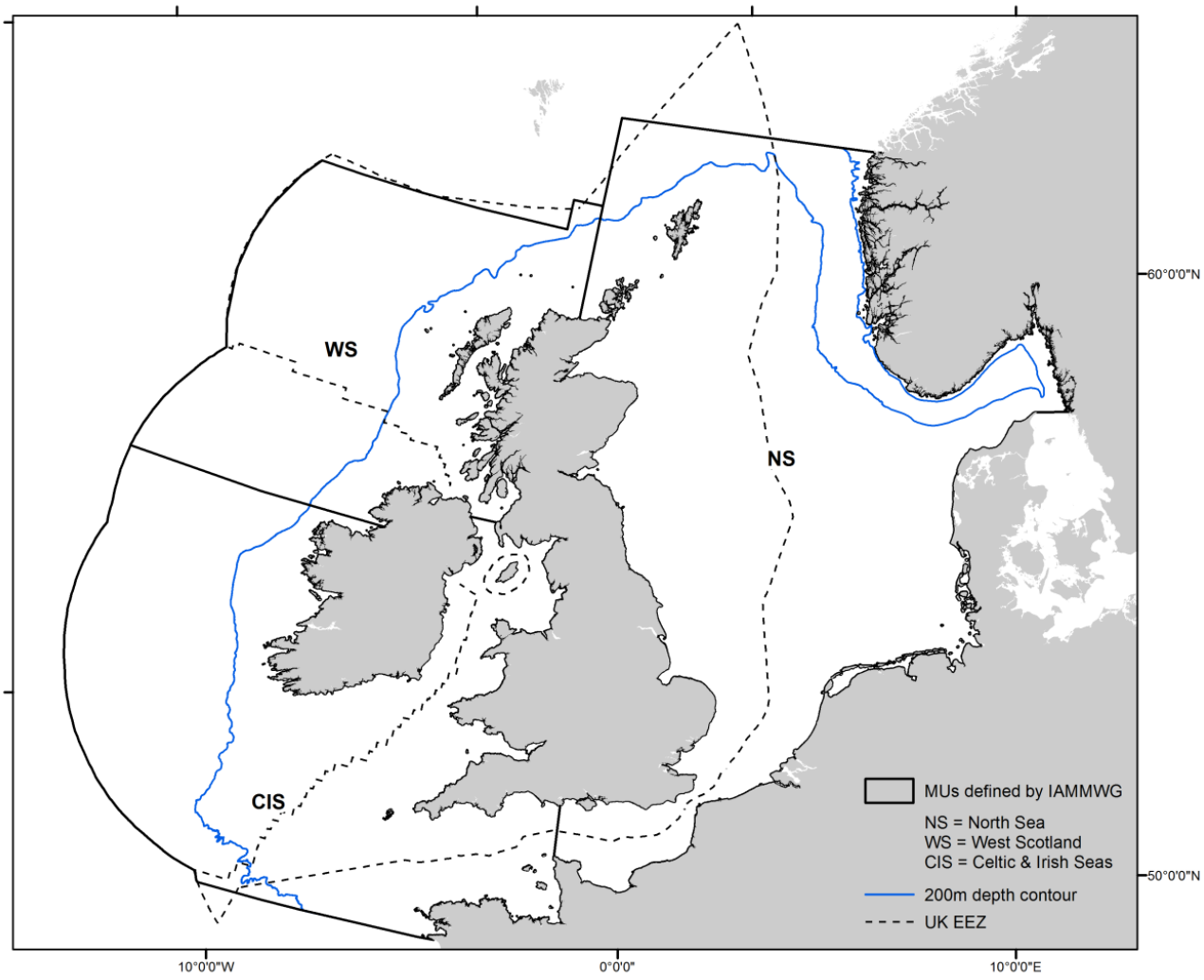

Figure 2: Harbour porpoise Management Units (MUs), noting that this species is largely confined to the continental shelf i.e. waters <200m depth. (From IAMMWG, 2015).

Table 2 shows the estimated abundance of harbour porpoise in each Management Unit.

Table 2: Estimates of abundance of harbour porpoise in the Management Units.

MU	Animal abundance in MU	95% confidence interval for MU	Abundance of animals in the UK portion of MU	95% Confidence interval for UK portion of MU
NS	227,298	176,360-292,948	110,433	80,866-150,811
WS	21,462	9,740-47,289	19,291	7,771 -47,888
CIS	104,695	56,774-193,065	47,229	25,611-87094

The Southern North Sea (SNS) SAC site is located in the North Sea MU and has been recognised as an area with predicted persistent high densities of harbour porpoise. The main area included within the site covers important winter and summer habitat, which emerged as part of the top 10% persistent high density areas for these seasons within the UK. Approximately two thirds of the site, the northern

part, is recognised as important for porpoises during the summer season, whilst the southern part is more important during the winter (see Figure 3) (JNCC, 2017). The Sizewell C development is within and adjacent to the southern portion of the Southern North Sea SAC (see Figure 3).

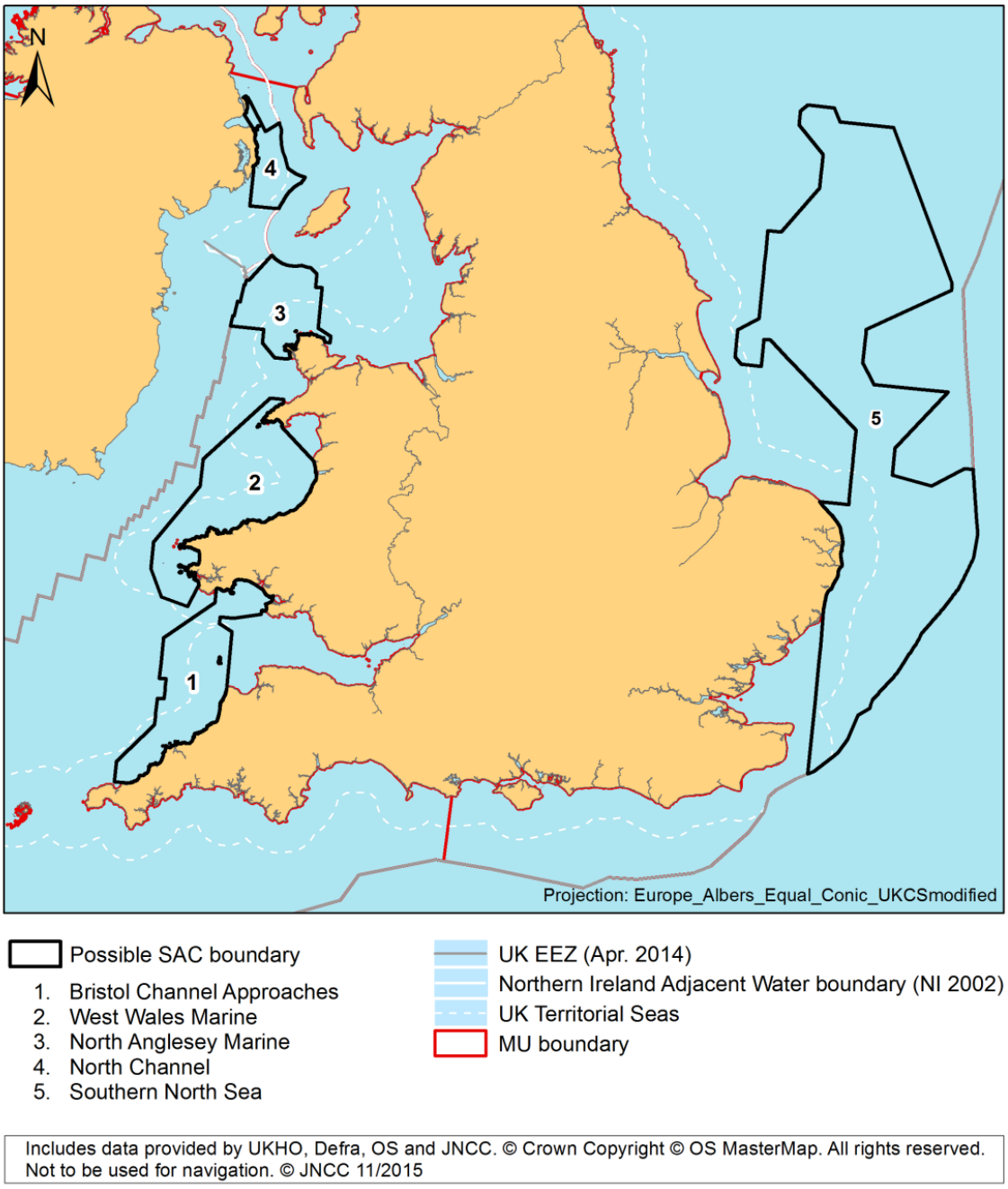

Figure 3: SAC boundaries for harbour porpoise submitted to EC by JNCC on 30 Jan 2017.

The water depths within the SNS site range between 10 m and 75 m, with the majority of the site shallower than 40 m. Analysis of harbour porpoise sightings indicate a preference for water depths between 30 and 50 m throughout the year. It is estimated (based on survey data collected in July 2005) that the site supports approximately 18,500 individuals (95% Confidence Interval: 11,864 - 28,889) for at least part of the year, as seasonal differences are likely to occur, and represents

approximately 17.5% of the population within the UK part of the North Sea MU. It should be noted that because this estimate is from a one-month survey in a single year it cannot be considered as a confident estimate of population abundance for the site. It is, therefore, not appropriate to use site population estimates in any assessments of effects of plans or projects (i.e. Habitats Regulation Assessments), as these must take into consideration population estimates at the MU level, to account for daily and seasonal movements of the animals (JNCC, 2017).

Satellite tracking has shown that harbour porpoises have very large foraging ranges. In a study using 8 tagged porpoises over periods of 2 – 212 days (mean 50± 65 days), Read and Westgate (1997) estimated that porpoises in the Bay of Fundy/Gulf of Maine travelled 13.9 to 28.1 km per day with the exception of 1 animal with a mean daily distance of 58.5 km. Mean rates of travel ranged from 0.6 to 2.3 km h^{-1} and mean distances from the shore ranged from 6.6 to 81.4 km with an overall mean of 50.2 ± 46.2 km. Porpoises spent between 3 ± 1 and 7± 4% of their tracking periods at the surface (when they would have been visible to observers). When the movements of tagged individuals were examined at their largest scale, the home range of harbour porpoises occupied most of the Gulf of Maine and was approximately 50,000 km^2.

Sveegaard *et al.,* (2011) studied the movements of 64 harbour porpoises, satellite tagged between 1997 and 2007, in order to determine their distribution in the North Sea, the western Baltic, and the waters in between. Results show that harbour porpoises are not evenly distributed, but congregate in nine high-density areas within the study area. Several of these areas are subject to significant seasonal variation. The study found no differences in the home range size of males and females, but immature harbour porpoises had larger home ranges than mature porpoises. The porpoises belonged to 2 groups which did not spatially overlap; the Inner Danish Waters (IDW) and the Skagerrak groups. The home range of the Skagerrak group was 45,000-70,000 km^2 for immature animals and 10,000 - 20,000 km^2 for mature animals and crossed Danish, Norwegian, Swedish, German and British EEZs. The IDW group had a home range of 30,000 km^2 for immature and 8,000 -15,000 km^2 for mature animals. Both groups had several high density areas within the measured extents of their home ranges that had a total area of approximately 5000 km^2 for each group. Both groups showed distinct seasonal movements; the Skagerrak high density areas moved westwards in winter and the IDW group moved southwards in winter.

2.1.11 Harbour seal (*Phoca vitulina*)

UK harbour seal populations are predominately located around the west coast of Scotland, the Hebrides and the Northern Isles (approximately 80% of the UK population). However, smaller concentrations of harbour seals may also be found along the east coast, in the Moray Firth, Firth of Tay, The Wash and the Thames Estuary (SCOS, 2017; Figure 4 [left]). The most recent estimate of the UK population in 2016 is 43,500 (~ 95% CI: 35,600-58,000) with 82% in Scotland, 15% in England and 3% in Northern Ireland (SCOS 2017).

Changes in size of UK harbour seal populations vary both temporally and geographically (see TR324). The latest advice from the Special Committee on Seals (SCOS 2017) states that there have been general declines in counts of harbour seals in several regions around Scotland, but other UK populations have remained stable or increased. Within England, clear rises are seen at some sites (e.g. The Wash and what have been classed by SCOS as ‘other east coast sites’), whilst more modest increases have been observed at other sites (e.g. Blakeney Point and Scroby Sands in North Norfolk), with declines elsewhere (Donna Nook in Lincolnshire).

The nearest Harbour seal haul-out sites to Sizewell Bay are The Wash and Blakeney Point (north Norfolk) and Horsey Beach to the north, and the Thames Estuary to the south (Russell et al 2017; Figure 4 [right]). The Wash, on the east coast of England, is the largest colony in the UK, accounting for 7% of the total UK population. and has been designated as an SAC due to the presence of harbour seals.

The Wash and North Norfolk Coast SAC and Thames Estuary are both approximately 120km from SZC. Thompson *et al., (*1996) noted that the Moray Firth population of harbour seals travelled a maximum of 75km between haul out sites and only 60km to forage. However, more recent tagging

studies have shown that they can travel up to 200km between haul-out sites and up to 220km to forage (Sharples et al., 2012). Taking this into consideration, it is possible that the seals from The Wash could transit to the wider proposed development area.

Habitat use, is low to moderate in Sizewell Bay, particularly compared to The Wash and the Thames (Figure 5). The Galloper and Greater Gabbard wind farm EIA surveys (2011) reported only three harbour seals within the vicinity of the wind farm site, with SCOS (2009) reporting that the Essex and Kent coastlines only account for approximately 0.3% of the British population. However, Sharples *et al.,* (2008) undertook tagging studies of harbour seals in the Thames Estuary and found that, while most stayed in the general haul out area, some did travel up to other sites in north Norfolk and into Lincolnshire (Figure 5, [Right, A]). There is, therefore, some at-sea usage of Sizewell Coastal waters (Figure 5, [Right, B]).

The Zoological Society of London's 2013 Thames Estuary harbour seal telemetry study (Barker *et al.*, 2014) found that although 2 out of 10 tagged seals travelled between the estuary and The Wash most stayed within the estuary. Seal tracks were primarily concentrated around the estuary, The Wash and the area around Lowestoft, however occasional lines were recorded around the Greater Sizewell Bay (Figure 5 [right]). Wildfowl and Wetland Trust Consulting (2009) undertook aerial marine mammal surveys and, while they were unable to reliably identify animals to species level, seals were recorded close to the proposed development (Figure 4 [right]).

In summary, habitat utilisation by harbour seals is limited off the coast off the proposed development and haul out usage is low. However, harbour seals do transit along the coastline between the Thames and north Norfolk.

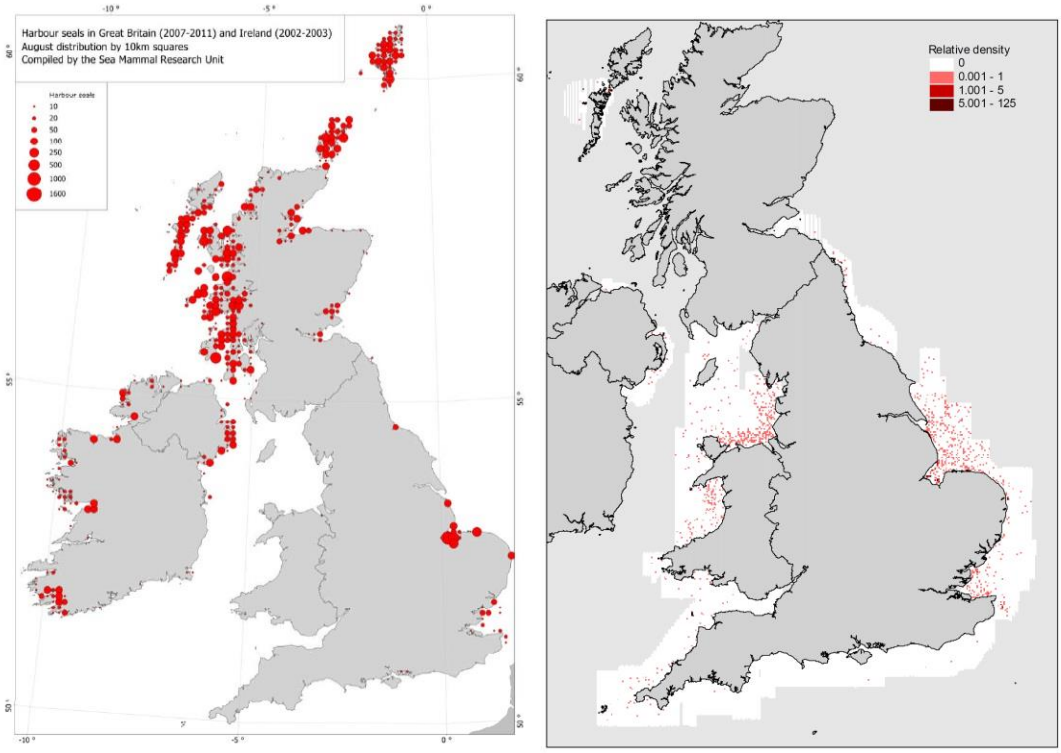

Figure 4: UK seal distribution maps. Left: Harbour seals haul out counts around the UK and Ireland (Russell et al 2017). Right: Seal distribution recorded from aerial surveys around England and Wales (WWT, 2009; not identified to species level).

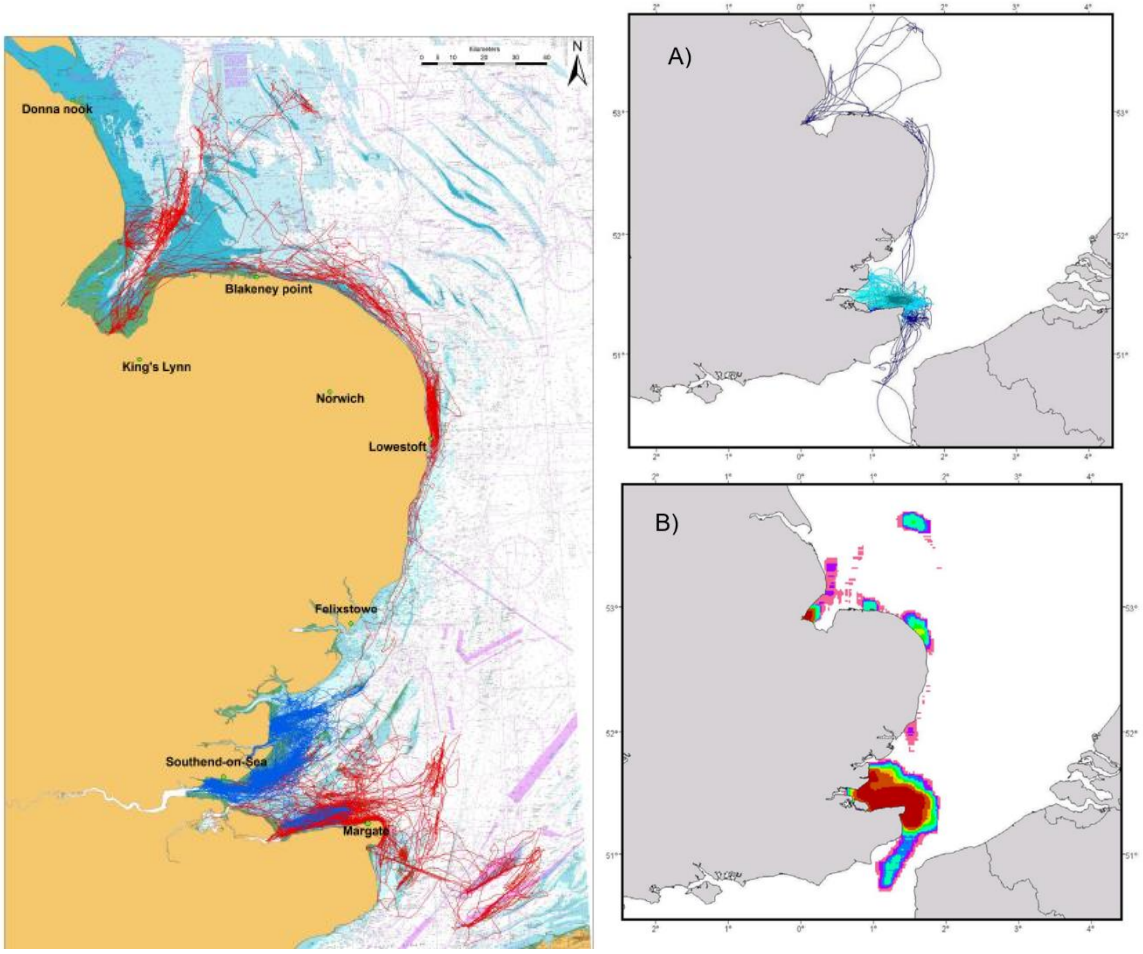

Figure 5: UK Seal sea usage maps. Left: (A) Individual filtered tracks of all harbour seals captured in the Thames Estuary. (B) Density of 'at sea' surface densities per 100m^2 from nine tagged seals. (Sharples *et al.*, 2008); Right: Seal tracks generated from the Zoological Society of London's 2013 Thames Estuary tagging study. Seals were tagged at Margate (red tracks) and Southend-on-Sea (blue tracks). From Barker *et al.* (2014).

2.1.12 Grey seal (*Halichoerus grypus*)

Grey seals are found in the North Atlantic, Barents and Baltic Seas. There are two main concentrations within these areas, one along the east coast of Canada and the USA (centred on Nova Scotia and the Gulf of St. Lawrence) and the other in northwest Europe around the UK (SCOS, 2012). Approximately 86% of the UK grey seal pups are born in Scotland, 11% in England and 3% in Wales (SCOS 2017). The UK contains an estimated 38% of the world population (based on pup production) and the UK grey seal population in 2016-2017 was estimated to be 141,000-150,000 (SCOS 2017). Figure 6 illustrates the distribution and abundance of grey seals around the UK (from 2000 – 2006, Duck, (2010), taken from unreferenced SMRU work).

Grey seal pup numbers have increased year-on-year at the Lincolnshire / East Anglian sites, according to SCOS and National Trust data (Figure 8). Specifically, the grey seal breeding colony at Blakeney Point is now recognised as the largest breeding colony in England, despite only appearing in 2001 (National Trust 2019). A study of seal numbers in the Thames Estuary by ZSL in 2014 recorded 449 grey seals, which was double the previous year's count (Barker *et al.*, 2014).

Southern North Sea grey seal populations are found in The Wash, East Anglia and the Thames Estuary. SCOS data on grey seal movements and habitat use shows little evidence of habitat usage in Sizewell Bay and the surrounding area (see Figure 7) and seal surveys undertaken for the Greater Gabbard and Galloper wind farms recorded only six grey seal sightings in the vicinity of the windfarm site (GWF, 2011). However, marine mammal observations during recent geotechnical surveys in Greater Sizewell Bay recorded grey seal presence in the vicinity of Bridgwater Bay on a reasonably regular basis (seals recorded on 15 of 40 survey days during February and March 2015 see Figure 9 and Fugro EMU Ltd, 2015), and WWT survey data (2009) report seal sightings (not identified to species level) throughout the area (see Figure 4 [right]).

Grey seals are thought to travel up to 365 km between haul out sites and although typical foraging trips are within 100km, trips of several hundred km have been recorded (SCOS, 2017). The closest SAC designated for the presence of grey seals is the Humber Estuary, approximately 220km from the SZC development site, and there is one additional small colony (Goodwin Sands) approximately 100km to the south. It appears that grey seals are present around the proposed development, but do not utilise the area heavily. There are no grey seal haul out sites within 45 km of SZC (Russell et al 2017), but it is thought that seals do forage in the local area or pass through in transit between sites.

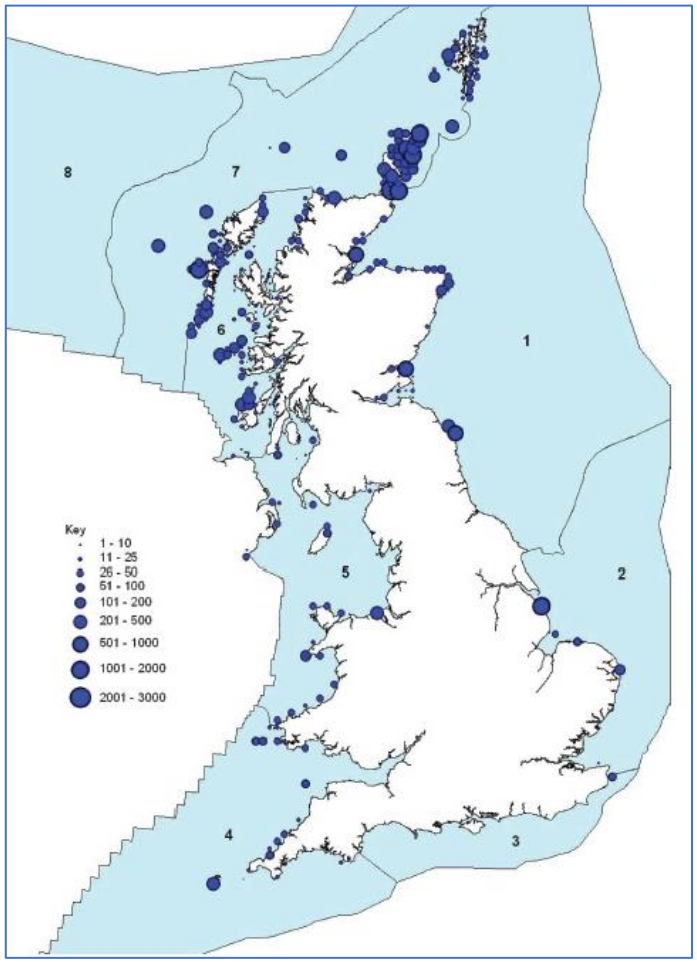

Figure 6. The distribution and abundance of grey seals around the UK (2000 – 2006, Duck, 2010).

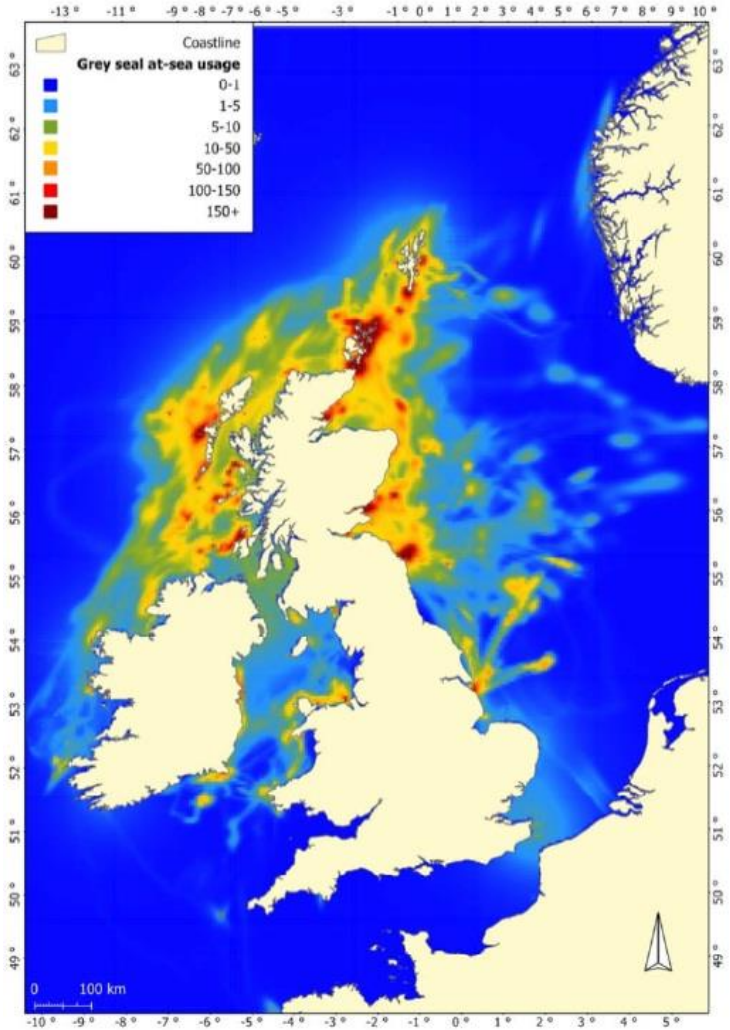

Figure 7. Estimated grey seal at sea usage around the UK (SCOS, 2012).

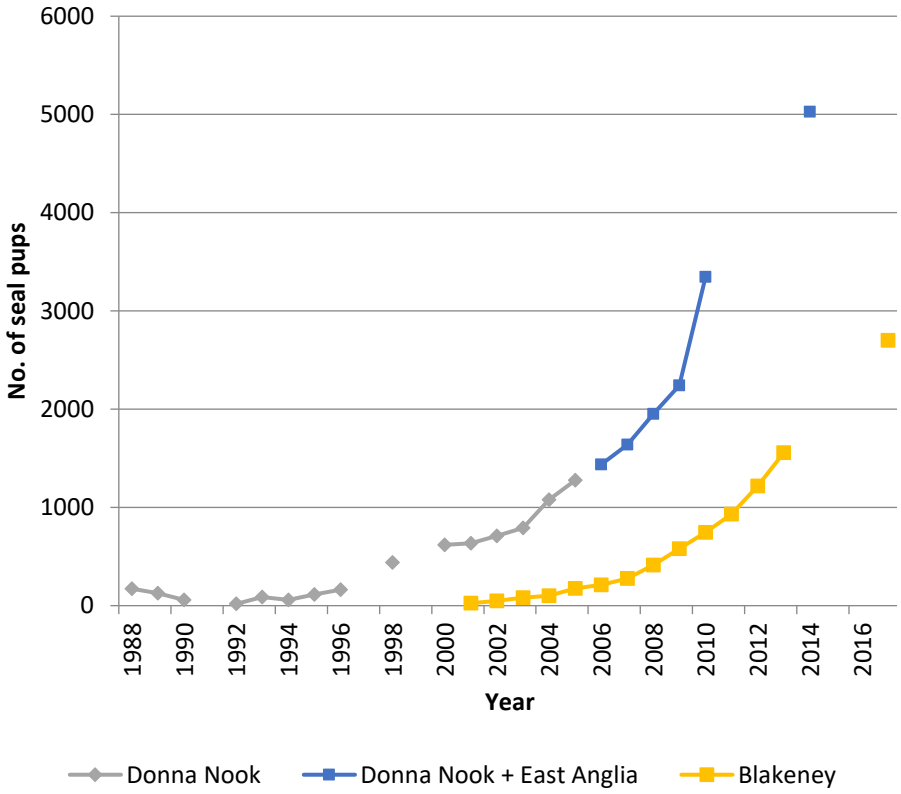

Figure 8. Grey seal pups in Lincolnshire and East Anglian colonies Years refer to the winter period i.e. 2001 represents winter 2001/2002. Donna Nook/Donna Nook and East Anglia data taken from the special committee on seals (SCOS) reports 1996 to 2011 (see http://www.smru.st-andrews.ac.uk/pageset.aspx?psr=411), Blakeney data taken from the National Trust's Eastern England site ((http://eastofenglandnt.wordpress.com/2014/02/01/successful-breeding-season-for-grey-seals/; accessed 21/10/2014).

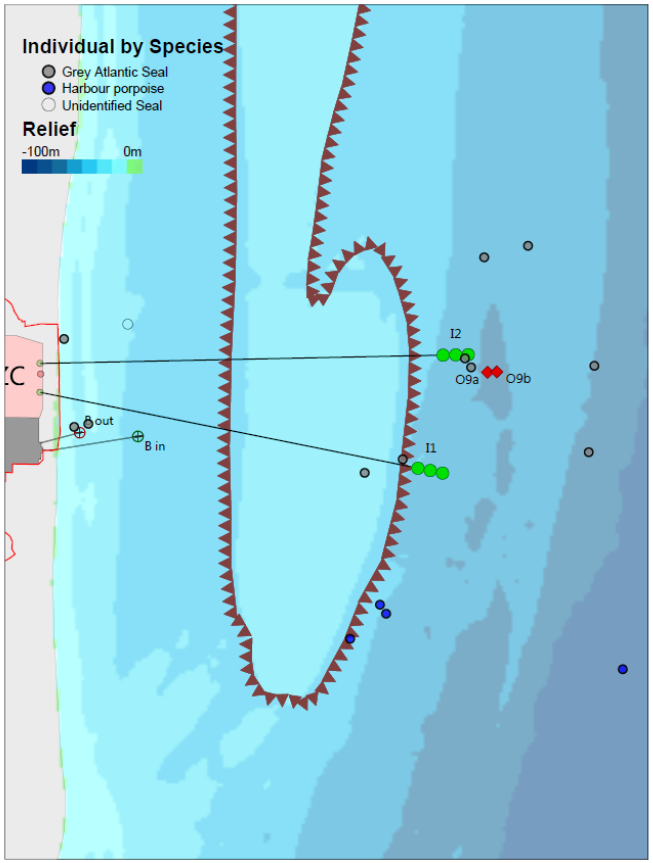

Figure 9. Sightings of harbour porpoise and grey seals during the February-March 2015 Fugro EMU geotechnical survey of the proposed Sizewell C cooling water infrastructure. The inshore Sizewell B and offshore proposed Sizewell C (green circles) cooling water infrastructure is

shown for reference. The serrated line denotes the Sizewell-Dunwich sandbank. Note that sightings were limited to up to 1 km of the survey vessel and so the absence of sightings in the north of the area should not be considered to evince an absence of mammals in this area. Data taken from Fugro EMU (2015).

2.2 Bird species recorded foraging around Greater Sizewell Bay

Sizewell site-specific usage information of the relevant protected marine bird species is available from ornithology surveys commissioned by EDF Energy from 2011 to 2014 (AMEC, 2012; Hyder, 2013a; Hyder, 2013b; Hyder, 2014). These surveys were primarily aimed at three species of local conservation importance - the SPA species red throated diver *Gavia stellata* during the winter and the little tern *Sternula albifrons* and sandwich tern *Thalassia sandvicensis* during the summer - though other species using the Greater Sizewell Bay were also recorded. The surveys were based on a 'vantage-point and viewshed' design, whereby viewing points were set at regular intervals along the coast (the vantage point) and observers recorded birds encountered within a semi-circular viewing area approximately 2 km[1] seawards of the point (the viewshed) (see Figure 10). Observers recorded the birds' behaviour, where possible. The survey contractors were consistent in recording foraging, although they differed in how they recorded other behaviour classes (not relevant to the present report) (Hyder, 2013b).

The initial surveys covered an area between Minsmere in the north and Orford Ness in the south. Later surveys were extended northwards to Dunwich, to account for possible vessel transit routes during construction of the Sizewell C infrastructure. Full details of the survey methodologies and outputs are given in Hyder (2013a, 2013b, 2014) and AMEC (2012).

[1] A distance of 2 km from the shore was determined by the contractors to be the approximate maximum distance within which red throated divers could be identified with a degree of certainty.

Figure 10: Example of the AMEC and Hyder Cresswell ornithology survey design, showing vantage points (numbered circles) and viewsheds (seawards semi-circles) at and immediately north and south of Sizewell. Earlier surveys utilised 12 vantage points, later surveys included 15. Taken from Hyder (2013b).

Seventy-nine bird species were recorded during the Greater Sizewell Bay surveys; fifty-five of them exhibiting some form of foraging behaviour; the remainder commuting/passing through and/or resting in the area (Full results are described in Hyder, 2013a; 2013b; 2014 and AMEC, 2012). Table 3 shows that red throated diver, sandwich tern, little tern and lesser black-backed gull were consistently found to be foraging in the Greater Sizewell Bay.

This site-specific information, along with other relevant foraging studies into the Sizewell SPA bird species has allowed the foraging ranges and colony sites to be identified for each relevant SPA bird species (Table 4

Table 3: Consistency of foraging activity for relevant species of conservation importance in the Greater Sizewell Bay. Species are marked as positive for foraging if they were observed foraging anywhere in the Bay at any point during a given month. Years are separated by colour for ease of viewing. There were no ornithology surveys in the months shaded in grey (Data taken from Hyder, 2013a; 2013b; 2014 and AMEC, 2012).

	2011										2012												2013												2014			No. months present	% of months present	Consistently foraging?
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	August	Sep	Oct	Nov	Dec	Jan	Feb	Mar			
Red throated diver																																						19	63	Yes, in winter
Sandwich tern																																						9	30	Yes, in two summers
Little tern																																						5	17	Yes, in two summers (no colonies third)
Lesser black-back																																						25	83	Yes


ed
gull

Table 4: Bird foraging ranges and colony information for relevant species of conservation importance in the Greater Sizewell Bay.

SPA	Species, presence	Foraging Range	Colony Information
Minsmere to Walberswick, Alde-Ore Estuary and Outer Thames Estuary	Breeding Little Tern (May to August)	2.4 km offshore, 3.9 km north and south (Parsons *et al.*, 2015)	1. Minsmere beach (O.S Grid Reference TM 477 666) 2. Dingle marshes (O.S. Grid Reference TM 489 733) 3. Slaughden beach (O.S. Grid Reference TM 463 550) (Arcadis, 2013. Pers. Communication with Philip Peason of the Suffolk Little Tern Group)
Alde-Ore Estuary	Breeding Sandwich Tern (April to August)	32 km radius (Wilson *et al.*, 2014)	1. Minsmere beach (O.S Grid Reference TM 477 666) 2. Orfordness, near the radio towers (approximately O.S. Grid Reference TM 454 512) 3. Slaughden beach (O.S. Grid Reference TM 463 550) (Suffolk Birds' Reports - Suffolk Naturalists Society 2004 to 2010-2013) (Amec Seabird report 2011-2012), (Hyder 2013b Little Tern survey report)
Alde-Ore Estuary	Breeding Lesser black-backed gull (April to August)	141km (Thaxter *et al.*, 2012)	1. Orfordness, near the radio towers (approximately O.S. Grid Reference TM 454 512) (Natural England, Alde-Ore Estuary Site Improvement Plan)
Outer Thames Estuary	Over wintering Red Throated diver September to March	Whole of SPA	Does not breed in this region.
Outer Thames Estuary	Breeding Common Tern (May to August)	18.6 km radius (Wilson *et al.*, 2014)	1. Orfordness, near the radio towers (approximately O.S. Grid Reference TM 454 512) 2. Minsmere scrape (O.S Grid Reference TM 475 667) (Arcadis, 2013. Pers Communication with RSPB), (Hyder 2013b Little Tern survey report)

3 Seasonal presence of fish and crustacea at Sizewell

Table 5 shows the measured seasonal presence of fish at Sizewell from the Sizewell B impingement surveys (BEEMS Technical Report TR345).

The most important fish families taken by breeding piscivorous seabirds in the North Sea are sandeels and clupeids with diets varying geographically and seasonally depending on the site-specific food availability (Tasker and Furness., 1996). The scientific literature frequently indicates that sandeels form a major part of the diet of terns (Common, Sandwich and Little Tern) and lesser black backed gulls in the North Sea. For example, Furness and Tasker 2000 estimate that sandeels form 40%, 60% and 20% respectively of the diet of the above three tern species in the southern and south-eastern North Sea. For seabirds in the north-western North Sea (such as Shetland and Orkney), there are no food-fish other than sandeels or adult herring and adult mackerel *Scomber scombrus*. These adult fish are too big for most seabirds to eat, and so most seabirds in this region feed predominantly on sandeels.

However, in the southern and eastern North Sea, the fact that sandeels form only a small part of the diet of many seabirds and that clupeids are predominant in many diets, suggests that clupeid abundance may be more important in determining breeding success than is sandeel abundance in these areas. This is supported by detailed studies of Common Tern breeding success in the southeastern North Sea, where it has been found that chick growth rate and fledging success are closely correlated with abundance of young herring (Greenstreet *et al.,* 1999).

The weight of evidence from BEEMS fishing, plankton, impingement and entrainment sampling is that sandeels are present at Sizewell but in small numbers (BEEMS Technical Report TR345). Sandeels spend most of their time buried in the sediment and are only found in the water column for a proportion of daylight hours. Due to their morphology they can pass through coarse mesh nets. For example, the 10mm drum screen mesh at Sizewell B would retain some sandeels with a variable proportion being entrained dependent upon the size of the fish. Impingement sampling data with a 10 mm mesh therefore provides a relative index of sandeel abundance not an absolute measure. In the BEEMS entrainment sampling (using pumped sampling from the Sizewell B forebay with 500 and 270 µm mesh nets) sandeel larvae only represented 2% of the number of fish entrained compared with 31% for clupeids (BEEMS Technical Report TR318).

The dominant fish species at Sizewell are sprat and herring which represent 64% of the total annual impingement numbers. The evidence from surveys is that only two of the five North Sea sandeel species are present at Sizewell:

- Lesser sandeel (*Ammodytes tobianus*). This is a small, common inshore species which reaches a maximum length of 20 cm, and is found along sandy shores from the mid-tide level to 30 m water depth. The species spawns from late March to early April throughout its range, depositing its eggs on the sandy substrate. This species represented 0.03% (See Table 5) of the annual Sizewell impingement numbers with 79% being caught in the December- January period.
- Greater sandeel (*Hyperoplus lanceolatus*) attains a length of approximately 32 cm. It is found in sand from the inter-tidal to 150 m depth. The species spawns in April and May at depths of 20-100 m. This species represented 0.026% (see Table 5) of the annual Sizewell impingement numbers with 71% being caught in the June -September period.

To put the relative abundances in context, the total annual sandeel impingement catch at Sizewell was 0.1% of the sprat catch and in the seabird breeding season of May to August sandeel only represented 0.5% of the sprat catch (indicative results from an interim analysis of BEEMS impingement surveys from 2009-2013). In the BEEMS pelagic fishing surveys in April and

May 2015 (with 2mm mesh nets) at three sites along Sizewell Bay, the near surface catch composition was 81-98% sprat and herring with sandeel never exceeding 1% of catch (BEEMS Technical Report TR356). From the available evidence it is concluded that sandeel form a negligible part of the fish assemblage at Sizewell and are, therefore, not an important component of SPA/SAC protected species in the region of the site.

Table 5: Relative abundance of fish and crustacea at Sizewell from impingement records (SZB numbers are indicative from a 2016 interim analysis of BEEMS impingement data)

Colour	Abundance: % peak month (marked 'X')	Colour	Abundance: % peak month (marked 'X')
	26% - 100%		1% - 5%
	6% - 25%		Not present or <1%

Species		SZB annual impingement numbers	% of total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sprat	*Sprattus sprattus*	1,933,302	47.5	x											
Herring	*Clupea harengus*	682,912	16.8			x									
Whiting	*Merlangius merlangus*	459,378	11.3		x										
Bass	*Dicentrarchus labrax*	363,990	8.9		x										
Sand Goby	*Pomatoschistus minutus*	185,196	4.6									x			
Dover sole	*Solea solea*	118,392	2.9				x								
Dab	*Limanda limanda*	66,317	1.6									x			
Anchovy	*Engraulis encrasicolus*	39,496	1.0						x						
Mullet, thin lipped	*Liza ramada*	33,674	0.8		x										
Flounder	*Platichthys flesus*	11,778	0.29			x									
Plaice	*Pleuronectes platessa*	10,466	0.26										x		
Cod	*Gadus morhua*	10,297	0.25	x											
Smelt, cucumber	*Osmerus eperlanus*	9,186	0.23								x				
Ray, thornback	*Raja clavata*	2,032	0.05				x								
European eel	*Anguilla anguilla*	1,046	0.03										x		
Mackerel, horse	*Trachurus trachurus*	979	0.02									x			
Shad, twaite	*Alosa fallax*	872	0.02					x							
River lamprey	*Lampetra fluviatilis*	830	0.02										x		

Mackerel	*Scomber scombrus*	364	0.01				x									
Sea trout	*Salmo trutta*	8	0.00					x								
Shad, allis	*Alosa alosa*	3	0.00					x								
Crustacea																
Swimming crab	*Liocarcinus holsatus*	429,076	6.9 (of crustacea)									x				

4 Likely marine prey of SPA/SAC designated species at Sizewell

4.1 Breeding Little Tern

Little terns are surface feeders capable of plunge-diving to depths of around one body length (22–24 cm) (Perrow *et al.,* 2011). A study at Winterton-on-Sea on the Norfolk coast in the period 2002- 2006 showed that the surface fish biomass was dominated by clupeids with very low numbers of greater sandeel. Clupeids dominated chick provisioning (82% of identified items). Perrow *et al.,* 2011.

Based upon fish availabilities at Sizewell (BEEMS Technical Report TR345), the prey of breeding Little Tern during the period May to August is expected to consist of schooling pelagic fish species that are found near to the sea surface during daylight hours - sprat, herring and anchovy.

4.2 Breeding Sandwich Tern

Sandwich Terns are surface feeders that can plunge-dive to a maximum depth of 2 m. Sandwich Terns predominantly feed on a few high quality prey species; in the southern North Sea these prey are mainly *Clupeidae* and *Ammodytidae*. A study on island of Griend situated in the centre of the western Dutch Wadden Sea during the breeding season in 1992-98 found that Sandwich Terns were feeding almost exclusively on clupeids (sprat *Sprattus sprattus* and herring *Clupea harengus*) and sandeeels (lesser sandeel *Ammodytes tobianus* and greater sandeel *Hyperoplus lanceolatus).* In total these prey species amounted to 99.3% of the chick diet. Other prey brought to the chicks on Griend in 1992-98 consisted of goby *Gobies* spp., cod *Gadus morhua,* whiting *Merlangius merlangus* and smelt *Osmerus eperlanus.* (Stienen *et al.,* 2000).

Based upon fish availabilities at Sizewell (BEEMS Technical Report TR345), the prey of breeding Sandwich Tern during the period April to August is expected to consist of schooling pelagic fish species that are found near to the sea surface during daylight hours - sprat, herring and anchovy.

4.3 Breeding Common Tern

Common Terns are surface or plunge divers. Herring (Clupea harengus) and sprat (Sprattus sprattus) are the key prey resources of common terns (Sterna hirundo) breeding in the Wadden Sea. (Danhardt and Becker, 2011).

Based upon fish availabilities at Sizewell (BEEMS Technical Report TR345), the prey of breeding Common Tern during the period May to August is expected to consist of schooling pelagic fish species that are found near to the sea surface during daylight hours - sprat, herring and anchovy.

4.4 Breeding Lesser Black-Backed gull

The lesser black-backed gull, *Larus fuscus*, is a surface-feeding seabird with a widespread, patchy distribution in the SE North Sea. The species can dive to about 0.5 m deep (Goethe, 1975) or take food items floating close to the surface by dipping. Swimming crabs *Liocarcinus* spp. are a major dietary item of this gull species. This natural food source is primarily captured close to the shore; at longer distances from the coast the gulls mainly feed on other natural prey items or discarded fishes from trawlers and avoid competition with other breeding gull species. (Schwemmer and Garthe, 2005; Kubetzki and Garthe, 2003).

Studies in the German Bight, SE North Sea at two different colonies revealed swimming crabs, *Liocarcinus* spp, fishes (up to 39 species) and terrestrial invertebrates to be the most frequent food items with proportions varying annually and between the two colonies studied (Kubetzki and Garthe, 2003). During the chick-rearing period, *Liocarcinus* spp. was found to be the most common prey type (44% -78%) followed by fishes (7-28%) and terrestrial invertebrates (17-18%). It was considered that fishes could be captured naturally, but could also originate from discards or by-catch of fishing vessels. When identifying fishes from pellets of lesser black-backed gulls to species level, a large quantity of fish species (such as gadids) that live close to the bottom were found which could only become available to gulls through anthropogenic activities. Discard experiments have shown that lesser black-backed gulls following fishing vessels mainly took up fishes but hardly fed on discarded crustaceans. Thus, it is considered likely that the high proportion of *Liocarcinus* spp. found in diet samples are obtained by natural feeding. By feeding mainly on pelagic crustaceans near the coast and following fishing vessels in offshore areas, the lesser black-backed gull tends to adopt two different feeding strategies resulting in different spatial and temporal distribution patterns. (Kubetzki and Garthe, 2003)

Based upon fish availabilities at Sizewell (BEEMS Technical Report TR345), the prey of breeding Lesser black-backed gull during the period April to August is expected to consist of schooling pelagic fish and crustacea that are found near to the sea surface - sprat, herring, anchovy and swimming crabs together with the waste from fishing vessels.

4.5 Over wintering red-throated divers

Red throated divers are piscivorous seabirds considered to be opportunistic feeders; their diet composition is reported to depend on local availability rather than on food specialisation (Guse *et al.,* 2009).

In the southwestern Baltic Sea, the diet of over wintering divers comprised eleven different fish species from nine different families. Their diet was dominated by zander and ruff in winter and herring in March-April. Prey size ranged from 2.4 cm total length, 0.1 g gobies to 29.5 cm, 180 g herring. The herring consumed had a mean length of 21-23 cm in spring, and 12 cm in winter. The distinct seasonal changes in the diet composition were paralleled and most probably in response to the migration pattern of the Western Baltic spring spawning herring which has its main spawning grounds adjacent to the study area. Red throated divers were reported to be selective feeders and did not take locally common flatfish. (Guse *et al.,* 2009).

In North Sea waters of northwest Denmark gadoids such as whiting (*Merlangius merlangus*) and blue whiting (*Micromesistius poutassou*) comprised the most important target species, followed by clupeids. (Durinck *et al.,* 1994). In the coastal waters of Lithuania smelt was the most important prey species and accounted for 75% of total fish biomass consumed, followed by herring (Zydelis, 2002). Cod, gobies, herring and sticklebacks dominated the diet of red throated divers in the Kattegat and Belt Sea (Guse *et al.,* 2009).

In summary, locally abundant benthopelagic schooling fish species typically found in the depth range of 2-8 m dominate the red throated diver's over wintering diet.

Based upon fish availabilities at Sizewell (BEEMS Technical Report TR345), the prey of overwintering red throated diver during the period September to March is expected to consist of the most commonly occurring benthopelagic species - sprat, herring, whiting and bass.

4.6 Bittern

The Bittern has a diverse diet, including fish, amphibians, insects, worms, leeches, molluscs, crustaceans, spiders, lizards, small birds and small mammals and the dietary constituents vary with locality and season. In the UK, fish, particularly eels, *Anguilla anguilla*, (47%) and rudd, *Scardinius erythrophthalmus*, (34%), are the most important component of their diet (Gilbert *et al.,* 2003) especially for the chicks (Noble *et al.,* 2004).

Gilbert *et al.* (2003) made an assessment of both nestling diet composition and selection of fish prey by bitterns in Britain. Sixty regurgitate samples from 44 broods were examined during visits to bittern nests made at nine sites in England from 1996 to 2001. Compositional analysis was used to assess the influence of age, season and year effects on diet. The fish component of the diet was compared with species found to be generally available within each site from electro fishing data. Eel (*Anguilla Anguilla)* and rudd (*Scardinius erythrophthalmus)* made up the greatest proportion of biomass of the diet and this proportion did not significantly change with the age of the chicks. The amount of eel in the diet changed during the season and the amount of rudd between years. From those fish species available, female Bitterns preferred to feed chicks on nine-spined sticklebacks *Pungitius pungitius*, eels (0-40 g), three-spined sticklebacks *Gasterosteus aculeatus* and rudd (0-20g).

Noble *et al.* (2004) surveyed the fish communities in the different compartments at Minsmere and found that rudd was the most prominent species with the abundance of eels in all compartments being generally low with catches comprising only a few relatively large individuals (>300 mm length and >100 g weight). This was in contrast to the Leighton Moss reserve in Lancashire which had much greater quantities of the smaller eels that bittern preferentially select for feeding their chicks (Knights, 2003).

The low eel abundance at Minsmere is not surprising given the nature of the site:

> *The Minsmere reedbed is a complex system of essentially isolated units in terms of fish movement, formed from three catchments and is controlled by a complex system of bunds and water control features. The wetland system is extensively controlled by a system of > 150 pipe sluices and one large sluice regulating the flow of water out of the site into the sea (the Minsmere tidal sluice) …. that regulates the drainage of the three catchments (*Noble *et al.,* 2004).

The three catchments are the Minsmere River (New Cut), Scott's Hall Drain from the north and Leiston Drain from the south (Figure 11). The Minsmere sluice was originally intended to prevent saltwater incursion into the site via gates on the New Cut and the Leiston Drain (water flow from the Scott's Hall drain into the sluice chamber is controlled by a manually operated penstock outside of the main sluice chamber). As such the Minsmere sluice would have acted as a substantial barrier to the migration of glass eels or elvers from the marine environment to freshwater which would be expected to occur via tidal stream transport on the flood tide. Nevertheless, some eels do manage to enter the Minsmere reserve (Knights, 2003).

When the Minsmere sluice was repaired in 2013/2014 it was found that the Leiston Drain sluice gate was corroded and was partially wedged open allowing seawater ingress on the flood tide. The restored tidally operated gate has been designed to close slowly on the rising tide thereby continuing to allow saltwater incursion to maintain the brackish habitat that has developed in that drain (Figure 12).

On both the New Cut and the Leiston Drain there are limited tidal windows when juvenile eels could migrate into the Minsmere area via the Minsmere Sluice and once into the site eels are capable of crossing damp land to reach different water courses.

The Scotts Hall penstock is used to deliberately allow some saltwater into the Minsmere reserve and is typically opened 3-4 times a month in the autumn, usually during daylight hours, just before high tide. The penstock is left open until the Reserve staff judge that sufficient flow has occurred. (Adam Rowlands, RSPB pers. comm. 6 September 2016). However, glass eels would not be expected to be present in autumn and so this occasional pathway would not be expected to be a viable migration route into the site for eels.

Given the substantial barriers to migration into the site for juvenile eels it is not surprising that eels are not common at Minsmere and that bitterns have to largely rely on freshwater fish prey.

The prey of Bitterns at Minsmere is expected to consist mostly of non-marine prey together with a limited number of eels.

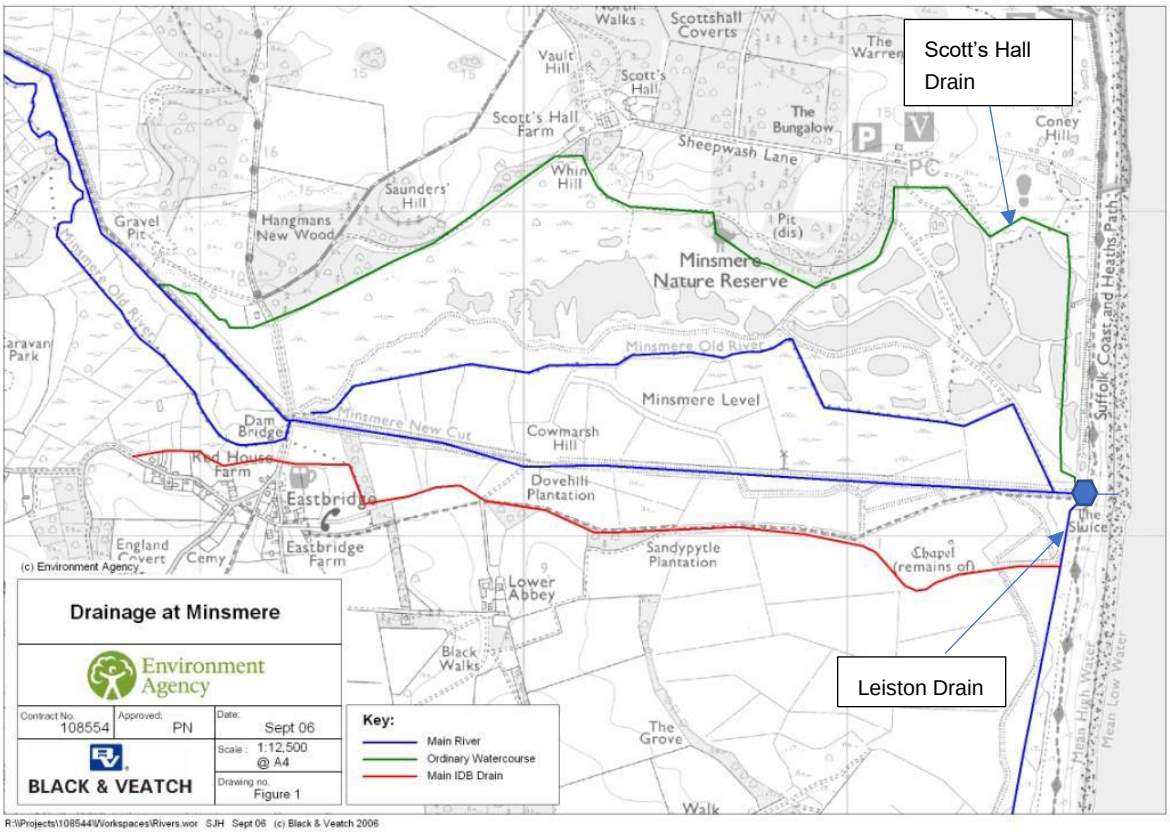

Figure 11: Minsmere drainage system from “Minsmere Sluice and Embankment Work” (EA, 2013).

Figure 12: Internal arrangement of Minsmere sluice from "Minsmere sluice update - work now complete" (RSPB, 2014).

4.7 Pied avocet (*Recurvirostra avosetta*)

Pied Avocets (*Recurvirostra avosetta*) feed in emerged intertidal areas and generally select muddy sediments as preferred feeding grounds (Moreira 1993). The foraging mechanism of the Recurvirostridae is unique among shorebirds and involves scything; picking or sweeping its curved bill laterally to locate prey (Hume 2009). Feeding is non-selective within the top 20 mm of sediment (Moreira, 1995a) and is thought to involve tactile or visual foraging strategies, depending on prey density (Ross, 2013). Prey species include the ragworm *Nereis diversicolor* and *Capitella capitata*, oligochaete worms including *Tubificoides pseudogaster* and *Monopylephorus rubroniveus,* siphons of the bivalve mollusc *Scrobicularia plana,* plant fragments, shrimps (*Palaernon spp*. and *Crangon crangon*), fish (*Pornatoschistus spp.*) and, occasionally, crabs *Carcinus maenas* (Moreira 1995; Moreira 1995a).

The prey of pied avocet is expected to consist mostly of on aquatic invertebrates such as insects, crustaceans, worms and molluscs.

4.8 Dark-bellied Brent Goose (*Branta bernicla bernicla*)

The Dark-bellied Brent Goose (*Branta bernicla bernicla*) primarily feeds on intertidal vegetation when these are exposed or covered by shallow water (Ranwell and Downing 1959). Feeding behaviour of the Brent Goose is highly seasonal.

Following migration to Europe from Russian breeding grounds, the geese initially feed on *Zostera* beds and green algae (*Enteromorpha* and *Ulva lactuca*). Salt marsh habitat is also targeted, although

this is largely at high tide when intertidal areas were not exposed (Summers and Critchley 1990). In winter months the birds exploit terrestrial food resources, adopting a diet of grasses and cereals. From mid-March onwards large numbers of geese returned to forage in intertidal habitats, and salt-marsh in particular is exploited both at high and low tide (Summers and Critchley 1990).

Tubbs and Tubbs (1982) described how seasonal movement of geese between intertidal habitats in autumn, to agricultural land in winter can be attributed to depletion of preferred food resources. Availability of *Zostera* in The Solent is historically low between early October and late December following leaf loss and storm damage. Similarly, green algae production peaks in August and September and declines to a minimum in January and February. These changes in availability coincide shifts in Brent Goose foraging areas.

The prey of the Dark-bellied Brent Goose is expected to consist *Zostera* beds, green algae such as *Ulva* and *Enteromorpha*), salt marsh plants and terrestrial grasses or farm crops.

4.9 Alde Ore seabird assemblage

The Alde-Ore SPA seabird assemblage predominantly consists of Little Tern, Sandwich Tern, Common Tern, Lesser black-backed gull, Black headed gull and Herring gull. The prey of the first four species have been described in this section 3.

The prey of Black headed gull and Herring gull are largely non-marine (see section 1).

The marine prey components of the Black headed gull diet are primarily bivalves and polychaetes from the intertidal zone.

The marine prey components of the Herring gull diet are primarily bivalves and crustacea from the intertidal zone together with discarded fish waste from fishing boats operating up to 40 km from shore.

4.10 Harbour Porpoise

BEEMS passive acoustic monitoring surveys found that harbour porpoise are common in the region of Sizewell, with the species detected on 64% of days during more than 1 year of automated acoustic monitoring. The highest occurrence rate was in winter (October – March), with more detected at night than during the day. The highest occurrence rate was also offshore (10-20 km from the Sizewell coast), with lower rates inshore (1-2 km from the coast) (BEEMS Technical Report TR271).

In the North Atlantic harbour porpoise feed on small shoaling fish species from both demersal and pelagic habitats (Gilles *et al.,* 2009). In Scottish North sea waters in the period 1992 – 2003 Santos *et al.* 2004 found geographical and seasonal variation in porpoise diets that reflected the local availability of fish species. Whiting and sandeels were the dominant prey fish whereas prior studies had found herring, sprat and whiting to be the main prey. The authors considered that the dietary change was due to seasonal changes in fish abundance.

In eastern Canadian coastal waters during 1969–1972 harbour porpoise diets comprised of nine fish species from seven families, with *Clupea harengus* (herring), *Gadus morhua* (cod), and Scomber scombrus (mackerel) accounting for more than 78% of the total. *Osmerus mordax* (smelt), Pollachius virens (pollock), Merluccius bilinearis (silver hake), Sebastes marinus (redfish), and Macrozoarces americanus (ocean pout) and Squid (Illex sp.) were also present (Smith and Gaskin, 1974).

In the German North Sea analysis of harbour porpoise stomach contents revealed that goby (Gobiidae), cod *Gadus morhua*, sole *Solea solea*, sandeel *Ammodytes* sp. and herring *Clupea harengus* were important constituents of their overall diet. (Gilles *et al.,* 2009).

Given the variation in the diet of the porpoise, they could be considered opportunistic predators, or flexible feeders that they can switch to a different prey species if the preferred prey are not sufficiently available. However, prey abundance is not the sole factor influencing feeding rates, and prey quality can lead to selective foraging strategies Spitz *et al.,* (2012).

Based upon fish availabilities at Sizewell (BEEMS Technical Report TR345) the prey of harbour porpoise is expected to consist of:

- **In winter (the period when harbour porpoise occur most frequently at Sizewell) – sprat, herring, whiting, bass, gobies and Dover sole.**
- **In summer – sprat, whiting, Dover sole, gobies and dab.**

4.11 Harbour seal (*Phoca vitulina*)

The Scottish Government funded a project in 2010 to provide a comprehensive assessment of common seal diet, through the analysis of prey remains in scat. The results show that common seal diet in the North Sea (including Orkney and Shetland) where local harbour seal populations are in decline, is heavily dominated by sandeels which are the primary prey throughout the year (Wilson and Hammond, 2016). This is reflected in other studies, for example, Pierce *et al.,* (1991) and Thompson *et al.,* (1991) observed that the diet of common seals in the Moray Firth tended to be predominantly sandeels in summer and clupeids in winter, although octopus and gadoids (predominately whiting) were also important. Pierce *et al.,* (1991) concluded that the trends they observed were consistent with opportunistic foraging on the most abundant prey.

Similar results were observed in a study in Iceland (Hauksson and Bogason, 1997), where again sandeel were seen to be a more important component in common seal diet in summer, with capelin (*Mallotus villosus*) and herring (*C. harengus*) were more important in winter. However, cod was important in their diet throughout the year and a range of other prey species were found, including redfish (*Sebastes* sp.), saithe (*Pollachius virens*) and catfish (*Anarhichas lupus*). Similar too were results from a study in the Rødsand area of Denmark. Andersen *et al.*, (2007) processed 26 samples over a five-year period and found evidence of 20 different prey species. The diet at Rødsand was predominantly made up of cod, herring, sandeel, flounder (*Platichthys flesus*), plaice (*Pleuronectes platessa*) and dab (*Limanda limanda*), with importance in diet depending on the season.

In the south western North Sea, however, the common seal diet was different, with whiting, Dover sole (*Solea solea*), dragonet (*Callionymus lyra*) and sand gobies (*Pomatoschistus minutus*) making up the majority (63 %) of their diet and a total of 31 different species recorded (Hall *et al.,* 1998). Diet again varied by season and the authors concluded that diet composition appeared to be mainly linked to prey availability and abundance. A small study of common seals during the months of January to May in the Thames Estuary (n = 6 scats) found flounder, whiting, sprat and sandeel otoliths present in the scats (3, 2, 1 and 1 otoliths, respectively; Barker *et al.*, 2014). Hall *et al.,* (1998) also reviewed studies from other areas of Europe and concluded that common seals are opportunistic foragers, consuming a wide variety of prey species, dependant on the seasonality and local availability. Work undertaken by Iverson *et al.,* (1997) further support this conclusion, where fatty acid profiles in prey showed that common seals depend on a very localised prey source. However, as for harbour porpoise, it seems that while common seals are opportunistic predators and feed on a wide variety of prey species, their diet is dominated by a few key species.

Based upon fish availabilities at Sizewell (BEEMS Technical Report TR345) the prey of common seals is expected to consist of whiting (*Merlangius merlangus*), Dover sole (*Solea solea*), and sand gobies (*Pomatoschistus minutus*)

4.12 Grey seal (*Halichoerus grypus*)

In north eastern Scotland, Hammond *et al.* (1994) investigated the diet of grey seals by collecting and analysing approximately 1000 seal scats. Sandeels comprised by weight almost half the diet. Other important components of their diet were gadoids (in particular cod), flatfish (in particular plaice) and sculpins. As for common seals, the importance of sandeels varied depending on time of year, but no differences were found in the numbers of cod, haddock (*Melanogrammus aeglefinus*) or saithe consumed during the year. Seal scat was again examined from seals in the south western North Sea (Donna Nook in Lincolnshire; Prime & Hammond, 1990), where only three species (sandeel, cod and Dover sole) accounted for approximately 56 % of the diet, with dab, flounder and plaice contributing another 22 %. As for other studies, the importance of prey species depended on the time of year, though in Prime & Hammond's (1990) study, all species changed in importance, while in the Scottish studies certain species were present in the diet year-round. In the Baltic, herring appears to be the dominant prey followed by species such as common whitefish (*Coregonus lavaretus*), flounder, cyprinids (*Cyprinidae*), sprat, lumpsucker (*Cyclopterus lumpus*), cod and eelpout (*Zoarces viviparus*; Lundström *et al.*, 2007). A more recent study by Hammond and Wilson (2016), has shown that the diet of grey seals in the North Sea was dominated by sandeels (56%) with gadoid prey (particularly cod and saithe) comprising about 20% of the total diet.

Like common seals, grey seals appear to be opportunistic foragers, eating a wide variety of prey types depending on location and season, but the diet predominantly consists of a few key species. Grey seals tend to range more widely than common seals and are able to forage several hundred kilometres offshore, with foraging trips lasting between one and 30 days, accordingly some differences in their diets based on differences in fish distributions may be expected.

Based upon fish availabilities at Sizewell (BEEMS Technical Report TR345) the prey of grey seals is expected to largely consist of Dover sole (*Solea solea*), flounder (*Platichthys flesus*), and plaice (*Pleuronectes platessa*).

5 References

AMEC. 2012. Seabird Report 2011 to 2012. Report to EDF Energy.

Andersen, S. M., Teilmann, J., Harders, P. B., Hansen, E. H., and Hjollund, D. (2007) Diet of harbour seals and great cormorants in Limfjord, Denmark: interspecific competition and interaction with fishery. *ICES Journal of Marine Science*, **64 (6):** 1235-1245.

Barker, J., Seymour, A., Mowat, S., and Debney, A. (2014). Thames harbour seal conservation project. UK and Europe conservation programme. Zoological Society of London. June 2014.

BEEMS Technical Report TR271. Static Acoustic Monitoring for Harbour Porpoise and Dolphins off the Sizewell Site Using C-PODs. SMRU.

BEEMS Technical report TR318. Predictions of entrainment by Sizewell C in relation to adjacent fish and invertebrate populations. Cefas, Lowestoft.

BEEMS Technical Report TR345. Sizewell Characterisation report – Fish. Cefas, Lowestoft.

BEEMS Technical Report TR356. Sizewell Glass eel surveys. Cefas, Lowestoft.

BEEMS Technical Report TR483. . Cefas, Lowestoft.

Camphuysen, K.C.J. 1995. Herring Gull *Larus argentatus* and Lesser black-backed Gull *L. fuscus* feeding at fishing vessels in the breeding season: competitive scavenging versus efficient flying. ARDEA 83(2).

Cleeves, T., & Holden, P. (2014). RSPB handbook of British birds. A&C Black.

Cramp, S. and K. E. L. Simmons, Eds. 1983. Handbook of the Birds of Europe, the Middle East and North Africa. The Birds of the Western Palearctic, vol. III. Oxford University Press, London.

Danhardt, A. and Becker, P.H. 2011. Herring and Sprat Abundances Indices Predict Chick Growth and Reproductive Performance of Common Terns Breeding in the Wadden Sea. Ecosystems 14: 791–803.

del Hoyo, J., Elliott, A., and Sargatal, J. 1996. Handbook of the Birds of the World, vol. 3: Hoatzin to Auks. Lynx Edicions, Barcelona, Spain.

Duck, C. (2010) Charting Progress 2 Healthy and Biological Diverse Seas Feeder Report: Section 3.5: Seals. Published by Department for Environment Food and Rural Affairs on behalf of UKMMAS. Pp. 506-539. In: *UKMMAS (2010) Charting Progress 2 Healthy and Biological Diverse Seas Feeder Report (Eds. Frost, M & Hawkridge, J).*

Durinck, J., Skov, H., Jensen, F.P., and Pihl, S. 1994. Important marine areas for wintering birds in the Baltic Sea.

EA. 2013. Minsmere Sluice and Embankment Work. Available from: http://aldringham.onesuffolk.net/assets/Uploads/News--Events-Documents/Minsmere-sluice-fact-sheet-Jan-2013.pdf.

EDF Energy. 2014. Sizewell C Proposed Nuclear Development HRA Evidence Plan, October 2014.

Fugro EMU Ltd (2015). Sizewell offshore services – site survey. Marine mammal mitigation report UKCS Block: 24. Fugro EMU project number J/3/05/278. Fugro EMU Ltd, Portchester.

Furness, R. W., and Tasker, M. L. 2000. Seabird-fishery interactions: quantifying the sensitivity of seabirds to reductions in sandeel abundance, and identification of key areas for sensitive seabirds in the North Sea. Mar Ecol Prog Ser Vol. 202: 253–264.

Furness, R.W., Wade, H.M., Robbins, A.M.C., and Masden, E.A. 2012. Assessing the sensitivity of seabird populations to adverse effects from tidal stream turbines and wave energy devices. ICES J Mar Sci 69 (8): 1466-1479.

Gilbert, G., Tyler, G., and Smith, K.W. 2003. Nestling diet and fish preference of Bitterns *Botaurus stellaris* in Britain. Ardea 91(1): 35-44.

Gilles, A., Scheidat,M., and Siebert, U. 2009. Seasonal distribution of harbour porpoises and possible interference of offshore wind farms in the German North Sea. Mar. Ecol. Prog Ser. Vol. 383: 295–307.

Goethe, F. 1975. Zur Biologie der Heringsmöwe *Larus fuscus* unter besonderer Berücksichtigung ethologischer Aspekte. Ornis Fennica 52:5–12.

Greenstreet, S.P.R., Becker, P.H., Barrett, R.T., Fossum, P., and Leopold., M.F. 1999. Consumption of pre-recruit fish by seabirds and the possible use of this as an indicator of fish stock recruitment. ICES Coop. Res. Rep. No. 232: 6-17.

Guse, N., Garthe. S., and Schirmeister, B. 2009. Diet of red-throated divers Gavia stellata reflects the seasonal availability of Atlantic herring Clupea harengus in the southwestern Baltic Sea. Journal of Sea Research 62: 268–275.

Galloper Wind Farm (GWF) Limited (2011) Galloper Wind Farm Project. Environmental Statement – Chapter 1 Introduction. Document Reference 5.2.1, pp. 2128.

Hall, A.J., Watkins, J and Hammond, P.S. 1998. Seasonal variation in the diet of harbour seals in the south-western North Sea. *Marine Ecology Progress Series,* **170:** 269 – 281.

Hammond, P.S., Hall, A.J. and Prine, J.H. 1994. The diet of grey seals around Orkney and mainland sites in north eastern Scotland. *Journal of Applied Ecology,* **2:** 340 – 350.

Hammond, P.S. and Wilson, L.J. 2016. Grey Seal Diet Composition and Prey Consumption. *Scottish Marine and Freshwater Science*, 7 (20): 47pp.

Hauksson, E. and Bogason, V. 1997 Comparative feeding of grey (*Halichoerus grypus*) and common seals (*Phoca vitulina*) in coastal waters of Iceland, with a note of the diet of hooded (*Cystophora cristata*) and harp seals (*Phoca groenlandica*). *Journal of the Northwest Atlantic Fisheries Science,* **22:** 125 – 135.

Hume, R. 2009. RSPB complete birds of Britain and Europe. Dorling Kindersley Ltd.

Hyder. 2013a. Sizewell C Nuclear Power Station, Red Throated Diver Survey Report 2012 - 2013. Report No. 003 - UA004506-S-EX036.

Hyder. 2013b. Sizewell C Ecological Support, Little Tern Survey Report 2013. Report No. UA004506-S-EX064-001.

Hyder. 2014. Sizewell C Ecological Support, Red Throated Diver Survey Report 2013 - 2014. Report No. S-EX066-UA005653-UE21-Red-throateddiverreport2013-14-R-01.

IAMMWG. 2015. Management Units for cetaceans in UK waters (January 2015). JNCC Report No. 547, JNCC Peterborough.

Iverson, S.J., Frost, K.J., and Lowry, L.F. 1997 Fatty acid signatures reveal fine scale structure of foraging and distribution of harbour seals and their prey in Prince William Sound, Alaska. *Marine Ecology Progress Series,* **151:** 255-271.

JNCC (2001). The UK SPA Network: Its Scope and Content: Volume 1: Rationale for the Selection of Sites. Joint Nature Conservation Committee.

JNCC. 2017. SAC Selection Assessment: Southern North Sea. January, 2017. Joint Nature Conservation Committee, UK. Available from: http://jncc.defra.gov.uk/page-7243.

Knights, B. 2003. Enhancing stocks of European eel, *Anguilla anguilla*, to benefit bittern, *Botaurus stellaris*. In: I.G. Cowx (ed.). Interactions between fish and birds: Implications for management. Oxford: Fishing News Books, Blackwell Science, pp. 298–313.

Kubetzki, U., and Garthe, S. 2003. Distribution, diet and habitat selection by four sympatrically breeding gull species in the south-eastern North Sea. Marine Biology, 143: 199.

Moreira. F. 1993. Macrohabitat selection by waders in the Tagus estuary (Portugal). Port. 2001. 2: 1-15.

Moreira. F. 1995. The winter feeding ecology of Avocets Recur- wirostru avosetta on intertidal areas. I. Feeding strategies. Ibis 137: 92-98.

Moreira, F. 1995a. The winter feeding ecology of Avocets Recurvirostra avosetta on intertidal areas. II. Diet and feeding mechanisms. *Ibis*, *137*(1), 99-108.

National Trust (2019). https://www.nationaltrust.org.uk/news/blakeney-point-remains-largest-grey-seal-colony-in-england accessed 19th June 2019

Noble, R.A.A., Harvey,J.P., and Cowx, I.G. 2004. Can management of freshwater fish populations be used to protect and enhance the conservation status of a rare, fish-eating bird, the bittern, *Botaurus stellaris*, in the UK? Fisheries Management and Ecology, 11, 291‐302.

Parsons, M., Lawson, J., Lewis, M., Lawrence, R., and Kuepfer, A. 2015. Quantifying foraging areas of little tern around its breeding colony SPA during chick-rearing. JNCC report No.548. JNCC, Peterborough.

Perrow, M.R., Gilroy, J.J., Skeate, E.R., and Tomlinson, M.L. 2011. Effects of the construction of Scroby Sands offshore wind farm on the prey base of Little tern *Sternula albifrons* at its most important UK colony. Marine Pollution Bulletin 62, 1661–1670.

Pierce, G. J., Thompson, P. M., Miller, A., Diack, J. S. W., Miller, D. and Boyle, P. R. 1991 Seasonal variation in the diet of common seals (*Phoca vitulina*) in the Moray Firth area of Scotland. *Journal of Zoology,* **223:** 641–652.

Prime, J. H., & Hammond, P. S. 1990. The diet of grey seals from the south-western North Sea assessed from analyses of hard parts found in faeces. *Journal of Applied Ecology*, 435-447.

Ranwell, D. S., & Downing, B. M. 1959. Brent goose (Branta bernicla (L.)) winter feeding pattern and Zostera resources at Scolt Head Island, Norfolk. *Animal Behaviour*, *7*, 42-56.

Read, A.J. and Westgate, A.J. 1997. Monitoring the movements of harbour porpoises (*Phocoena phocoena*) with satellite telemetry. Marine Biology 130: 315-322.

Ross, K. E. 2013. Investigating the physical and ecological drivers of change in a coastal ecosystem: from individual to population scale impacts (Doctoral dissertation, Bournemouth University).

RSPB. (n.d.). Information on birds and wildlife. Available from: https://www.rspb.org.uk/birds-and-wildlife/bird-and-wildlife-guides/bird-a-z/.

RSPB. 2014. Minsmere sluice update – work now complete. Available from: http://www.rspb.org.uk/community/placestovisit/minsmere/b/minsmere-blog/archive/2014/04/10/minsmere-sluice-update-work-now-complete.aspx.

Russell, D. J. F., Jones, E. L., & Morris, C. D. (2017). Updated Seal Usage Maps: The Estimated at-sea Distribution of Grey and Harbour Seals. Scottish Marine and Freshwater Science, **8**(25), 2027-1.

Santos, M B., Pierce, G.J., Learmonth, J.A., Reid, R.J., Ross,H.M., Patterson, I.A.P. Reid, D.G., and Beare, D. 2004. Variability in the diet of Harbor Porpoises porpoises (*Phocoena phocoena*) in Scottish waters 1992–2003. Marine Mammal Sci. Vol. 20, Issue 1: 1–27.

Schwemmer, P., and Garthe, S. 2005. At-sea distribution and behaviour of a surface-feeding seabird, the lesser black-backed gull *Larus fuscus*, and its association with different prey. Mar Ecol Prog Ser Vol. 285: 245–258.

Sharples, R.J., Matthiopoulos, J. and Hammond, P.S. 2008 Distribution and movements of Harbour seals around the coast of Britain. *Report to the Department of Energy and Climate Change (DECC).* Sea Mammal Research Unit, St Andrews, UK, 65pp.

Sharples, R. J., Moss, S. E., Patterson, T. A., and Hammond, P. S. 2012. Spatial Variation in Foraging Behaviour of a Marine Top Predator (*Phoca vitulina*) Determined by a Large-Scale Satellite Tagging Program. PLoS ONE, 7: e37216.

Special Committee on Seals (SCOS). 2009. Scientific Advice on Matters Related to the Management of Seal Populations: 2009. Available at www.smru.st-and.ac.uk

Special Committee on Seals (SCOS). 2012. Scientific Advice on Matters Related to the Management of Seal Populations: 2012. SCOS Main Advice Report: 159–163. Available at www.smru.st-and.ac.uk

Special Committee on Seals (SCOS). 2017. Scientific Advice on Matters Related to the Management of Seal Populations: 2017. St Andrews: Sea Mammal Research Unit, SCOS Main Advice.: 116. Available at www.smru.st-and.ac.uk

Spitz J., Trites A.W., Becquet V., Brind'Amour A., Cherel Y., Galois R., Ridoux V. 2012 Cost of living dictates what whales, dolphins and porpoises eat: the importance of prey quality on predator foraging strategies. PLOS ONE 7: e50096

Smith, G. J. D., and Gaskin, D. E. 1974. The diet of harbor porpoises (*Phocoena phocoena* (L.)) in coastal waters of Eastern Canada, with special reference to the Bay of Fundy. Canadian Journal of Zoology, 52(6): 777-782, 10.1139/z74-102.

Stienen, E.W.M., van Beers, P.W.M., Brenninkmeijer, A., Habraken, J.M.P.M., Raaijmakers, M.H.J.E., and van Tienen, P.G.M., 2000. Reflections of a specialist: patterns in food provisioning and foraging conditions in sandwich terns *Sterna sandvicensis*. Ardea 88, 33–49.

Summers, R. W., & Critchley, C. N. R. (1990). Use of grassland and field selection by Brent Geese Branta bernicla. *Journal of applied ecology*, 834-846.

Sveegaard, S., Teilmann, J., Tougaard, J., Dietz, R., Mouritsen, K.N., Desportes, G. and Siebert, U. 2011. High-density areas for harbor porpoises (*Phocoena phocoena*) identified by satellite tracking. Marine Mammal Science, 27(1): 230–246 (January 2011).

Tasker, M.L., and Furness, R.W. 1996. Estimation of food consumption by seabirds in the North Sea. In Seabird/fish interactions, with particular reference to seabirds in the North Sea. ICES Coop. res.rep., No 216.

Thaxter, C.B., Lascelles, B., Sugar, K., Cook, A.S., Roos, S., Bolton, M., Langston, R.H. and Burton, N.H. 2012. Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas. Biological Conservation, 156: 53-61.

Thompsen, P.M., Pierce, G.J., Hislop, J.R.G, Miller, D and Diack, J.S.W. (1991) Winter foraging by common seals (*Phoca vitulina*) in relation to food availability in the inner Moray Firth, N.E. Scotland. *Journal of Animal Ecology,* **60 (1):** 283 – 294.

Thompson, P.M., McConnell, B.J., Tollit, D.J., MacKay, A., Hunter, C. and Racey, P.A. (1996) Comparative distribution, movements and diet of harbour and grey seals from Moray Firth, N.E. Scotland. *Journal of Applied Ecology,* **33:** 1572 – 1584.

Tubbs, C. R., & Tubbs, J. M. 1982. Brent geese Branta bernicla bernicla and their food in the Solent, Southern England. *Biological Conservation*, 23(1), 33-54.

Vickery, J. A., Sutherland, W. J., Watkinson, A. R., Rowcliffe, J. M., & Lane, S. J. (1995). Habitat switching by dark-bellied brent geese Branta b. bernicla (L.) in relation to food depletion. Oecologia, 103(4), 499-508

Wildfowl and Wetlands Trust Consulting (2009) Distributions of Cetaceans, Seals, Turtles, Sharks and Ocean Sunfish recorded from Aerial Surveys 2001-2008. WWT Consulting. Report to Department of Energy and Climate Change.

Wilson, L.J., Black, J., Brewer, M.J., Potts, J.M., Kuepfer, A., Win, I., Kober, K., Bingham, C., Mavor, R. and Webb, A. 2014. Quantifying usage of the marine environment by terns *Sterna* sp. Around their breeding colony SPAs. JNCC Report No. 500. JNCC, Peterborough.

Wilson, L.J. and Hammond, P.S. 2016. Harbour seal diet composition and diversity. *Scottish Marine and Freshwater Science*, 7 (21), 84pp.

Žydelis, R., Gražulevič, G., Zarankaitė, J., Mečionis, R. and Mačiulis, M., 2002. Expansion of the Cormorant (Phalacrocorax carbo sinensis) population in western Lithuania. Acta Zoologica Lituanica, 12(3), pp.283-287.