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**METOC**

**Note: This document is only a section of the Final Environmental Report**

**Scottish Marine Renewables SEA**  
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# Glossary & Abbreviations

CEH	Centre for Ecology and Hydrology
EIA	Environmental Impact Assessment
JNCC	Joint Nature Conservation Committee
Loafing	The action of birds passively floating on the water
M	Metre
M <sup>2</sup>	Metre squared
RAMSAR	The Convention on Wetlands of International Importance, especially as waterfowl habitat.
RSPB	Royal Society for the Protection of Birds
SNH	Scottish Natural Heritage
SPA	Special Protection Area. Site designated to protect certain rare or vulnerable bird species under the 1979 EC Birds Directive. The sites generally support significant numbers of internationally important species.
UKBAP	UK Biodiversity Action Plan

# C8 Marine Birds

## C8.1 Introduction

This chapter considers description of the main distributions of bird species within the study area, and the potential effects that wave and tidal devices have on them. The description is split into species groups containing species with similar ecologies for ease of comparison. Consideration is given to the use of the waters of western and northern Scotland by birds during the breeding season. The most important breeding locations for species studied have been designated as Special Protection Areas (SPAs), and these are listed in Table C8.1. In addition, the importance of the area for migrating and wintering birds will also be considered. Descriptions made put the importance of the area in relation to the rest of the United Kingdom. The key references listed at the end of this report for distribution and numbers of divers, grebes and seaduck are Gibbons *et al* (1993), Lack (1986), Barton & Pollock (2004, 2005), Cranswick *et al* (2005), Collier *et al* (2005), Dean *et al* (2003, 2004a, 2004b) and Wilson *et al* (2006). The key references for distributions and numbers of seabirds (fulmar, shearwaters, storm-petrels, gannet, cormorants, skuas, gulls, auks) are Gibbons *et al.* (1993), Lack (1986), Stone *et al.* 1995; Mitchell *et al.* (2004); Mackey & Gimenez (2005), Barton & Pollock (2005) and JNCC's annual reports on seabird numbers and breeding success (most recent is Mavor *et al.* 2006).

Figure C8.1 accompanies this chapter.

## C8.2 Baseline Environment

### C8.2.1 *Bird Distribution*

#### C8.2.1.1 Divers

##### **Species: red-throated diver, black-throated diver, great northern diver**

The study area holds important breeding populations of red-throated and black-throated divers (8 SPAs and 9 SPAs respectively, scattered throughout the region). Black-throated divers are located in freshwater systems, both species are known to forage in inshore marine waters during the breeding season, in particular the red-throated diver do all their foraging in marine waters and only use freshwater as a landing pad/runway by the nests on the moorland. However, the distribution of these two species in summer is poorly understood and is being addressed by radio-tracking studies of breeding Red-throated divers by the Joint Nature Conservation Committee (JNCC).

These two diving species use the marine environment extensively outside the breeding season and may be broadly found in sandy bays throughout the study area. Whilst certain locations have been identified by surveys, the available data are patchy. However, whilst the north and west of Scotland holds important numbers of black-throated diver in winter, the main concentrations of red-throated are on the east coast of Scotland. During the non-breeding season, divers are marine, both close inshore and further offshore – up to several 10s of km.

Northern and western Scotland holds very important numbers of great northern diver in winter. The study area is the stronghold for this species in winter in the UK. Great northern divers prefer rocky to sandy shores, and their distribution extends more offshore than the other two diver species. Large concentrations are found in particular along the rocky shores and bays of the northern isles and Western Isles, and there is a concern, in Shetland at least, that numbers are in sharp decline (Heubeck 2005).

### C8.2.1.2 Grebes

**Species: great-crested grebe, red-necked grebe, Slavonian grebe, black-necked grebe**

There are no SPA designations in the study area pertinent to these species, and, unlike divers, they are distributed almost exclusively in freshwater environments in the summer. However, all these species forage in inshore marine waters outside the breeding season. The Slavonian grebe is the most marine of the grebe species outside the breeding season, and the most common in the study area with concentrations in the Western and Northern Isles. Great-crested grebes are less widespread and concentrated in the Solway Firth (North Channel) and Firth of Clyde (Argyll and Bute). Red-necked and black-necked grebes are both rare in the study area, and follow the winter distribution of great-crested grebes i.e. inshore coasts and bays in the southern portion of the study area.

### C8.2.1.3 Fulmar

**Species: northern fulmar**

The fulmar is common throughout much of Scotland, but the vast majority of breeding sites are to be found in the study area itself, with 10 SPAs designated for the important breeding populations of this species, notably in Shetland and the Western Isles. During the breeding season, the fulmar is principally an offshore feeder, obtaining the majority of its food outside the study area, but can also be found in considerable numbers in inshore regions. Furthermore, fulmars are the only British seabirds that occupy their nest sites throughout the winter, so presence in inshore waters close to the colonies occurs year-round. Fulmars can dive to 4 m but are generally surface feeders.

### C8.2.1.4 Shearwaters

**Species: Cory's shearwater, great shearwater, sooty shearwater, Manx shearwater, Balearic shearwater**

The only shearwater species present in important numbers is the Manx shearwater, with one colony with SPA status in the Inner Islands (a large colony on Rum), and one in the Outer Islands (a smaller colony on St Kilda). The Manx shearwater is principally an offshore feeder, believed to be obtaining the majority of its food outside the study area during the breeding season, but also spends considerable time in rafts in close proximity to colonies (McSorley *et al.* 2006). Manx shearwaters use several feeding modes – surface feeding and pursuit diving. It also uses the study area for migration, travelling along the western coasts of Scotland en-route to its wintering grounds in the southern hemisphere. The other four species are all scarce in the study area, with birds present on passage in autumn (in particular Sooty and great shearwaters), regularly seen on the same flying routes as the Manx shearwater.

### C8.2.1.5 Storm-petrels

**Species: European storm-petrel, Leach's storm-petrel**

The study area holds the main UK concentrations of breeding European storm-petrels (8 SPAs) and the entire known UK breeding population of Leach's storm-petrel (6 SPAs), principally in the Northern and Western Isles. These two species are difficult to survey and, in contrast to other seabird species described here; it is possible that some colonies have been overlooked. Precise foraging distributions are poorly understood but concentrations of both species, Leach's storm-petrel in particular, are to be found offshore to the west of colonies, close to the shelf edge. In winter, both species migrate to the tropics and southern hemisphere.

#### C8.2.1.6 Gannet

##### **Species: northern gannet**

Gannetries are scattered throughout the UK from southern Wales, much of Scotland and into northern England. The study area holds significant numbers of birds, including the largest colony in the world at St Kilda plus five other SPA-designated colonies. The gannet is principally a pelagic feeder during the breeding season (Hamer *et al.* 2000), capable of travelling several hundreds of kilometres on single foraging trips, but will also spend considerable time in close proximity to the colony for loafing and feeding (McSorley *et al.* 2003). Although much of the population disperses to southern Europe and western Africa in winter, birds can be seen in the vicinity of colonies and along coasts throughout the year.

#### C8.2.1.7 Cormorants

##### **Species: great cormorant, European shag**

Great cormorant colonies are scattered around the coasts of the UK. Although considerable numbers breed in northern and western Scotland, none of the SPAs within the region list great cormorants among their principal species. This species also breeds in substantial numbers in freshwater environments. Foraging is also divided between freshwater and marine habitats. Although precise locations of foraging at sea are poorly known, great cormorants typically feed inshore within a few km of the coast. The European shag is exclusively marine and also feeds in the inshore zone. 6 SPAs in the study area list the European shag as a qualifying feature, and whilst Shag colonies are scattered along the south and north-east coast of England and throughout the Scottish and Welsh coasts, the majority of the UK population is found in northern and western Scotland and the Northern Isles. European shags feed within a few kilometres of the colony during the breeding season, and do not disperse widely in winter, remaining associated with rocky shores throughout the year.

#### C8.2.1.8 Sea Ducks

##### **Species: greater scaup, common eider, long-tailed duck, common scoter, surf scoter, velvet scoter, common goldeneye, red-breasted merganser, goosander**

There are no SPA designations that list sea duck species as their qualifying feature. However, common eider breed throughout the study area, which is also important for sea ducks in winter. Comprehensive data on winter distributions are lacking, but targeted aerial surveys have identified important concentrations of common eider and long-tailed duck off the rocky coasts of the west coast of the Western Isles, and Scapa Flow in Orkney, with common scoter and red-breasted merganser found in considerable numbers in estuaries (e.g. Solway Firth and Islay). Whilst the surveys have been patchy, the results suggest that these four species are the most common of the sea ducks in the study area. Surf scoter, velvet scoter, common goldeneye and goosander are scarce in the study area.

#### C8.2.1.9 Phalarope

##### **Species: red-necked phalarope**

The red-necked phalarope breeds in small numbers in Shetland, Orkney and northern Scotland, and one SPA in the study area lists this species (North Fetlar, in Shetland). Furthermore, this species is likely to fly along the west coast of Scotland on passage. However, overall numbers of breeding and migrating individuals will be small.

C8.2.1.10 Skuas**Species: Pomarine skua, Arctic skua, long-tailed skua, great skua**

The study area is very important for breeding populations of Arctic skua (4 SPAs) and great skua (9 SPAs), with large concentrations in Shetland, Orkney and to a lesser extent the Western Isles. Although precise foraging locations are poorly understood, both species forage in close association with other seabird species such as black-legged kittiwakes, common guillemot, Atlantic puffin and Northern gannets, from which they klepto-parasitise prey, or, in the case of great skuas, prey on the smaller bird species. Thus, they spend a considerable portion of time during the breeding season in the inshore zone. Both species migrate in the winter, and the west coast is the main migration route, though precise locations are not well known.

C8.2.1.11 Gulls**Species: Mediterranean gull, little gull, Sabine's gull, blackheaded gull, common gull, lesser black-backed gull, herring gull, Iceland gull, glaucous gull, great black-backed gull, blacklegged kittiwake**

Important national populations of lesser black-backed gull (1 SPA: Ailsa Craig), greater black-backed gull (2 SPAs: North Rona and Copinsay) and black-legged kittiwake (11 SPAs: principally in Shetland, Orkney and mainland North-west Scotland) are located in the study area. All three species are widely distributed throughout the region, as are black-headed gull, common gull and herring gull. Of these six species, black-legged kittiwake is the most pelagic, foraging some distance from the colony during the breeding season, and dispersing away from the UK in the winter. Despite this, kittiwakes breeding in the region spend a considerable portion of time in the vicinity of the colony loafing and feeding. The remaining five species are more closely tied to the inshore zone than kittiwakes, rarely venturing further than 25 km from the shore (Camphuysen 2005). With the exception of the greater black-backed gull, these species also spend a considerable portion of foraging time in terrestrial habitats, where they also breed in large numbers. All five species are resident with the exception of the lesser black-backed gull which migrates in the winter, and therefore is likely to pass through the study area on passage.

Mediterranean gull, little gull, Sabine's gull, Iceland gull and glaucous gull are all scarce in the region throughout the year.

C8.2.1.12 Terns**Species: sandwich tern, roseate tern, common tern, Arctic tern, little tern**

The region holds nationally important numbers of common terns (2 SPAs: in the Western Isles and the Sound of Mull) and Arctic terns (9 SPAs: principally in Shetland and Orkney), with smaller colonies scattered throughout the region. Little terns are scarcer, but there are two nationally important colonies (2 SPAs in the Western Isles). During the breeding season, terns forage extensively in inshore regions, though precise locations are not well understood. In winter, all three species migrate so will pass through the region on passage. Sandwich terns may also pass through on passage to and from breeding colonies outwith the study area, but roseate terns are scarce.

### C8.2.1.13 Auks

#### **Species: black guillemot, common guillemot, razorbill, little auk, puffin**

The study area holds a number of internationally important populations of razorbills and common guillemots (11 and 15 SPAs respectively, distributed throughout the region). The study area holds important concentrations of breeding puffins (9 SPAs). The vast majority of the black guillemot population of the UK is found within the study area (listed in 2 SPAs), with particular concentrations in Shetland, Orkney, the Western Isles and Inner Isles. The first three species generally feed within 50 km of the breeding colony during the breeding season, and therefore spend a considerable portion of foraging time within the inshore zone. Furthermore, loafing and social activities take place in the vicinity of colonies. All three species disperse in winter, although common guillemots and razorbills will still be found close to the coast in large numbers. The black guillemot is an exclusively inshore foraging species, so is resident throughout the year. The little auk is a winter visitor only.

### C8.2.1.14 Summary

The study area is the most important region in Britain for breeding seabirds, holding nationally and internationally important populations of northern fulmar, Manx shearwater, European storm petrel, Leach's storm petrel, northern gannet, European shag, Arctic skua, great skua, lesser black-backed gull, greater black-backed gull, blacklegged kittiwake, common tern, Arctic tern, little tern, black guillemot, common guillemot, razorbill and Atlantic puffin. These species all use inshore waters adjacent to colonies for loafing, and also for feeding, the extent to which depends on their foraging ecologies. Red-throated and black-throated divers breed in freshwater environments in summer, but use inshore marine areas for feeding. However, the precise distribution of all these species at sea, and in particular foraging locations, is poorly known.

Divers, grebes and sea ducks use inshore regions in the study principally in winter, with nationally important numbers of great northern diver, black-throated diver, common eider and long tailed duck. The inshore waters are also used extensively by migrating species, in particular shearwaters, storm-petrels, skuas and gannet. As with species present in summer, detailed data on location and behaviour are lacking.

### C8.2.2 *Protected Sites*

The following areas have been identified as sites of importance for birds in the study area. They have been identified based on their designated status as Special Protection Areas under the Birds Directive. See Figure C8.1 for a map of SPA sites in the study area. In addition to those SPA sites within the study area itself, SPAs have also been included that are located in the adjacent marine and coastal areas, as birds in nearby sites may forage within the SEA study area. Protected SPA sites on the east coast as far as the Moray Firth and on the west coast as far as the southern Solway Firth have therefore also been included in the table below and Figure C8.1

Table C8.1: Protected Areas for Bird Populations in the Study Area

Study Area	Site Name	Key Features (B – Breeding, W – Wintering)	Potential Resource Area	Protected Status
Northern Isles	Auskerry	European storm-Petrel (B); Arctic tern (B)	Outside main area of interest	SPA
	Calf of Eday	Seabird assemblage (B)	Wave	SPA
	Copinsay	great black-backed gull (B); black-legged kittiwake (B); common guillemot (B); Seabird assemblage (B)	Outside main area of interest	SPA
	East Sanday Coast	Purple sandpiper (W); Ruddy turnstone (W)	Wave and tidal	SPA
	Fair Isle	Northern fulmar (B); European shag (B); Arctic skua (B); great skua (B); blacklegged kittiwake (B); Arctic tern (B); common guillemot (B); razorbill (B); Atlantic puffin (B); Fair Isle wren (B); Seabird assemblage (B)	Wave	SPA
	Fetlar	Northern fulmar (B); Whimbrel (B); Rednecked phalarope (B); Arctic skua (B); great skua (B); Arctic tern (B); black guillemot (B); Dunlin (B); Seabird assemblage (B)	Tidal	SPA
	Foula	Leach's storm-petrel (B); great skua (B); Arctic tern (B); common guillemot (B); Atlantic puffin (B); Seabird assemblage (B)	Wave	SPA
	Hermaness, Saxa Vord and Valla field	Red-throated diver (B); Northern fulmar (B); Northern gannet (B); European shag (B); great skua (B); common guillemot (B); Atlantic puffin (B); Seabird assemblage (B)	Wave	SPA
	Hoy	Red-throated diver (B); great skua (B); Seabird assemblage (B)	Wave	SPA
	Lochs of Spiggie and Brow	Whooper swan (W)	Wave	SPA
	Marwick Head	black-legged kittiwake (B); common guillemot (B); Seabird assemblage (B)	Wave	SPA
	Mousa	European storm-petrel (B); Arctic tern (B)	Outside main area of interest	SPA
	Noss	Northern fulmar (B); Northern gannet (B); great skua (B); black-legged kittiwake (B); common guillemot (B); Seabird assemblage (B)	Outside main area of interest	SPA
	Orkney Mainland Moors	Red-throated diver (B); Short-eared owl (B)	Wave	SPA
	Otterswick and Graveland	Red-throated diver (B)	Wave and tidal	SPA
	Papa Stour	Arctic tern (B)	Wave	SPA
	Papa Westray (North Hill and Holm)	Arctic tern (B)	Wave and tidal	SPA
	Ramna Stacks and Gruney	Leach's storm-petrel (B)	Wave	SPA
	Ronas Hill û North Roe and Tingon	Red-throated diver (B); great skua (B)	Wave	SPA
	Rousay	Arctic skua (B); black-legged kittiwake (B); Arctic tern (B); Seabird assemblage (B)	Wave	SPA
Sumburgh Head	Arctic tern (B); Seabird assemblage (B)	Tidal	SPA	
West Westray	Northern fulmar (B); European shag (B); Arctic skua (B); great skua (B); Mew gull (B); herring gull (B); black-legged kittiwake (B); Arctic tern (B); common guillemot (B); razorbill (B); black guillemot (B); Atlantic puffin (B); Seabird assemblage (B)	Wave	SPA	
Pentland Firth	Pentland Firth Islands	Arctic tern (B)	Tidal	SPA
	Switha	Barnacle Goose (W)	Outside main area of interest	SPA

Study Area	Site Name	Key Features (B – Breeding, W – Wintering)	Potential Resource Area	Protected Status
North Coast	Cape Wrath	black-legged kittiwake (B); common guillemot (B); razorbill (B); Seabird assemblage (B)	Wave and tidal	SPA
	North Caithness Cliffs	Northern fulmar (B); black-legged kittiwake (B); common guillemot (B); razorbill (B); Seabird assemblage (B)	Wave and tidal	SPA
	North Sutherland Coastal Islands	Barnacle Goose (W)	Wave	SPA
Western Isles	Flannan Isles	European storm-petrel (B); Leach's storm-petrel (B); common guillemot (B); razorbill (B); Atlantic puffin (B); Seabird assemblage (B)	Wave	SPA
	Handa	Arctic skua (B); great skua (B); blacklegged kittiwake (B); common guillemot (B); razorbill (B); Seabird assemblage (B)	Outside main area of interest	SPA
	Lewis Peatlands	Red-throated diver (B); black-throated diver (B); European golden plover (B); common greenshank (B); Dunlin (B);	Wave	SPA
	Mingulay and Berneray	Northern fulmar (B); European shag (B); black-legged kittiwake (B); common guillemot (B); razorbill (B); Seabird assemblage (B)	Wave	SPA
	Mointeach Scadabhaig	Red-throated diver (B); black-throated diver (B)	Wave	SPA
	Monach Islands	Barnacle goose (W); common tern (B); little tern (B); black guillemot (B)	Wave	
	North Uist Machair and Islands	Barnacle goose (W); Eurasian oystercatcher (B); Ringed plover (B); Ringed plover (W); common redshank (B); Ruddy turnstone (W); Dunlin (B); Breeding bird assemblage (B)	Wave and tidal	SPA
	Shiant Isles	Northern fulmar (B); European shag (B); Barnacle goose (W); common guillemot (B); razorbill (B); Atlantic puffin (B); Seabird assemblage (B)	Outside main areas of interest	SPA
	South Uist Machair and Lochs	Greylag goose (B); Eurasian oystercatcher (B); Ringed plover (W); Ringed plover (B); Northern lapwing (B); Sanderling (W); common snipe (B); common redshank (B); little tern (B); Dunlin (B); Breeding bird assemblage (B)	Wave	SPA
Outer Islands	North Rona and Sula Sgeir	Northern fulmar (B); European storm-petrel (B); Leach's storm-petrel (B); Northern gannet (B); great black-backed gull (B); black-legged kittiwake (B); common guillemot (B); razorbill (B); Atlantic puffin (B); Seabird assemblage (B)	Wave	SPA
	St Kilda	Northern fulmar (B); Manx shearwater (B); European storm-petrel (B); Leach's storm-petrel (B); Northern gannet (B); black-legged kittiwake (B); common guillemot (B); razorbill (B); Atlantic puffin (B); Seabird assemblage (B)	Wave	SPA
	Sule Skerry and Sule Stack	European storm-petrel (B); Leach's storm-petrel (B); Northern gannet (B); European shag (B); Atlantic puffin (B); Seabird assemblage (B)	Wave	SPA
Inner Isles	Canna and Sanday	Seabird assemblage (B)	Wave and tidal	SPA
	Priest Island (Summer Isles)	European storm-petrel (B)	Outside main area of interest	SPA
	Rum	Red-throated diver (B); Manx shearwater (B); Seabird assemblage (B)	Wave	SPA
Argyll and Bute	Ailsa Craig	Northern gannet (B); Lesser black-backed gull (B); razorbill (B); Seabird assemblage (B)	Outside main area of interest	SPA
	Bridgend Flats, Islay	Barnacle goose (W)	Wave	SPA

Study Area	Site Name	Key Features (B – Breeding, W – Wintering)	Potential Resource Area	Protected Status
	Coll	Greenland white-fronted goose (W); Barnacle goose (W)	Wave and tidal	SPA
	Eilean na Muice Duibhe (Duich Moss), Islay	Greenland white-fronted goose (W)	Wave	SPA
	Glas Eileanan	common tern (B)	Tidal	SPA
	Gruinart Flats, Islay	Greenland white-fronted goose (W); Barnacle goose (W); Light-bellied brent goose (W)	Wave	SPA
	Inner Clyde Estuary	common redshank (W)	Outside main area of interest	SPA
	Laggan, Islay	Greenland white-fronted goose (W); Barnacle goose (W)	Wave	SPA
	North Colonsay and Western Cliffs	Red-billed chough (B); Seabird assemblage (B)	Wave	SPA
	Rinns of Islay	Whooper swan; Greenland white-fronted goose (W); common scoter (B); Redbilled chough (B)	Wave and tidal	SPA
	Slúibhtean agus Cladach Thiriodh (Tiree Wetlands and Coast)	Greenland white-fronted goose (W); Barnacle goose (W); Eurasian oystercatcher (B); Ringed plover (W); Ringed plover (B); common redshank (B); Ruddy turnstone (W); Dunlin (B)	Wave	SPA
North Channel	Loch and Inch Torrs Warren	Greenland white-fronted goose (W)	Outside main area of interest	SPA
Outside of study area	Cromarty Firth	Common tern (B); Osprey (B); Redshank, Curlew (W); , Dunlin (W); Knot (W); Oystercatcher (W); Red-breasted Merganser (W); Scaup (W); Pintail (W); Wigeon (W); Greylag Goose (W); Bar-tailed godwit (W); Whooper Swan (W)	Outside study area	SPA
	Dornoch Firth and Loch Fleet	Osprey (B); Curlew (W); Dunlin (W); Oystercatcher (W); Teal (W); Wigeon (W); Greylag Goose (W);, Bar-tailed Godwit (W)	Outside study area	SPA
	East Caithness Cliffs	Guillemot (B), herring gull (B), razorbill (B); shag (B) Puffin (B), Great Black-backed Gull (B), Cormorant (B) Fulmar (B) Guillemot (B)	Outside study area	SPA
	Inner Moray Firth	Common tern (B); Osprey (B); Redshank, Curlew (W); Oystercatcher (W); Red-breasted Merganser (W); Scaup (W); Pintail (W); Wigeon (W); Greylag Goose (W); Bar-tailed godwit (W); Goosander (W); Goldeneye (W); Teal (W)	Outside study area	SPA
	Moray and Nairn Coast	Osprey (B); Pink-footed Goose (W); Dunlin (W), Oystercatcher (W); Red-breasted Merganser (W); Velvet Scoter (W); Common Scoter (W); Long-tailed duck (W) Wigeon (W); Redshank (W); Greylag Goose (W) Bar-tailed Godwit (W)	Outside study area	

Source: JNCC, 2007.

### C8.2.3 Sensory Capabilities – Marine Birds

#### C8.2.3.1 Vision

All marine birds use sight to obtain prey, and have adaptations for amphibious foraging (Martin 1998; 1999; Martin & Prince 2001). Most species are predators of fast-moving prey and have binocular vision (the main exception among the species described here being the marine ducks, which typically forage on more sessile prey such as bivalve molluscs). However, very little empirical data exist on the importance of visibility, but it is likely to depend on the type of prey and the extent to which birds can switch to tactile foraging.

### C8.2.3.2 Sound

It is evident from the behaviour of birds on land that they have acute hearing. However, little is known about the importance of hearing underwater and whether noise can disorientate birds or adversely affect their foraging success.

### C8.2.3.3 Chemo-reception

Northern fulmars use their sense of smell to detect olfactory cues in air for location of food over large distances (Nevitt 1999; Nevitt *et al.* 2006). In addition Petrels and shearwaters belong to the tubenose family, which may imply olfactory abilities. It is believed that olfactory cues are sensed principally through air, but olfactory cues underwater may also be used. However, no empirical data exists for this issue.

## C8.3 **Potential Effects**

### C8.3.1 *Introduction*

Marine bird species can potentially be affected in a number of ways, as outlined below. It should be noted that this report identifies generic effects, and, where possible, assigns strategic effect significance based on the available high level data. Any proposed marine renewable energy development would, of course, need to examine the potential effects specific to that development, which may require use of more detailed data sources, further data collection and detailed modelling studies.

#### C8.3.1.1 Installation Effects

**Collision risk:** There is the risk of marine birds colliding with construction machinery and vessels present during the project installation phase. Existing evidence from collisions with shipping activity indicates that whilst birds are generally more manoeuvrable than marine mammals they may also be at risk of collision with vessels, especially at night. Collision can typically occur in two situations – flying birds colliding with the surface structures of ships or ships colliding with birds rafting on the surface. Risk is likely to be low for all species and very low for cormorants since they spend the night on land (Daunt *et al.* 2006a). However, no empirical data are available. There are also no data on strike rates when birds are foraging underwater. Vessels involved in installation of both wave and tidal devices and export cables are likely to be either stationary or travelling considerably slower than commercial shipping vessels whilst involved in construction activities, and therefore the collision risk during construction is likely to be lower than that posed by commercial shipping activity.

**Physical disturbance:** Physical disturbance of birds in the immediate vicinity of construction activities is a potential temporary impact during array and export cable construction. Noise is a key factor in causing the disturbance impact, but the physical presence of the installation vessels themselves can also cause a disturbance impact due to physical and visual intrusion. Birds' likely response to disturbance impacts would be to avoid the immediate area during construction, which has implications of foraging and breeding success, stress on individuals and energy budgets. This has been looked at for shore birds, and it is recognised that disturbance may have long term effects if breeding is disrupted, or if birds feeding is disrupted with fitness impacted. However, there is no quantified data to from which to determine estimated magnitude of impact.

**Marine noise:** Marine noise during installation could potentially impact marine birds whilst underwater, causing them to become disorientated and affecting their foraging success. Physiological impacts could result in temporary or permanent hearing damage. Key sources of noise during installation are shipping machinery, dredging and pile driving. Pile driving is anticipated to have the greatest potential effects on marine wildlife, as it generates very high sound pressure levels that are relatively broad-band (20 Hz - > 20 kHz). Impacts on surface feeding birds are likely to take the form of disturbance impacts (as described above).

**Increased turbidity (reduced visibility):** This can occur during seabed disturbing installation activities, as fine particles travel further from the disturbed area, swept by tidal currents. Increased turbidity can have effects on foraging, and predator/prey interactions. The magnitude of this impact will depend on the high number of variables involved in determining both background and project caused suspended sediment levels and turbidity. However, given that the wave and tidal turbines will be placed in high energy environments, it is likely that the small amounts of sediment released into the water column during turbine and cable installation will be rapidly dispersed into the surrounding environment, and will have a negligible impact on background suspended sediment and turbidity levels. This conclusion will of course have to be re-assessed on a case-by-case basis for specific developments. Marine birds are thought to have a high sensitivity to reductions in visibility.

**Disturbance of contaminated sediments** is also possible during cable and device installation, which may cause potential detrimental impacts on species that are sensitive to contamination. Areas of potential contamination risk and the associated implications for water quality are assessed in Chapter C2.

#### C8.3.1.2

##### Operation Effects

**Collision risk:** Collision risk is considered to be a key potential effect during device operation, and it is considered that, bearing in mind the wide range of devices that may be deployed, all species of birds using the study area are at some risk of collision with devices. However, there is considerable lack of empirical knowledge on this risk, and it is important to bear in mind that, turbine blades (tidal energy devices), either of the horizontal or vertical axis type present a threat quite unlike anything that marine birds have previously experienced. Therefore, whilst an overview of the factors likely to influence collision risks posed by marine renewable devices is summarised in this section, it is not possible to quantify this risk based on the current state of knowledge. It is also worth noting that wave devices and venturi tidal devices that do not have rotating blades are considered to pose a lower collision risk than horizontal and vertical axis tidal turbines.

Mooring equipment such as anchor blocks and plinths are likely to function like other natural or artificial seabed structures and hence pose few novel risks for vertebrates in the water column. Cables, chains and power lines extending up through the water will have smaller cross-sectional area than vertical support structures and so produce reduced flow disruption and fewer sensory cues to approaching diving birds. Instead of being swept around these structures, mammals are more likely to become entangled in them.

Marine birds have means of escaping moving or stationary hazards. The response of marine birds to a wave or tidal scheme will depend on whether it is detected above or below the surface and how close the object is before the animal detects it, and whether it is interpreted as a hazard that needs to be avoided.

**Above the surface:** If schemes are visible from above the surface, birds in flight will probably operate broadly similar avoidance tactics to those employed when encountering other natural and man-made obstructions i.e. by taking alternative flight routes and avoiding obstructions to a greater degree at night (Desholm & Kahlert 2005).

**Below the surface:** Similar avoidance tactics are likely to be employed by diving birds when they detect a stationary or moving object as flying birds when detecting obstructions. More drastic avoidance behaviours are likely to be required if an object is only detected very late, especially if the bird is in the path of a turbine blade. Birds have a moderately fast burst speed, which, although considerably slower than the speed of the outer edge of blades (Fraenkel 2006), would enable escape under many situations where the bird manages to move out of the path of the blades.

Collision risk is also expected to be influenced by the nature of the environment where the turbines are located, proximity to protected areas/SPAs, foraging behaviour and encounter rates.

**Open waters:** The above concerns are likely to be of general relevance to schemes placed in open waters, which will potentially be equally visible from all directions (device orientation notwithstanding) both above and below the water surface to marine birds. However, marine birds do not fly evenly and in all directions across open water, and are aggregated in relation to oceanographic conditions and prey availability (Daunt, *et al.* 2006b). Thus, detailed data on the use made of the area by birds, including travelling and underwater foraging trajectories, would be required to further understand this issue.

**Sounds and channels:** Device location and orientation are likely to be particularly important where topography restricts options for bird avoidance behaviours e.g. sounds and channels. This is true both for birds in flight and underwater. In such cases, detailed data are required on how birds use the area. Sounds are used for both activities by marine birds (Daunt 2006c). For birds in flight, in the majority of cases, heading will be longitudinal to the sound, so a parallel design is likely to be preferable to a series design for schemes that protrude above the sea surface. It is less clear which design is likely to increase collision risk among underwater foraging birds. All other things being equal, devices placed in series are more likely to impact on marine birds in sounds and channels since topography will be more likely to restrict avoidance options, especially in cases where the scheme spans the width of the sound or channel.

**Sea loch entrances:** Sea loch entrances are likely to be regions of high tidal currents, so are likely to be important areas for foraging (Daunt 2006c). The relative risk of parallel and series placement is unclear for foraging birds, but as with sounds the added component of topography may result in a greater risk associated with a series placement, in particular if it spans the width of the sea loch entrance.

**Flow characteristics:** Most species are attracted to areas of high flow because of good foraging opportunities (Daunt *et al.* 2006b). Risk of collision will be increased if renewable schemes alter the flow characteristics, especially if such changes create new foraging opportunities for marine birds, since this may impact on the manoeuvrability and underwater swimming agility of the birds. However, no empirical data exist. Risk will be higher among diving than surface feeding species. However, overall risk associated with change in flow characteristics is likely to be linked to the extent to which birds feed at night.

**Water depth:** Collision risk will depend on the extent to which species and devices are distributed through the water column. Thus, diving species will be at greater risk of collision with subsurface rotating turbines and mooring cables than surface feeding species, which would be at a lower risk of impact with floating devices, and above surface structures as these do not use rotating blades. Empirical data exist on the depth usage of a range of species including European shags, northern gannets, northern fulmars, common guillemots, razorbills and Atlantic puffins (Wanless *et al.* 1988; Harris *et al.* 1990; Wanless *et al.* 1991; Garthe *et al.* 2000; Garthe & Furness 2001; Daunt *et al.* 2003; Daunt *et al.* 2005; Daunt *et al.* 2006b). In general, depth distribution depends on maximum foraging depth, with shallow divers spending most time near the sea surface and progressively less time at depth, whereas deep divers, which are principally benthic feeders, showing a bimodal depth distribution with peaks of time spent at the sea surface and at deep depths and less time spent at intermediate depths.

**Water quality:** Collision risk can be expected to be greater for turbines deployed in regions of moderate to high turbidity, or if the turbines increase turbidity, because of their reduced visibility. Birds' vision can be affected by small levels of turbidity (Strod *et al.* 2004). However, no data exist on collision risk in relation to turbidity. Diving species will be more at risk of collision in turbid waters than surface feeding species, and night-time feeders more at risk than daytime foragers.

Ecological impacts resulting from bird interactions with devices can be expected to range from: no impacts to the potential removal or injury of individuals, and, if rates are sufficiently high, to declines in populations as a result of adverse impacts on foraging and breeding success, stress on individuals and energy budgets. A bad injury or break to an appendage that is critical to foraging could be expected to result in the death of the bird in question. However, there is no quantified data from which to determine estimated magnitude of impact.

**Marine noise:** As for construction noise, noise produced during operation of devices could also potentially disrupt prey location and underwater navigation in marine birds, or even result in temporary or permanent hearing damage. Whilst the noise levels likely to be generated during device operation are currently not known (as there are no arrays of devices currently installed in UK waters), operation noise is expected to be considerably less in magnitude than construction noise. The potential noise sources during device operation include: rotating machinery, flexing joints, structural noise, moving air, moving water, moorings, electrical noise, and instrumentation noise.

**Habitat exclusion:** The presence of wave and tidal arrays will cause loss of habitat during device operation. Devices may exclude birds from a suitable foraging habitat by providing a physical or perceptual barrier, or producing noise that results in avoidance behaviour. Exclusion may limit other device interactions, such as collisions, but will also limit the available habitat, with associated impacts on foraging and breeding success, stress on individuals and energy budgets. Based on discussions with developers, typical array sizes are likely to be 4 km<sup>2</sup> for wave and 0.5 km<sup>2</sup> for tidal arrays.

Evidence from wind farm projects indicates that many species, most notably diver and sea-duck have been displaced some 2 – 4 km from wind farm areas, and this wider displacement impact is thought to be due to the birds perceptual reaction to turbines or maintenance vessels.

Whilst it is considered that alternative foraging areas may be available to these species, the array will create a net loss of foraging area and removal of food resource, depending on the means of securing the device to the seabed. There may also be a knock-on effect on adjacent bird populations arising from increased competition for prey species in adjacent areas.

However the installation of marine turbines may also create new habitat that could potentially be colonised by benthic species and affect the availability of prey species in the vicinity of turbines.

**Changes in suspended sediment levels and turbidity** may be caused by changes to sedimentation patterns resulting from extraction of tide and wave energy. Depending on the specific environmental parameters at a given location this may result in increases or decreases of both sediment suspension and deposition. High confidence estimates, based on expert knowledge can be given for the extent of impacts on sediment processes of up to 50 m from devices (see Chapter C3).

**Contamination:** Leaching of toxic compounds from sacrificial anodes, antifouling paints or hydraulic fluids (if present) from the device is a potential effect during device operation. A small number of both wave and tidal devices are expected to use antifouling coatings, and whilst organotins are now banned, the use of copper is still permitted. As discussed in Section B, the quantities and toxicities associated with sacrificial anodes and antifouling coatings are generally expected to be extremely small.

Marine birds are particularly sensitive to contamination by oil based compounds which may be included in the hydraulic fluids used by some devices. The oil damages the plumage causing it to lose its waterproofing (Wernham *et al.* 1997). Furthermore, considerable physiological damage occurs as a result of marine birds ingesting oil. The susceptibility of species is dependent on their distributions and general behaviour, in particular the proportion of time spent on the sea surface in relation to time spent flying and on land. Devices which use hydraulic systems will normally be designed such that at least two seal or containment failures are required before a leaking fluid reaches the sea. It is not possible to be definitive for every device listed in this document as a number of them are still at concept stage and this aspect is a matter for detailed design. However, the industry's design guidelines (Carbon Trust, 2005), if followed, would lead a developer to minimise risks of hydraulic fluid leakage. Potentially more significant still are the possible impacts that could result from leakage of cargoes or fuel carried by a vessel involved in a collision with renewable device arrays. This impact is impossible to quantify due the number of variables such as vessel cargo, risk of vessel collision, etc.

It is not possible to make any realistic estimate of the geographical extent of this impact, due to the large numbers of variables involved (quantities leaked, metocean conditions, etc).

**Creation of resting and breeding habitat:** If devices have surface structures, then there is potential that seabirds will use them as perching or breeding locations. Man-made objects are frequently used as perching posts by a range of species, notably gulls, terns, gannets and Cormorants. They may also provide breeding locations to these same species (Craik, 2004).

**Foraging opportunities:** Marine renewable devices, with associated seabed moorings and vertical structures, will potentially function as artificial reefs or fish aggregating devices. In changing the habitat they therefore have the potential to also change the distribution of marine seabirds. Their structures may offer enhanced opportunities for foraging for some species. The action of moving parts may scatter schooling prey or injure fish or squid and thus draw in opportunistic foragers.

**Increased predation (mink):** Mink predation of ground nesting birds, such as seabird colonies is considered to be a problem in Mainland Scotland and the Western Isles where mink are present. Whilst they can swim to islands within 2 km of shore, they cannot reach those further offshore. Islands considerably further offshore can, however, be accessed if there is a chain of islets running shoreward that are less than 2 km apart which the mink use as a haul-out for rest, and foraging. It has therefore been suggested that arrays of devices with surface structures, could provide a substitute for islet chains and have the potential increase the risk of mink accessing the offshore islands of the region which currently do not contain mink populations (although they do not provide food, as real islets might).

Islands that could be potentially at risk of this impact, based on mink distribution on the adjacent mainland or islands, include Orkney, Barra and the Treshnish Isles (Pers Comm SNH) Should installation of wave and tidal devices be considered across the waters between these islands and the mainland (Pentland Firth, Barra Sound and east of Mull respectively), less than 2 km apart, the potential effect of mink accessing these islands would need to be assessed.

**Table C8.2: Summary of Potential Effects of Marine Birds**

Effect	Development Phase	Direct/Indirect	Duration	Extent
Collision risk (construction)	CC CD	Direct	Temporary (during installation)	Construction area (unknown)
Physical disturbance	CC CD	Direct	Temporary (during installation)	Construction area (unknown)
Marine noise (construction)	CC CD	Direct	Temporary (during installation)	Unknown
Increased suspended sediment and turbidity (reduced visibility)	CC CD	Indirect	Temporary (during installation)	Negligible
Disturbance of contaminated sediments	CC CD	Indirect	Temporary (during installation)	Negligible

Effect	Development Phase	Direct/Indirect	Duration	Extent
Collision risk (operation)	OD	Direct	Temporary (during installation)	Within array area: wave - 4 km <sup>2</sup> ; tidal - 0.5 km <sup>2</sup>
Marine noise (operation)	OD	Direct	Long term (device life)	Unknown
Habitat exclusion	OD	Direct	Long term (device life)	Within array area: wave - 4 km <sup>2</sup> ; tidal - 0.5 km <sup>2</sup>
Increased turbidity (reduced visibility)	OD	Indirect	Long term (device life)	Negligible
Contamination from anti-fouling paints and sacrificial anodes	OD	Direct	Long term (device life)	Negligible
Accidental contamination (hydraulic fluids or vessel fuel/cargo)	OD	Direct	Long term (device life)	Impossible to quantify
Creation of resting and breeding habitat	OD	Direct	Long term (device life)	Impossible to quantify
Foraging opportunities	OD	Indirect	Long term (device life)	Impossible to quantify
Increased predation (mink)	OD	Indirect	Long term (device life, and beyond)	Impossible to quantify

## C8.4 Sensitivity of Receptors

Sensitivity of bird species found in the study area to the expected impacts of wave and tidal devices is summarised in Table C8.3 and Table C8.4 below. Only sensitivity to those impacts for which it is possible to estimate sensitivity has been described. Sensitivity has been estimated based on available knowledge.

### C8.4.1 Collision Risk

Sensitivity will depend on the species' foraging mode, with plunge divers at greatest risk from the device types expected to pose the greatest collision risk - devices with submerged rotating turbines (tidal horizontal and vertical axis devices), followed by diving species, with surface feeding species least at risk – as these would only be at risk from the static surface structures and floating devices. Collision risk is also likely to depend on the proportion of feeding that takes place at night, although this has been quantified in very few species. For example, European shags only feed during daylight, whereas a proportion of foraging time of common guillemots occurs at dawn and dusk (Daunt *et al.* 2006). The latter species may therefore be more at risk of collisions than the former. Table C8.3 provides a risk score (high, medium or low) for the different species groups, but it can only be considered as a tentative list at this stage because of the lack of quantitative data on collision risk. The collision risk study (Appendix C6.A) breaks down estimated collision risk to include risk in more detail in association with other relevant environmental factors such as turbidity, water depth, time of day and season etc. In all cases these are estimates, limited by the limited understanding of foraging ecology and the lack of empirical data on collision impacts of underwater renewable schemes.

**Table C8.3: Sensitivity of Birds to Collision Impacts**

Species Group	Foraging Mode	Prey Detection	Foraging Speeds	Collision Risk
Divers	Pursuit diver	Visual/tactile	Unknown	Medium
Grebes	Diver	Visual/tactile	Unknown	Medium
Fulmar	Surface feeder	Visual/Olfactory	Unknown	Low
Shearwaters	Surface feeder/pursuit diver	Visual	Unknown	Medium
Storm-petrels	Surface feeder	Visual	Unknown	Low
Gannet	Plunge/pursuit diver	Visual	Ca. 6 ms <sup>-1</sup>	Medium
Cormorants	Pursuit diver	Visual/tactile	1-2 ms <sup>-1</sup> underwater	Medium
Phalarope	Surface feeder	Visual	Unknown	Low
Sea ducks	Diver / Pursuit diver	Visual/tactile	Unknown	Medium
Skuas	Surface feeder	Visual	Unknown	Low
Gulls	Surface feeder	Visual	Unknown	Low
Terns	Surface feeder	Visual	Unknown	Medium
Auks	Pursuit diver	Visual/?tactile	1-2 ms <sup>-1</sup> underwater	Medium

#### C8.4.2 *Marine Noise*

It is evident from the behaviour of birds on land that they have acute hearing. However, little is known about the importance of hearing underwater and whether noise can disorientate birds or adversely affect their foraging success. Table C8.4 summarises the estimated sensitivity of birds to marine noise impacts from marine renewable schemes.

#### C8.4.3 *Increased Suspended Sediment*

All marine birds use sight to obtain prey, and have adaptations for amphibious foraging (Martin 1998; 1999; Martin & Prince 2001). Most species are predators of fast-moving prey and have binocular vision (the main exception among the species described here being the marine ducks, which typically forage on more sessile prey such as bivalve molluscs). Very little empirical data exist on the importance of visibility, but it is likely to depend on the type of prey and the extent to which birds can switch to tactile foraging. Table C8.4 summarises the estimated sensitivity of birds to reduction in visibility impacts from marine renewable schemes.

#### C8.4.4 *Accidental Contamination – Hydraulic Fluids*

The susceptibility of species is dependent on their distributions and general behaviour, in particular the proportion of time spent on the sea surface in relation to time spent flying and on land. Table C8.4 classifies the species groups into low, moderate and high risk.

**Table C8.4: Sensitivity of Marine Birds to Impacts from Wave and Tidal Device Arrays**

Species Group	Increased Suspended Sediment (reduced visibility)	Accidental Contamination (hydraulic fluid)	Underwater Noise
Divers	Very High	High	Unknown
Grebes	Very High	Medium	Unknown
Fulmar	Very High	Low	Unknown
shearwaters	Very High	Low	Unknown
Storm-petrels	Very High	Low	Unknown
Gannet	Very High	Low/medium	Unknown
Cormorants	Very High	Low/medium	Unknown
Red-necked Phalarope	Very High	Low	Unknown
Sea ducks	Very high	Low/medium	Unknown
Skuas	Very High	Low	Unknown
Gulls	Very High	Low/medium	Unknown
Auks	Very High	Very High	Unknown

## C8.5 Potential Significance of Effects

### C8.5.1 Assessment Criteria

The assessment of effect significance has been undertaken based on the criteria below. These have been developed specifically for the SEA and take into account the information available to inform the assessment of significance. Due to the strategic nature of this assessment, it has not been possible to quantify magnitude of impacts, and the assessment of significance is therefore based primarily on the sensitivity and importance of receptors.

**Table C8.5: Significance Assessment Criteria - Marine Birds**

Significance Level	Determining Criteria
Major	Potential to affect an entire population / habitat causing a decline in abundance and / or change in distribution beyond which natural recruitment would not return that population / habitat, or any population / habitat dependent upon it, to its former level within several generations of the species being affected.
Moderate	Potential to cause damage or disturbance to habitats or populations above those experienced under natural conditions, over one or more generation, but which does not threaten the integrity of that population or any population dependent on it.
Minor	Potential to cause small-scale or short-term disturbance to habitats or species, with rapid recovery rates, and no long-term noticeable effects above the levels of natural variation experienced in the area. The impacts are not sufficient to be observed at the population level.
Negligible/No impact	Potential to cause minimal impact from the work. Very minor damage, if any or to species /habitats of low ecological importance, or with immediate recovery rates.

### C8.5.2 *Mapping of Effect Significance*

It has not been possible to map the significance of marine renewable energy development impacts on marine birds. This is due to both the lack of detailed baseline data for bird distribution at sea, and also the lack of understanding of how birds will be impacted by and will react to marine renewable devices. Gaps in knowledge are discussed in more detail in Section C8.8 It was felt that too many assumptions would have to be made to make mapping these effects a useful and meaningful exercise.

It should be noted that that the assessment of significance has been undertaken at a strategic level, and applies the precautionary approach by assuming maximum impacts, where possible, for impacts on the key known locations of important or protected species in the study area.

### C8.5.3 *Results of Significance Assessment*

#### C8.5.3.1 Installation Effects

**Collision risk:** Sensitivity of marine birds to collisions has been estimated to range from low to medium for most species. This impact is temporary in nature, and is therefore considered to be of generally minor potential significance, reducing to negligible after use of appropriate mitigation, which could include avoiding sensitive sites, and avoiding installation at night when birds are most vulnerable to collisions, and increasing visibility of installation vessels.

**Physical disturbance:** This impact would be most significant if installation activities were to take place close to breeding bird colonies, which is most likely for installation of the export cables, or shoreline wave devices in the intertidal area. This impact has therefore been assigned a major potential significance level for breeding bird colonies, and a moderate significance for foraging or loafing birds, which are likely to be able to move away from disturbing activities. This impact could be expected to reduce to a minor residual significance assuming appropriate mitigation such as avoidance of sensitive areas and breeding seasons during construction are employed.

**Marine noise:** It is not possible to assess the likelihood, or magnitude of noise impacts on underwater birds, as whilst it is evident from their behaviour on land that they have acute hearing, little is known about their sensitivity to underwater noise, and the importance of hearing underwater in birds. It is therefore not possible to make any estimates about the potential significance of this impact.

**Increased turbidity (reduced visibility):** Given the transient nature of this impact, and the high energy environments where devices are likely to be installed, this impact is considered likely to be of negligible potential significance.

#### C8.5.3.2 Operation Effects

**Collision risk:** The extent to which collision impacts will impact on population size and migration are not possible to assess without empirical data on injury and death rates as a result of tidal and wave schemes in relation to age and time of year. Effect significance would also depend on rarity – a loss of one rare bird would be more significant than the loss of an individual from a more common species. Collision risk during device operation therefore has the potential to be an impact of major significance. However, the actual impact is unknown, and further research is needed to understand this issue.

**Marine noise:** It is evident from the behaviour of birds on land that they have acute hearing. However, little is known about the importance of hearing underwater and whether noise can disorientate birds or adversely affect their foraging success. Generally, diving species could be expected to be more adversely affected by operation noise than surface feeding birds. However, it is not possible, given the data available, to make an estimate about the potential significance of operation noise on marine birds.

**Habitat exclusion:** The extent to which wave and tidal schemes could have an impact on marine birds will depend on the importance of these areas as foraging habitat for the bird species in question. There may be immediate impacts on foraging, or more far-reaching consequences for bird populations. The latter may depend on the time of year. For example, excluding or altering habitats during the breeding season may impact on adult and offspring survival, whereas impacts on habitats used outside the breeding season is more likely to affect over-wintering survival of immature and adult birds rather than dependent young in the nest. Evidence from wind farm projects indicates that many species, most notably diver and sea-duck have been displaced some 2 – 4 km from wind farm areas, and this wider displacement impact is thought to be due to the birds' perceptual reaction to turbines or maintenance vessels.

It is therefore considered that this is an impact of potentially major significance during the breeding season and moderate significance at other times of year. Whilst it is considered likely that alternative foraging areas will generally be available to these species, the array will create a net loss of foraging area and removal of food resource, depending on the means of securing the device to the seabed. There may also be a knock-on effect on adjacent bird populations arising from increased competition for prey species in adjacent areas, and energetic costs associated with having to avoid array areas. Use of appropriate mitigation measures such as avoiding sensitive areas could be expected to reduce this residual effect to minor.

**Changes in suspended sediment levels and turbidity:** All marine birds use sight to obtain prey, and are therefore likely to be impacted by a reduction in visibility caused by increased turbidity around marine turbines. However, given that devices are likely to be present in high energy environments where any disturbed sediment is likely to be rapidly dispersed, and this impact is limited to the immediate vicinity of the array; it is only considered to be of negligible significance.

**Contamination:** As discussed in Chapter C4, the quantities and toxicities associated with sacrificial anodes and antifouling coatings are generally expected to be extremely small, and it is therefore considered that this potential effect will be of negligible significance.

The potential for leakage of hydraulic fluids through accidental storm or collision damage, or vessel fuel and/or cargo through collision damage could potentially present an impact of major significance if it occurred. It is, however, considered that there is a very low likelihood of such a leakage occurring and therefore the residual significance of this impact is considered to be minor. The residual significance assumes that appropriate design is used to minimize the risk of hydraulic fluids occurring, and that shipping lanes and other areas of high potential collision risk are avoided.

**Creation of resting and breeding habitat:** There is potentially a positive impact, associated with increasing the area available for seabirds, such as providing perches for birds to use for resting and to forage from. However, there may also be adverse impacts associated with changes to population dynamics, and competitive interactions between different species. It is therefore not possible to make an estimate as to the potential significance of this impact.

**Foraging Opportunities:** Whether these opportunities would enhance the foraging prospects for such species for the better or attract them into otherwise dangerous situations is not yet clear. It is therefore not possible to assign a significance rating to this impact as it is currently not known whether it constitutes a positive or negative effect.

**Increased predation (mink):** Should mink be able to colonise offshore islands such as Orkney, Barra and the Treshnish Isles as a result of installation of wave and/or tidal renewable devices this has the potential to be an impact of major significance, as mink predation could have significant impacts on the important breeding bird colonies located in these areas. Should devices be considered in areas where this is a potential effect, mitigation measures such as device design to ensure that there are no platforms at sea levels which the mink could climb onto could be expected to reduce the residual effects to negligible.

Table C8.6: Potential Significance of Effects - Marine Birds

Potential Effects	Device Characteristics	Development Phase	Receptor	Potential Significance of Effects	Likely Impact Extent	Source	Confidence	Figure Number
Collision Risk (construction)	All wave and tidal devices	CD CC	Surface birds and diving birds (primarily divers, grebes, cormorants, auks and gannets)	Minor	Installation area (unknown)	Specialist collision risk study	Low	Not mapped
Physical Disturbance	All devices and cables	CC CD	Breeding birds (breeding) Foraging and loafing birds (non breeding)	Major Moderate	Installation area (unknown)	Estimate based on expert knowledge	Low	Not mapped
Marine Noise (construction)	Piled devices	CC CD	Surface birds and diving birds	Unknown	Unknown	COWRIE, specialist noise study	Low	Not mapped
Increased suspended sediment and turbidity (reduced visibility)	Piled devices and cables	CD CC OD	Diving birds	Negligible	Negligible	Estimate based on expert knowledge	Low	Not mapped
Collision Risk (operation)	All wave and tidal devices	CD CC	Surface birds and diving birds (primarily divers, grebes, cormorants, auks and gannets)	Unknown	Within array area: wave - 4 km <sup>2</sup> ; tidal - 0.5 km <sup>2</sup>	Specialist collision risk study	Low	Not mapped
Marine Noise (operation)	All wave and tidal devices	OD	Surface birds and diving birds	Moderate	Unknown	COWRIE, specialist noise study	Low	Not mapped
Habitat exclusion	All wave and tidal devices	OD	Surface birds and diving birds	Major (during breeding) Moderate (outside breeding season)	Within array area: wave - 4 km <sup>2</sup> ; tidal - 0.5 km <sup>2</sup>	Discussions with developers	Moderate	Not mapped
Contamination from anti-fouling paints and sacrificial anodes	Devices using anti-foulants and sacrificial anodes	OC	Surface birds and diving birds	Negligible	Negligible	Discussions with developers	Moderate	Not mapped
Accidental contamination (hydraulic fluids or vessel fuel/cargo)	Devices using hydraulic fluids	CC CD OD	Surface birds and diving birds	Major	Impossible to quantify	Discussions with developers	Very low	Not mapped
Creation of resting and breeding habitat	Devices with surface structures	OD	Surface birds	Unknown	Within array area: wave - 4 km <sup>2</sup> ; tidal - 0.5 km <sup>2</sup>	Discussions with developers	Very low	Not mapped
Increased foraging opportunities	All wave and tidal devices	OD	Diving birds	Unknown	Within array area: wave - 4 km <sup>2</sup> ; tidal - 0.5 km <sup>2</sup>	Discussions with developers	Very low	Not mapped
Increased predation (mink)	All wave and tidal devices	OD	Ground nesting birds	Major	Impossible to quantify	N/A	Very low	Not mapped

## C8.6 Mitigation Measures

Where potentially significant impacts have been identified for a specific receptor, the following mitigation measures are appropriate for reducing/mitigating impacts.

**Table C8.7: Possible Mitigation Measures - Impacts on Birds**

Effect	Development Phase	Mitigation Measure
Physical disturbance	CC CD	Avoid sensitive sites/species Avoid installation during sensitive seasons
Increased turbidity (reduced visibility)	CC CD OD	Minimise depth of piling Use cable and device installation methods that minimise sediment re-suspension Release sediment in appropriate tidal conditions to minimise effect Carry out work in appropriate tidal conditions to minimise effect
Collision risk	OD	Design device for minimal impact Avoid siting devices in particularly sensitive areas – e.g. migration routes, feeding, breeding areas Do not undertake installation activities at night when birds are more vulnerable to collisions. Increase device visibility, or use of acoustic warning devices. Device blades should not be shiny, as diving birds may mistake them for fish. Use of protective netting or grids
Disturbance of contaminated sediments	CC CD OD	Avoid device placement in areas of known sediment contamination Use installation methods that minimise disturbance of sediments Carry out work in appropriate tidal conditions to minimise effect
Contamination from anti-fouling paints, sacrificial anodes and grout	OD	Design devices to minimise leakage of pollutants Use of non toxic anti-foulants Minimise use of anti-foulants Minimise use of sacrificial anodes Use low toxicity grout Minimise contact of grout with water Minimise quantity of grout used
Accidental contamination (hydraulic fluids or vessel fuel/cargo)	OD	Design devices to minimise risk of leakage of pollutants Risk assessment and contingency planning Design to reduce risk Avoid shipping routes and other areas of potential high collision risk
Marine Noise	OD CD CC	Minimise use of high noise emission activities such as impact piling Avoid installation during sensitive periods Use full sound insulation on plant equipment device design. Underwater noise during operation may be beneficial in alerting species to the presence of the device, reducing the risk of collisions. This requires further research.
Increased predation (mink)	OD	Design device so that no potential platforms are available to mink at sea level.

## C8.7 Likelihood of Occurrence

Based on the information currently available to inform the assessment of impacts of marine renewable energy development on marine birds, the likelihood of occurrence of such impacts is difficult to determine.

It is likely that marine birds will be present within the areas identified as of interest for wave and tidal energy development, and they are therefore potentially vulnerable to impacts associated with interactions with the devices. Tidal schemes in particular are likely to be situated in areas that are particularly favoured by marine birds, which preferentially forage in areas of high tidal activity (Daunt *et al.* 2006).

With regard to the potential effect on ground nesting birds, should mink be able to use devices with surface structures as “stepping stones” to islands where they are not currently present. This effect is considered extremely unlikely to occur in the Pentland Firth between the mainland and Orkney, as it is extremely unlikely that installation of devices 2 km apart will be possible across this busy shipping area. Whilst the installation of devices in the waters adjacent to Barra could be more likely, SNH is currently taking steps to remove the mink population from the southern western isles, which would remove this as a potential effect in this area. Furthermore, there is currently no documented evidence to indicate that mink would use man-made structures as stepping stones in order to colonise offshore islands.

## C8.8 Confidence and Knowledge Gaps

In general, only a low confidence can be placed on the significance of impacts on seabirds. This is due to both a limited understanding of bird distribution at sea, of the possible interactions, and implications of interactions with devices.

### C8.8.1 *Baseline Data*

#### C8.8.1.1 Distribution and Behaviour of Birds at Sea

The breeding distribution of most marine bird species is well established, the exceptions being the two storm-petrel species whose colonies may have been overlooked and are difficult to survey.

At sea, distributions of seabirds from surveys carried out over the past 20 years are held in the European Seabirds at Sea (ESAS) database. However, these are not generally adequate for assessment of important areas for birds in relation to renewable energy schemes because the data are patchy and of too broad a scale in all seasons.

Marine birds use the sea for a variety of different activities, notably loafing (including preening and social behaviour), feeding, or on passage. To interpret the importance of an area it is imperative to establish what it is utilised for. For example, it may be that birds have more flexibility with passage routes than foraging locations. However, the ESAS contains limited information on the activity of birds surveyed, making it problematic to establish how birds utilise different areas.

Recent work by JNCC has aimed to establish the size of areas used seaward of colonies for loafing. Distribution of rafts of birds close to the colony have been surveyed in some detail using boat-based surveys and radio-tracking, leading to recommendations that breeding colony SPAs should be extended out by a distance of 1 km for common guillemot, razorbill and Atlantic Puffin (McSorley *et al.* 2003), 2 km for gannets (McSorley *et al.* 2003) and 4-9 km for Manx shearwaters (depending on colony, McSorley *et al.* 2006).

However, much less is known about foraging distributions of marine birds, both during the breeding season and over the winter. As stated previously, marine birds congregate in areas of high tidal activity (as these are generally areas of high productivity), but data are lacking on the precise location of hotspots. Centre for Ecology and Hydrology (CEH) and the Royal Society for the Protection of Birds (RSPB) are developing a foraging model of breeding seabirds, parameterised from data from birds breeding on the Isle of May in the Firth of Forth that may be informative in estimating foraging areas of birds breeding in SPAs in the SEA area.

Recent research suggests that hotspots (key foraging locations for multiple top marine predator species) are quite limited spatially (Scott *et al.* 2005). Some of these locations may only be obvious or represent critical habitat on a seasonal basis, but are essential for the successful transfer of food resources through multiple trophic levels. Identifying the locations of hotspots and determining what level of change will affect their unique properties may be a very efficient method to greatly increase the certainty in the environmentally sound deployment of the off-shore renewable industries. It is understood that research is currently underway by Dr Beth Scott at Aberdeen University to increase understanding of this issue. The results of this research, when available, will be useful in determining key marine bird foraging areas.

### C8.8.2

#### Potential Interactions with Devices

There is little empirical data on the direct and indirect impacts of wave and tidal energy schemes on birds described in the previous section. Currently, we must rely on lessons learned from wind farm schemes, and of our understanding of the marine environment and how marine birds use it. There is an imperative need to quantify these effects.

Identified data gaps, and opportunities for filling the data gaps are given in Table C8.8 below.

**Table C8.8: Data Gaps - Marine Birds**

Data Gap	Unknown	Potential to Fill Data Gap
Seabirds distribution and abundance	Fine-scale distribution in most areas. Information on vertical distribution, hotspots and swimming behaviour within the water column is required. Local demographic trends in bird populations	Individual project related site specific survey.
Bird distribution within the water column	The data collected on depth usage by marine birds is exclusively on breeding birds in summer. These findings should not be extrapolated to other times of the year. For example, cormorants in polar regions make shallower dives on average in winter than in summer (Grémillet <i>et al.</i> 2005b). Nothing is known about the depth usage of juvenile birds, which tend to have lower foraging proficiency so may forage more extensively at night than adults to compensate.	Individual project related site specific survey.
Capacity of key senses in birds, and abilities to detect devices	Effects of turbidity on use of vision and switching to dependence on other senses not known Importance of sound underwater. Some data on above surface detection abilities of birds in flight exists. There is no similar data for birds underwater.	Observation / monitoring of appropriately sited demonstration devices deployed in the field.
Collision risk – behavioural response of marine bird species to marine renewables.	Some data on above surface evasion behaviour of birds in flight. There is no similar data for birds underwater. Behaviour outside the breeding season and in younger age classes is poorly understood	Observation / monitoring of appropriately sited demonstration devices deployed in the field.
Ecological impacts	Implications for habitat exclusion, especially in favoured habitats. Long-term impacts of short-term behavioural responses	Observation / monitoring of appropriately sited demonstration devices deployed in the field.
Physiological impacts	Magnitude of collisions required to cause significant injuries. Relative vulnerabilities of different parts of the body in different species. Potential collision rates in bird populations.	Observation / monitoring of appropriately sited demonstration devices deployed in the field.

## C8.9 Residual Significance of Effects

The table in this section summarise the overall significance of the potential effects identified for marine birds in the study area, and indicates how the residual effects might be reduced through the application of appropriate mitigation. As previously stated, the assessment of significance has been limited by a number of factors which need to be borne in mind when reading the significance tables.

The significance assessment applies the precautionary approach to assessment of impacts and therefore, for the most part, presents maximum potential effects. However, confidence in the significant assessment is limited by the following factors.

- Spatial data on important areas for birds are limited to the areas designated as SPAs
- There is very limited information on the sensitivity of marine birds, and behavioural responses of marine birds to wave and tidal devices.

Table C8.9 below, summarises potential and residual effect significance, possible mitigation, and confidence for the key possible effects identified in the preceding sections, and provides an overview of effects over the entire study area.

**Table C8.9: Potential and Residual Significance of Effects - Marine Birds**

Potential Effect	Device Characteristics	Development Phase	Receptor	Potential Significance of Effects	Industry Good Practice Mitigation	Likelihood of Occurrence	Residual Significance of Effects	Confidence
Collision risk (construction)	All wave and tidal	CD CC	Diving birds and surface birds	Minor	Avoid of sensitive sites and seasons; increase vessel visibility; avoid night working	High	Negligible	Low
Physical disturbance (construction)	All devices and cables	CC CD	Breeding birds (breeding) Foraging and loafing birds (non breeding)	Major Moderate	Avoid sensitive areas and seasons	High	Minor	Low
Marine noise (construction)	Piled devices	CC CD	Surface birds and diving birds	Unknown	None identified	Unknown	Unknown	Low
Increased suspended sediment and turbidity (reduced visibility)	Piled devices and cables	CD CC OD	Diving birds	Negligible	None identified	High	Negligible	Low
Collision risk (operation)	All wave and tidal	OD	Surface birds and diving birds	Major	Increase device visibility	Unknown	Unknown	Low
Marine noise (operation)	All wave and tidal	OD	Surface birds and diving birds	Unknown	None identified	Unknown	Unknown	Low
Habitat exclusion (operation)	All wave and tidal	OD	Surface birds and diving birds	Major (during breeding season) Moderate (outside breeding season)	Avoid sensitive areas	High	Minor	Moderate

Potential Effect	Device Characteristics	Development Phase	Receptor	Potential Significance of Effects	Industry Good Practice Mitigation	Likelihood of Occurrence	Residual Significance of Effects	Confidence
Contamination from anti-fouling paints and sacrificial anodes	Devices using anti-foulants and sacrificial anodes	OC	Surface birds and diving birds	Negligible	None identified	Low	Negligible	Moderate
Accidental contamination (hydraulic fluids or vessel fuel/cargo)	Devices using hydraulic fluids	CC CD OD	Surface birds and diving birds (particularly auks and divers)	Major	Device design to minimise risks	Very Low	Minor	Moderate
Creation of resting and breeding habitat	Devices with surface structures	OD	Surface birds	Unknown	None identified	Unknown	Unknown	Very Low
Foraging opportunities	All wave and tidal devices	OD	Diving birds	Unknown	None identified	Unknown	Unknown	Very Low
Increased predation (mink)	All wave and tidal devices	OD	Ground nesting birds	Major	Device design	Very low	Negligible	Very Low

CD = Construction/decommissioning impact – devices

CC = Construction/decommissioning impact – cables

OD = Operation impact – devices

OC = Operation impact – cables

## C8.10 Recommended Baseline Survey and Monitoring

### C8.10.1 Introduction

Targeted survey and monitoring of marine birds associated with a specific development will need to be determined and agreed as part of the EIA and consenting process, but some suggested aspects that this would need to take account of are given below. In each case, it is important that the surveying protocols and post-construction monitoring methodologies agreed upon need to be both scientifically and statistically robust.

COWRIE have recently produced a standardised methodology for bird surveys, which is designed to provide a statistically robust spatial and temporal comparison of the variety of different aerial and boat-based sampling techniques (and variation within techniques), determining the relative strengths and weaknesses of each across a representative range of locations in UK waters (Kees *et al*, 2004).

### C8.10.2 Baseline Survey

The ultimate aim of monitoring is to establish the impact of energy schemes on population size of local marine birds. This is a challenging aim because to establish impacts on population size takes many years in long-lived species such as marine birds (e.g. fulmars only commence breeding at several years of age, and may live to be over 50 years old).

Therefore, the first main aim would be to establish the importance of a proposed area for development to the birds' ecology prior to installation taking place. This is achieved by surveying the area and control areas adjacent to it. The available technologies for measuring bird populations in a given area are listed below:

- **Surveys:** ship-borne or aerial line transects surveys. The former is expensive, slow and comprehensive; the latter is cheaper, covers a wider area but is less comprehensive.
- **Shore-based counts**
- **Radar:** this technology has been used recently to establish distributions of birds at sea
- **Animal-borne instrumentation:** by attaching data loggers or transmitters to breeding animals, precise location and activity can be recorded. The disadvantage over surveys is the small sample sizes.

Details on methodologies on surveys and shore-based counts can be found in Kees *et al.* (2004), Camphuysen *et al.* (2004), Collier *et al.* (2005) and Cranswick *et al.* (2005). Abundance is determined from distance sampling (Buckland *et al.* 2001) and density from geostatistical interpolation (Cressie 1991). Details of how these analyses are used for marine bird surveys can be found in McSorley *et al.* (2005) and Webb *et al.* (2006). Details on animal-borne instrumentation, and the relative merits of surveys versus data loggers, can be found in Daunt *et al.* (2006). An example of how density can be obtained from animal-borne instrumentation can be found in Matthiopoulos *et al.* (2004).

Secondly, information on demographic trends could also be required to allow for the impact of energy schemes on population size, of the local birds population to be determined. This would measure the extent to which variation in population size is driven by adult survival, breeding success, emigration or immigration. Population size is the simplest currency to measure, but tells you little about the underlying mechanisms. A survey of demographic trends would need to monitor a range of colonies, so that movements between them can be assessed. Demographic studies are time-consuming and results for long-lived species may only become apparent after several years.

### C8.10.3

#### *Monitoring*

Once the baseline has been established, the programme of monitoring marine bird distributions in relation to the development and control sites, and assessment of demographic parameters and population size at local colonies, could continue during device installation and operation. Surveys such as this will establish the potential positive or negative impacts the scheme will have indirectly on the birds, by altering their foraging conditions and potentially their population size.

Should monitoring direct effects of installation be required, the impact of collisions on marine birds should be monitored in a systematic fashion, for example using underwater cameras, to be deployed under the full range of diurnal and tidal conditions. The distribution of birds in relation to the magnitude and distribution of noise should also be monitored systematically. The presence of any contaminants such as oil resulting from the installation is likely to be monitored in an ad-hoc fashion immediately following the escape, so ideally contingency funds should be in place to carry out such a survey.

#### C8.10.3.1

##### Survey Area

The extent of the buffer area around the development where monitoring should take place will depend on the size of the area, and the species of birds recorded prior to development. It is unlikely that any buffer zone should be less than 1 km and in many situations should be greater than this, particularly when the area is frequented by species more sensitive to human disturbance, such as divers.

### C8.10.3.2 Frequency of Monitoring

It is not possible to give an exact estimate of the frequency of monitoring, because it will be dependent on the variation present in the data (i.e. bird distributions). It is strongly recommended that statistical power analysis is carried out prior to any monitoring. This will aid in assessing the confidence in establishing patterns from the data obtained, and will facilitate decisions on the number of repeated surveys required (Skov & MacLean in prep). An example of both consistencies and variation in distribution and numbers can be seen in the repeated aerial surveys over the last four winters of divers, Grebes and water duck carried out by JNCC (Dean *et al.* 2003, 2004a, 2004b, Wilson *et al.* 2005).

### C8.10.3.3 Length of Time for which Monitoring Required

The length of time monitoring is required will depend on whether only the short-term impacts of direct and indirect schemes on individual birds are assessed, or the long-term impacts of these effects on demographic parameters and ultimately population size. Should the latter be assessed, monitoring of demography at local colonies, and of foraging locations and behaviour at sea, would need to continue for several years prior to and after installation has taken place.

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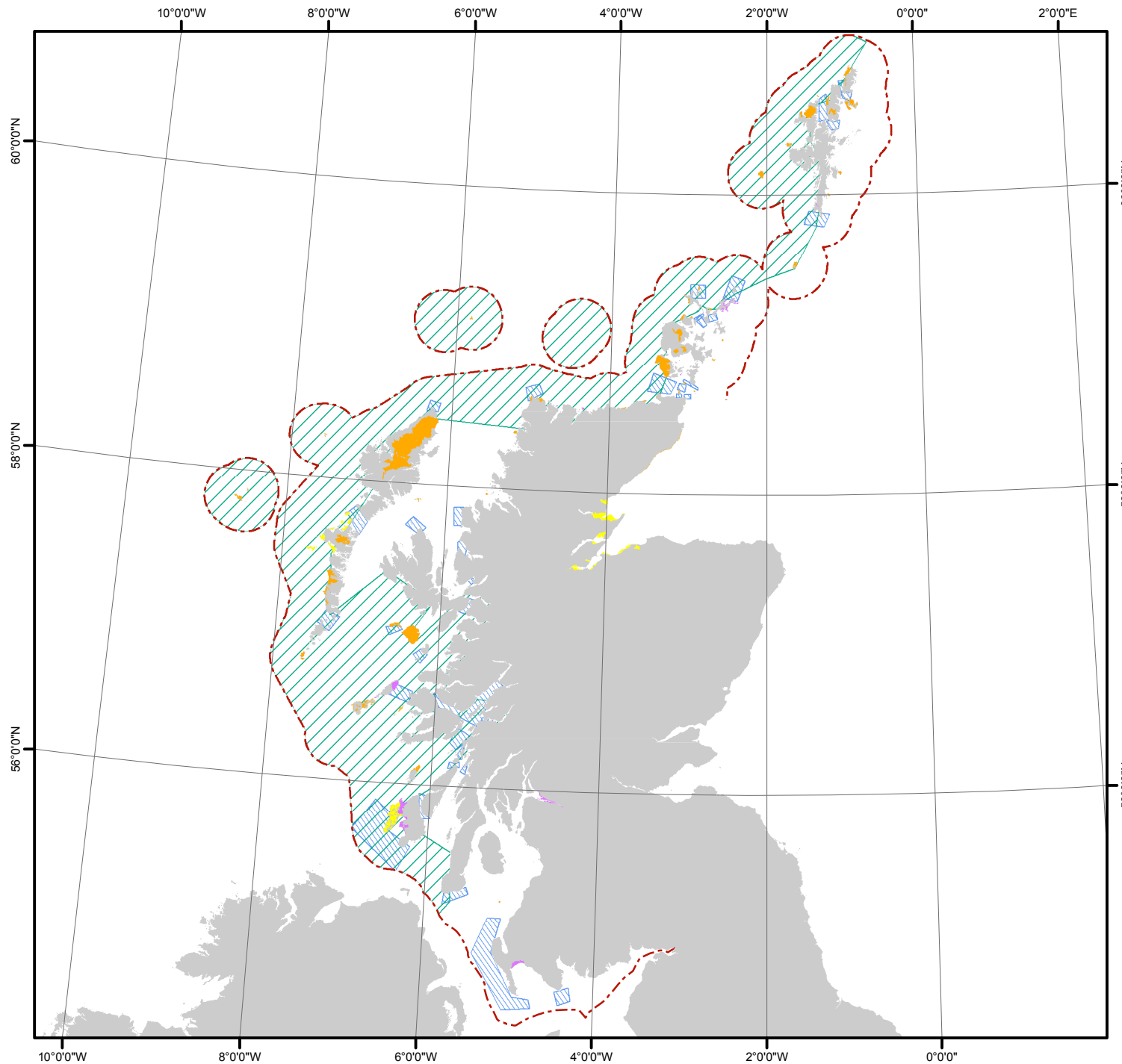
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# Figures

Figure C8.1: Distribution of SPAs designated for the protection of birds in the study area



**Legend**

Special protection areas

- Breeding
- Breeding and Wintering
- Wintering

Potential development area

- Tidal resource
- Wave resource

Land

12 Nautical mile limit (study area only)

Date	8th February 2007	
Projection	Transverse Mercator	
Spheroid	Airy	
Datum	OSGB36	
Data Source	SNH and SMRU (seal counts), Matthiopoulos et al. 2004 (grey seals at sea), SNH (SSSI data), JNCC (SAC data)	
File Reference	P736\GIS\Mxd\SEA\Baseline maps	
Checked	SH	GIS Specialist
	FLB	Project Manager